

*The Wilson Journal of Ornithology* 120(3):641–645, 2008

## Diet of the Long-eared Owl in the Northern and Central Negev Desert, Israel

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**ABSTRACT.**—This is the first report of the diet composition of Long-eared Owl (*Asio otus*) in the northern and central Negev desert, Israel. The diet consisted of 71.3% small mammals, 26.5% birds, 2.0% invertebrates, and 0.1% reptiles. There were no significant differences among the seven localities studied or among seasons in percent rodents or invertebrates in the diet. However, the proportion of psammophilous rodents within the diet was larger in settlements where the soil was sand or sandy-loess and smaller where the soil was loess or rocky. Percent birds in the diet did not differ among localities, but differed among seasons. Migratory birds formed a significantly larger part of the total birds consumed during migration than during the non-migratory months. *Received 15 August 2007. Accepted 24 December 2007.*

The Long-eared Owl (*Asio otus*) is a Holarctic, nocturnal bird of prey whose diet has been extensively studied in North America and Europe. The literature on its diet indicates that it feeds mainly on rodents, especially voles, and other small mammals, complemented by other animals, including birds and invertebrates (Cramp and Simmons 1985). It forages in the open, but also hunts near and below trees (Cramp and Simmons 1985) where it feeds on birds that roost in trees. In Israel there are resident, migratory, and wintering populations of Long-eared Owls (Paz 1987, Shirihai 1996). The species inhabits most low-lying areas in Israel, chiefly in the Mediterranean region, but also in agricultural settlements in the desert during the last three decades. This species prefers semi-open areas in Israel such as agricultural settlements, plan-

tations, and patches or lines of trees (Shirihai 1996). The diet of the Long-eared Owl has not been studied in Israel. We collected data on the diet of the Long-eared Owl and report on the composition of the diet in the northern and central Negev desert, Israel.

### METHODS

We studied Long-eared Owls in the northern and central Negev, Israel, a relatively arid region where rain occurs only during winter (Nov–Apr). Annual precipitation ranges between 300 mm in the north to 100 mm in the south and varies greatly from year to year. Mean monthly temperature ranges between 26° C in July and 11° C in January (Jaffe 1986).

We located communal winter roosts of Long-eared Owls and nesting sites during the breeding season in or near agricultural settlements; these were visited once or twice every month between May 2002 and December 2003. Long-eared Owls roost in dense vegetation which, in our study area, occurs only in settlements. All pellets were collected during each visit and the area was cleaned of pellets and remains of prey; each collection was composed of “fresh” pellets accumulated since the last visit. Each pellet was placed in a separate bag and its date and locality were recorded. All pellets were allocated to one of four seasons: winter (Dec–Feb), spring (Mar–May), summer (Jun–Aug), and autumn (Sep–Nov). Pellets were identified by their gray or light-black color and relatively (in comparison with those of the sympatric Barn Owl [*Tyto alba*]) narrower width, and with duller color. Pellets where species identification was not clear were not used. Each pellet was either separated to its components in the laboratory using tweezers or soaked in water until the remains, and cranial and post-cranial elements

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could be separated. Species identification was by comparison with identified specimens in the collection of the Zoological Museum of Tel Aviv University and the collection of The Hebrew University of Jerusalem.

We treated each single pellet as a unit containing the remains of the complete portion of food eaten. Bones of one prey item under field conditions usually appear in one pellet and only rarely are they discarded in two or more pellets (Raczyński and Ruprecht 1974). However, there is the possibility that owls will cache large prey items and return to them later. In these cases, over estimation of the large prey items would occur using our pellet analysis. Our data suggests that over estimation could have occurred for only one prey species (*Rattus rattus*) in one locality (Nirim).

The main identifiable elements were crania, mandibles, and femura for mammals, skulls and humeri for birds, mandibles for reptiles, and exoskeleton pieces for invertebrates. The minimum number of individuals (MNI) was calculated from the most common element for every species. All remains in the pellets were identified to the lowest possible taxon. Differences between species were often small and most remains were identified to genus. A small proportion (2–11%) of post cranial remains could not be identified to genus. These remains belonged to either *Meriones* or *Gerbillus* (Gerbilidae) and we divided them between the two genera by their relative amount actually found in the identifiable remains. Identified bird species were categorized by their status in Israel (residents or migrants). However, some bird genera and even species have both resident and migratory populations in Israel. The remains in these cases were categorized to the status of the most common species in the genus in the study area.

The seven settlements from which we collected pellets were (number of pellets collected in parentheses): Sde Boqer 30° 52' N, 34° 48' E (280 pellets), Revivim 31° 03' N, 34° 44' E (380), Gevulot 31° 12' N, 34° 28' E (340), Tse'elim 31° 12' N, 34° 32' E (97), Tzohar settlements (a group of 6 settlements within 1–2 km) 31° 14' N, 34° 25' E (480), Omer 31° 17' N, 34° 50' E (157), and Nirim 31° 19' N, 34° 22' E (1,300).

All but one (Omer) of the sites were agricultural settlements, and all had ornamental

trees, bushes, and grass lawns. The surrounding fields contained agricultural crops (potatoes, peanuts, carrots, etc.) as well as plantations (olives, avocado) and had lines of or scattered ornamental trees (various genera of palms, *Tamarisk* ssp., *Acacia* ssp.). The natural small mammalian fauna consists of several species of rodents and shrews with a strong psammophilous element where loess soil was mixed with sand. Commensal rodents (mice and rats) were also present.

We used two-way ANOVA tests for each of the three food categories (rodents, invertebrates, and birds) to test if there were differences in diet composition among localities and seasons. We used the Shannon-Wiener Index to calculate a value for diet diversity for each locality and two-way ANOVAs to test differences in diet diversity among localities and seasons.

## RESULTS

We collected 3,034 pellets of Long-eared Owls, comprising 4,668 prey items with a composition of 71.3% small mammals, 26.5% birds, 2.0% invertebrates, and 0.1% reptiles (Table 1). There were no significant differences among localities or among seasons in percent rodents ( $P$ -values were 0.331 and 0.076, respectively) nor in percent invertebrates ( $P = 0.513$  and  $P = 0.473$ , respectively) in the diet. Percent birds in the diet did not differ among localities ( $P = 0.144$ ), but differed among seasons ( $P = 0.037$ ). There were no significant differences in diet diversity (Shannon-Wiener Index) among localities ( $P = 0.290$ ) or among seasons ( $P = 0.803$ ).

There were no differences in percent rodents (as a group) in the diet among localities, but rodent genera composition differed among localities: percent *Gerbillus* among rodents changed from 63–70% in Gevulot, Revivim, and Tse'elim to 43% in Tzohar, and 16% in Sde Boqer, and only 1–2% in Nirim and Omer, while the proportion of *Meriones* was highest (42–46%) in Nirim and Omer, 17–20% in Revivim, Tse'elim, Gevulot, and Tzohar and 10% in Sde Boqer. *Jaculus* composed 9, 6, and 1% in Revivim, Sde Boqer, and Gevulot, respectively. Commensal species comprised 67% (*Mus* only) of the rodents in Sde Boqer, 56% (30% *Mus* and 26% *Rattus*) in Nirim (with a possible risk of over estimation

TABLE 1. Genera and species identified in Long-eared Owl pellets. ( $n$  = number of individuals in each taxonomic class; % = percent of these individuals among the total number of individuals in the pellets).

Mammalia ( $n$  = 3,327; 71.3%)

Rodentia

*Acomys* spp.  
*Gerbillus* spp.  
*Jaculus jaculus*  
*Meriones* spp.  
*Microtus guentheri*  
*Mus musculus*  
*Rattus rattus*  
*Spalax ehrenbergi*

Soricomorpha

*Crocidura* spp.

Chiroptera

*Otonycteri hemprichii*  
*Pipistrellus* spp.

Aves ( $n$  = 1,236; 26.5%)

Passeriformes

Alaudidae sp.  
*Carduelis carduelis*  
*C. chloris*  
*Cercomela melanura*  
*Emberiza* spp.  
*Fringilla coelebs*  
*Hippolais* spp.  
*Hirundo* spp.  
*Lanius* spp.  
*Motacilla* spp.  
*Nectarinia osea*  
*Oenanthe* spp.  
*Passer domesticus*

Coraciiformes

*Merops apiaster*

Galliformes

*Coturnix coturnix*

Reptilia ( $n$  = 3; 0.1%)

Squamata

Gekkonidae sp.  
 Scincidae sp.

Insecta ( $n$  = 93; 2.0%)

Blattodea

Blattidae sp.

Coleoptera

Scarabaeus spp.  
 Curculionidae sp.

Hymenoptera

*Dorylus fulvus*

Mantodea sp.

Orthoptera

Gryllidae sp.  
*Gryllotalpa gryllotalpa*

Arachnida ( $n$  = 2; 0.0%)

Solifugae sp.

Unidentified ( $n$  = 7; 0.1%)

of *Rattus* in the pellets), 52% (42% *Mus* and 10% *Rattus*) in Omer, and 37, 18, and 11% in Tzohar, Tse'elim, and Gevulot, respectively.

We found a total of 1,236 bird remains (Table 1) and identified 881 of them. These belonged to at least 23 species, and between 31 and 85% of which (depending upon location) were House Sparrows (*Passer domesticus*). Percent birds in the diet differed significantly among seasons. The number of remains of resident birds was 156, 92, 203, and 295 in autumn, winter, spring, and summer, respectively, while the respective numbers for migrants were 33, 11, 73, and 18. The number of resident bird remains was similar during the migratory (spring and autumn) and non-migratory (winter and summer) seasons (359 and 387, respectively), but the number of migrant remains, which consisted mainly of small passerines, was 3.7 times larger during the migratory seasons than during the non-migratory period (106 and 29, respectively). Thus, migratory birds comprised a significantly larger part (of the total birds consumed) during migration than during the non-migratory months (Fisher's exact test,  $P = 2 \times 10^{-11}$ ).

## DISCUSSION

The diet of the Long-eared Owl in North America, Europe, and Japan is composed mainly of voles (Glue and Hammond 1974; Marti 1974, 1976; Nilsson 1981; Village 1981; Marks 1984; Bosakowski and Smith 1991; Tome 1994; Capizzi et al. 1998; Alivizatos and Goutner 1999; Navarro et al. 2003; Chiba et al. 2005). The one species of vole in the Mediterranean region in Israel (*Microtus guentheri*) is not found in the desert and occurs only in the northern part of our study area. We found only three voles in the diet of the Long-eared Owl (at Nirim, the most northern of our localities). The main species of prey in our study area were gerbils, jirds, mice, and rats. We believe the proportions of rodent species in the diet of the Long-eared Owl reflects the composition of the rodent communities where the pellets were collected. The soil in our study area is either sand or loess (wind deposited) or a mixture of different proportions of these two types. There are four species of psammophile *Gerbillus* (*G. pyramidum*, *G. allenbyi*, *G. gerbillus*, and *G. henleyi*) and one non-psammophile (*G. dasyurus*) that

occurs mainly in rocky habits. The diet of the Long-eared Owl in areas where the soil was sandy or had a large proportion of sand (Revivim, Gevulot, and Tse'elim) was mainly *Gerbillus* (63–70% of the rodents in the diet), while in loess-dominated areas (Nirim, Omer, Sde Boqer) it was below 17%. The proportion of *Gerbillus* constituted 43% of the rodents in Tzohar, where the soil is sandy-loess. *Gerbillus* was replaced by other rodents, mainly *Meriones*, where the soil was not sandy. Commensal rodents (house mouse [*Mus musculus*] and black rat [*Rattus rattus*]) comprised >50% of the diet in Sde Boqer, Nirim, and Omer. The high proportion of house mice in the diet in Sde Boqer is explained by a mice plague that occurred there in 2003, while the high proportion of commensal species in Omer is probably the result of this being an urban suburb of the city of Beer Sheva. Jerboas (*Jaculus jaculus*) occur on both types of soil, and occurred in a low proportion in Revivim (sand) and Sde Boqer (loess).

The numbers of resident bird remains were similar during the migratory (spring and autumn) and non-migratory (winter and summer) seasons (359 and 387, respectively). The number of remains of migrant birds was 3.7 times larger during the migratory season than during the non-migratory period (106 and 29, respectively).

The Long-eared Owl has been characterized as having a more specialized diet than other sympatric owls (Marti 1976, Andrews 1990). Other studies (Marks 1984, Bertolino et al. 2001) demonstrated that Long-eared Owls feed opportunistically. Our study indicates the diet of the Long-eared Owl in the northern and central Negev desert consists mainly of rodents (71.3%), but also of birds (26.5%). The proportion of psammophilous rodents within the diet was large in settlements where the soil was sand or sandy-loess, and small where the soil was loess or rocky, and the proportion of migratory birds was 3.7 times larger during migratory seasons than during non-migratory periods. These variations reflect the availability of the different prey types, and suggest a noticeable plasticity and an opportunistic feeding behavior of the Long-eared Owl.

## ACKNOWLEDGMENTS

We are grateful to Yoav Motro, Miriam Belmaker, Noam Leader, Mali Tores, Eran Levin, Leonid Friedman, Asaf Tsoar, Boaz Shacham, Igor Gavrillov, and three reviewers for their help, advice, and comments.

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*The Wilson Journal of Ornithology* 120(3):645–648, 2008

## First Observed Instance of Polygyny in Flammulated Owls

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**ABSTRACT.**—We document the first observed instance of polygyny in Flammulated Owls (*Otus flammeolus*) and the first among insectivorous raptors. Chronologies of the male's two nests, which were 510 m apart, were separated by nearly 2 weeks. Each brood initially consisted of three owlets, similar to the mean brood size in monogamous pairs. The male delivered considerably fewer prey to the secondary nest, compared with prey-delivery rates at nests of monogamous males during the nestling period. Evidence suggested that all owlets fledged from the primary brood, but only one fledged from the secondary brood. We were uncertain of the cause of polygyny, but a possible explanation is the Hayman Fire shifted the operational sex ratio of the owls in favor of females. The extent of polygyny in Flammulated Owls may be limited by costs to the reproductive success of secondary females. Received 10 February 2007. Accepted 22 December 2007.

Facultative polygyny has been reported in nine species of strigiforms (Korpimäki 1983; Solheim 1983; Marti 1990; Marks et al. 1989, 1999, 2002), most of which feed primarily on

small mammals. We document the first observed instance of polygyny in Flammulated Owls (*Otus flammeolus*), insectivores that feed primarily on moths (Reynolds and Linkhart 1987). This owl is a neotropical migrant, breeding in western North America and wintering as far south as Central America (McCallum 1994). Flammulated owls are cavity nesters and, in Colorado, breed in mature conifer forests dominated by ponderosa pine (*Pinus ponderosa*) (Linkhart 2001). The objective of this paper is to describe the polygynous event, and compare provisioning rates and fledging success at the male's two nests.

## OBSERVATIONS

We initiated a study in 2003 of recolonization by Flammulated Owls of the area affected in the Hayman Fire, which burned the largest area (560 km<sup>2</sup>) in recorded Colorado history in 2002 (Graham 2003). We located four territorial males in 2004, each of which occurred within a small parcel (20–30 ha) of unburned forest, and each separated by 7–20 km. One territorial male exhibited polygynous behavior, defined as a male feeding two females and their young at different nests at which no other male was detected. The two nests were 510 m apart, a distance somewhat greater than the mean ( $\pm$  SE) diameter of territories of monogamous males (428  $\pm$  29 m; Linkhart 2001). We discovered the nests, both of which were in natural cavities in aspen (*Populus tremuloides*) trees, on 22 June (CS2 nest) and 12 July (CS1 nest) after hearing

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adult feeding vocalizations near each nest. We captured and banded the CS2 female (USGS aluminum leg band #418) on 12 July, and the CS1 female (#381) on 13 July while each was day-roosting in her nest cavity. We captured the male with a small mist net (Reynolds and Linkhart 1984) on 15 July as he exited the CS1 nest at 1949 hrs MST and banded him (#419). We presumed he had delivered prey to the brooding CS1 female because his flight to the nest was preceded by food location calls, a distinctive sequence of behaviors shown by nesting males (Reynolds and Linkhart 1984). We captured the same male as he exited the CS2 nest at 2150 hrs following a presumed prey delivery. The male was not recaptured thereafter, but observations indicated he was the sole male tending the nests over the remainder of the nestling period. First, we observed only a banded male visiting the nests and the distance (7 km) to the nest of the closest banded male was sufficiently great (~6 times the maximum observed flight distance of radio-marked males; BDL, unpubl. data) that visits by other banded males were unlikely. Second, the male gave food location calls from the same particular perches near nests and we noted no deviations from this pattern that might suggest a second male. It also was unlikely a second male tended either nest prior to its discovery, since cooperative breeding is not known in this species (McCallum 1994).

Each brood initially consisted of three owlets, similar to the mean brood size in monogamous pairs ( $2.5 \pm 0.1$  owlets) (Linkhart and Reynolds 2006). We estimated, based on patterns of plumage development and mass gain in broods of monogamous pairs (BDL, unpubl. data), the CS1 owlets were 13, 17, and 18 days of age on 13 July, and the CS2 owlets were 1, 2, and 5 days of age on 12 July. Thus, the chronologies of the nests differed by nearly 2 weeks.

The male delivered considerably fewer prey to the secondary nest (CS2) during the nestling period compared with prey-delivery rates at nests of monogamous males. The male delivered 5.3 prey/hr (8 prey in 1.5 hrs) on one night (13 Jul) during the mid/latter portion of the nestling period at the CS1 nest, a somewhat lower rate than that by monogamous males at this time (8 prey/hr; Reynolds and Linkhart 1987). The male delivered 1.1 prey/

hr (6 prey in 5 hrs) over three nights (12, 13, and 15 Jul) at the CS2 nest during the first week of the nestling period, which is much lower than by monogamous males at this time (7 prey/hr; Reynolds and Linkhart 1987). The male failed to deliver any prey to the CS2 nest in 2 hrs of observation on the last night of the nestling period (31 Jul). Each female delivered  $\leq 2$  prey/hr to her nest on the above nights, a similar rate to that of monogamous females (Reynolds and Linkhart 1987).

The evidence suggested that all owlets fledged from the CS1 nest, whereas only one fledged from the CS2 nest. The youngest owlet in the CS1 nest fledged on 20 July at ~20 days of age. We presume its two older siblings had fledged by this date, given that on 18 July the eldest owlet would have been ~23 days of age, which is the mean ( $\pm$  SD) duration ( $\pm 1$  day) of the nestling period in Flammulated Owls (Reynolds and Linkhart 1987). It was unlikely the older siblings perished due to poor health, given that mass and feather development of each owlet on our previous visit (13 Jul) had been comparable to other owlets of similar age. In contrast, only the eldest owlet (#420) fledged from the CS2 nest at 23 days of age (30 Jul) when it had 24% less mass but similar primary development to other owlets at this age ( $n = 10$ ; BDL, unpubl. data). The youngest owlet was missing when we visited the CS2 nest on 19 July and the second-eldest owlet was in poor condition, as indicated by having 42% less mass and a 70% shorter 5th primary feather compared to other 9-day old owlets ( $n = 18$ ; BDL, unpubl. data). Two days later (21 Jul), we found the second-eldest owlet dead in the nest (specimen saved; BDL).

## DISCUSSION

Our observations constitute the first reported instance of polygyny among insectivorous raptors. We were uncertain of its cause. One possible explanation is the Hayman Fire, which likely caused a significant loss of owl habitat (few trees, if any, survived in 51% of the forested area; Graham 2003), reduced the density of breeding males more than females, which are not territorial (Linkhart and Reynolds 2007). Polygyny occurred in passerines when the operational sex ratio shifted in favor of females (Greenlaw and Post 1985, Kempnaers 1994).

Polygyny has obvious potential benefits to the reproductive success of males, but the extent of polygyny among birds is believed to be most limited by costs to females (Orians 1969). Polygynous males often have reduced rates of provisioning at secondary nests compared to primary nests (Sejberg et al. 2000) with the possible consequence of reducing the reproductive success of secondary females (Johnson et al. 1993). Reduced provisioning by the male at the CS2 nest during the nestling period likely caused the mortality of two of the three owlets.

Reproductive success of female Flammulated Owls is particularly reliant on provisioning by males, not only because males provide most of the prey to nests during the nestling period, as is true with most owls (Marks et al. 1999), but also because most prey are small (~0.1 g) and are delivered singly to nests (Linkhart et al. 1998). Documenting mortality of nestling Flammulated Owls is uncommon in Colorado, as 95% (144 of 151) of banding-age owlets of monogamous males fledged from 1981 to 1999 (Linkhart 2001). Even more unusual is observing partial mortality within a brood, given there was just one other occasion when a portion of a brood died while the rest survived to fledge ( $n = 79$ ; Linkhart 2001).

Polygyny in species with biparental care is more likely when chronologies of nesting cycles are staggered, according to the 'asynchronous-settlement model' (Leonard 1990), because of the difficulty of provisioning multiple nests when chronologies are similar (Johnson et al. 1993). A potential tradeoff of staggered nesting chronologies is that nestlings in secondary broods fledge at later dates, which may reduce survival rates of young in species such as Flammulated Owls that migrate long distances (Rappole 1995). Fledglings cannot forage independently of parents until 4–5 weeks after fledging (Linkhart and Reynolds 1987). Thus, owlet #420 could not have departed for migration before early September when arthropod prey becomes increasingly scarce in Colorado (BDL, unpubl. data). Owlets from only three broods ( $n = 132$  broods) fledged at later dates than owlet #420 since 1981 (BDL, unpubl. data). This suggests there is strong selection against late fledging and, indirectly, against polygyny in this species.

## ACKNOWLEDGMENTS

The authors thank C. E. Braun, J. S. Marks, and S. O. Williams III for helpful comments on the manuscript. We thank Colorado College, the Hulbert Center for Southwest Studies, the Hughes Undergraduate Research Program, the Lois Webster Fund (Audubon Society), and the USDA Forest Service for funding. The Rocky Mountain Research Station provided lodging.

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*The Wilson Journal of Ornithology* 120(3):648–651, 2008

## The Giant Hummingbird (*Patagona gigas*) in the Mountains of Central Argentina and a Climatic Envelope Model for its Distribution

Henrik von Wehrden<sup>1,2</sup>

**ABSTRACT.**—I present the first published observations of the Giant Hummingbird (*Patagona gigas*) in the mountains of central Argentina. This species was recorded in early and late summer 2006 and 2007. This new range resembles other summer habitats of the species, which are in the Andes >500 km distant. A climatic envelope model configured with known locations obtained from the literature predicts a high probability of occurrence in its “new” range. *Received 11 July 2007. Accepted 18 October 2007.*

The Giant Hummingbird (*Patagona gigas*) is the largest hummingbird in the world. Its distribution includes Ecuador (Ortiz-Crespo 1974, King and Holloway 1990), Colombia (Woods et al. 1998), Peru and Bolivia (Kokshaisky 2001, Wester and Classen-Bockhoff 2006), Chile (Vasquez and Simonetti 1999), and Argentina (Acreche et al. 1998, Osés 2003). This species typically inhabits high mountain habitats (Fjeldså and Krabbe 1990, Barnett and Pearmann 2001) and most records

originate from the Andes. The altitudinal distribution of the species ranges to 4,600 m (Osés 2003) and is energy-driven (Fernandez and Bozinovic 2003). Narosky and Yzurieta (2003) indicate this species overwinters within the eastern lowlands of Argentina. However, all summer records originate from western Argentina in the vicinity of the Andes with important over-wintering habitats in north-western Argentina (Fjeldså and Krabbe 1990, Schuchmann 1999). A recent phylogenetic analysis of hummingbirds confirmed the species as being relatively isolated in relation to other hummingbird taxa (Altshuler et al. 2004). Osés (2003) classifies the species as comparatively primitive compared to other Trochilidae, which may be the reason for the variety of plants used by the taxon (Sahley 1996, Kokshaisky 2001, Schlumpberger and Badano 2005, Wester and Classen-Bockhoff 2006).

### OBSERVATIONS

The Giant Hummingbird was encountered in the lower ranges of the Sierras Grandes de Córdoba, in central Argentina on 11 February 2006 at an altitude of ~1,430 m elevation (31° 40' S, 64° 40' W). The large size, char-

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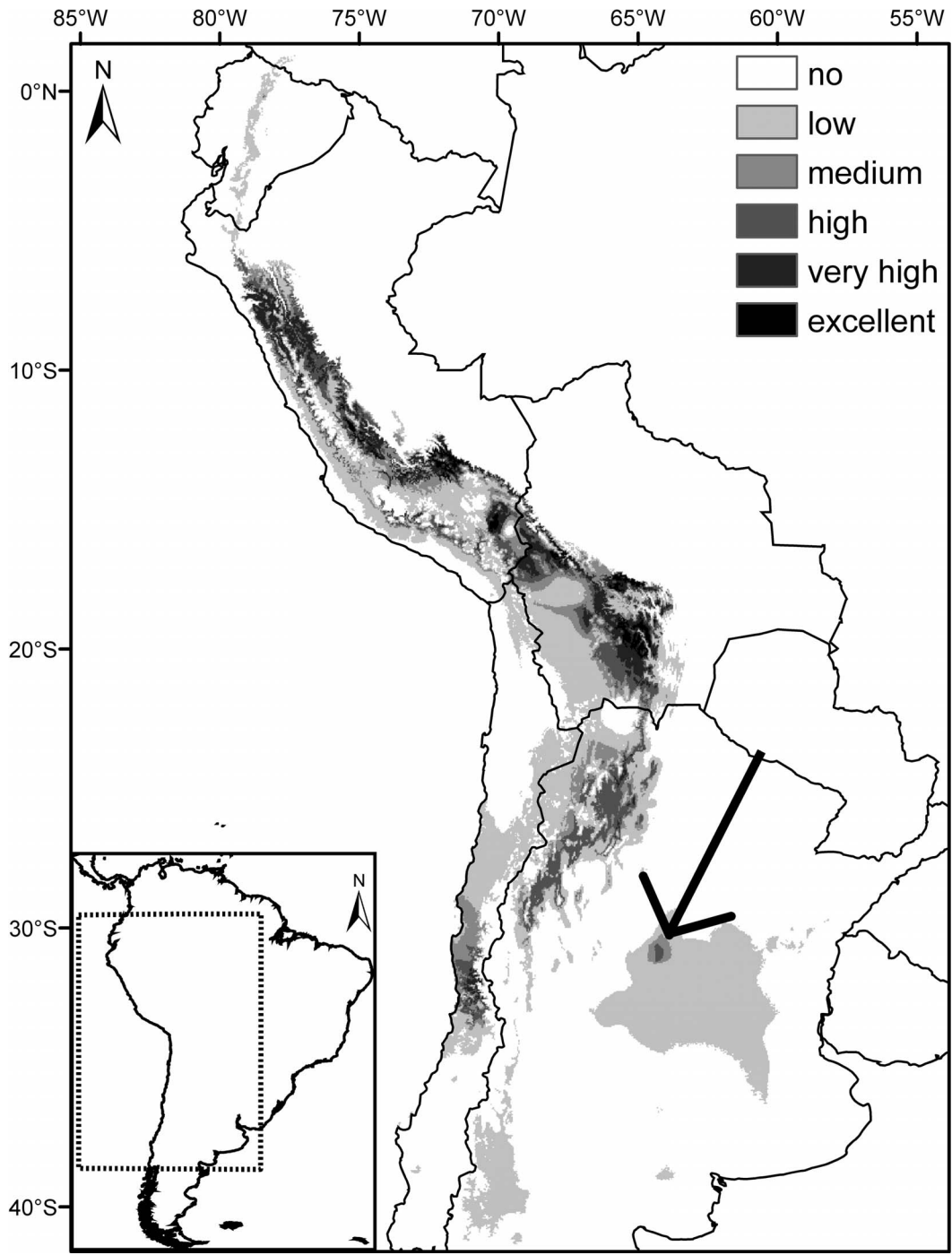


FIG. 1. Climatic envelope predicting distribution of the Giant Hummingbird in South America based on 99 known records. The arrow shows the area of the new records presented in this paper.

acteristic eye-ring, straight bill, and dull coloration made the identification definite (De La Pena and Rumboll 1998, Osés 2003). Further, the observed gliding flight is rather unusual within the Trochilidae. All other hummingbirds in the region are much smaller; the Red-tailed Comet (*Sappho sparganura*) was present, while the Blue-tufted Starthroat (*Helioaster furcifer*) and the Glittering-bellied Emerald (*Chlorostilbon aureoventris*) were observed at lower altitudes and are easily distinguishable.

The Giant Hummingbird was encountered in the same location on 3 days during summer 2007 (18 and 19 Feb, 3 Apr) with multiple observations each day. The species was seen nine times by the author on the first day and confirmed by other scientists. The habitat was heterogeneous grassland, which contained some shrubs and a few trees (mainly *Maytenus boaria*). Several flowering plants represented potential feeding sources for the hummingbird, yet it was most often seen feeding on *Siphocampylus foliosus* (Campanulaceae). The hummingbird was observed at a distance of <3 m, hovering close to the observers on several occasions. The species was also seen at another location closer to the mountain range at a distance of 4 km (1,630 m elevation) from the first site. The birds were observed resting frequently in trees at both locations. Weather conditions were variable and observations were made on clear sunny and misty rainy days.

#### DISCUSSION

A spatial data base was created to construct a climatic envelope model for the species based on data obtained from Osés (2003). The new observations presented here were not incorporated into this model. Thus, a presence only model was created, which is a standard tool within ecological sciences (Peterson 2001, Pearce and Boyce 2006). Annual mean temperature, annual precipitation, mean temperature of the warmest quarter of the year, and annual temperature range were used as predictors and a public domain climate model (Hijmans et al. 2005) was used to derive the spatial model.

The model predicted the species with a high probability for the mountains of central Argentina, where I observed the species (arrow

Fig. 1). I suggest the presence of the species in the area will be persistent since the species was present in both late and early summer over 2 years. The nearest known observations are from Salta (Acreche et al. 1998), San Juan (Contreras 1978), and Mendoza (Osés 2003) provinces, all of which are at a distance >500 km. The mountainous habitat where the observations were made resembles the known preference of the species, which is regarded to be selective for its habitat (Vasquez and Simonetti 1999). The observations support the unique island-like ecology of mountains of central Argentina (Nores 1995, Cabido et al. 1998). Thus, a permanent presence during the summer seems highly probable, which is also indicated by the climatic envelope model. The climatic distribution obtained from this model has a higher spatial resolution when compared to the standard literature. It demonstrates that climatic envelope models represent a valuable approach to identify the potential distribution of a species and helps researchers locate new distribution ranges. Model construction for other species might enhance our understanding of the distribution of these taxa as well.

#### ACKNOWLEDGMENTS

The author expresses gratitude to Heike Zimmermann and Heidi Hirsch for confirming his observation. Maurice Rumboll verified the record as new for the region. Danny McCluskey read earlier versions of this manuscript. Daniel Renison, C. E. Braun, and one anonymous referee provided helpful comments on the manuscript. The author thanks the Austrian Science Fund (Project P18624).

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*The Wilson Journal of Ornithology* 120(3):651–653, 2008

## Giant Hummingbirds (*Patagona gigas*) Ingest Calcium-rich Minerals

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**ABSTRACT.**—We report Giant Hummingbirds (*Patagona gigas*), regularly and deliberately, ingesting wood ashes and slaked lime in central Chile. These two minerals have high concentrations of calcium, which may be a scarce element in the nectar-based diet

of the species. Both observations occurred during the post-breeding period suggesting the birds were females ingesting calcium-rich compounds to replace minerals lost during eggshell production. *Received 31 March 2007. Accepted 10 November 2007.*

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The nectar-based diet of hummingbirds poses nutritional restrictions such as a limited

supply of proteins and some minerals. These nutrients are usually obtained from insects that hummingbirds include in their diet (Remsen et al. 1986). However, minerals may be lost at a much higher rate through the highly diluted urine of hummingbirds, or during egg production (Adam and des Lauriers 1998). The latter may cause hummingbirds to supplement their diet with mineral-rich compounds (Adam and des Lauriers 1998). We report two different observations of the Giant Hummingbird (*Patagona gigas*) deliberately ingesting calcium-rich minerals in central Chile.

#### OBSERVATIONS

We observed an adult Giant Hummingbird on several occasions during February 2005 (austral summer) visit a site where ashes from a barbecue had accumulated on the ground at the Pantanillos Forest Research Station (35° 32' S, 72° 17' W) near Constitución in central Chile. Our first impression was the bird was looking for insects but we soon realized it was apparently ingesting ashes. Each time the bird would sit on the ground and place its beak into the soil or at a short distance above the ground while licking the ashes with its tongue. The bird came to the site regularly, making 2–3 short visits (<2 min) during the morning (0800–1000 hrs) and afternoon (1700–1800 hrs).

MAV observed an adult Giant Hummingbird during most of February 2007 coming regularly to a wall of an old country house painted with slaked lime (calcium hydroxide) near the town of Quirihue (36° 20' S, 72° 38' W) in central Chile. The bird flew directly to two different spots in the wall where lime dust accumulated inside small crevices. At the spot closer to the ground (0.3 m) the bird would hover while licking the wall, whereas at the higher location (1.7 m) the bird would usually sit while reaching inside the crevice with its beak. Close inspection of these crevices failed to detect the presence of insects, spider webs or other nest building materials, which could be attracting the birds. The bird visited the site in the morning and in the afternoon, but made only one visit at each time of the day.

#### DISCUSSION

Calcium is one of the main components of wood ashes (des Lauriers 1994) and the slaked

lime dust, although probably mixed with dirt, was likely rich in calcium as well. We believe the observed birds were regularly and deliberately ingesting calcium-rich compounds.

We could not identify the gender of the birds because the Giant Hummingbird is sexually monochromatic with males and females differing only slightly in size (Araya et al. 1986). This is important because most records of hummingbirds ingesting calcium are of females (Verbeek 1971, des Lauriers 1994, Adam and des Lauriers 1998) that are likely trying to meet their requirements of calcium for eggshell production.

Our observations likely corresponded to birds in the post-breeding period as nesting for this species in this region normally occurs between October and January (pers. obs.). We cannot completely eliminate the possibility the birds were late breeders because, unfortunately, we did not look for nests. However, we doubt the latter was the case because the species migrates from the region in March.

It is believed that hummingbirds, being the smallest birds alive, do not have sufficient medullary bone for storing calcium for eggshell production (Adam and des Lauriers 1998). Ingestion of extraneous calcium by birds that cannot store calcium in medullary bones should peak near the period of maximum breeding activity (Dhondt and Hochachka 2001). Our observations suggest that Giant Hummingbirds were ingesting minerals to replace the calcium lost during eggshell production that had likely occurred 2–3 months earlier. It is possible the Giant Hummingbird, being four times heavier (18–22 g) than most hummingbird species (3–5 g), has a higher calcium storage capacity.

Ours are not the only observations of hummingbirds ingesting calcium after the breeding period. Verbeek (1971) reported a female Anna's Hummingbird (*Calypte anna*) feeding on calcium-rich sand more than a month after the last reported date for a clutch of the species. Most records of female hummingbirds apparently taking calcium are from the nesting period (des Lauriers 1994, Adam and des Lauriers 1998), including several Anna's Hummingbirds (Adam and des Lauriers 1998). We did not observe consumption of calcium by Giant Hummingbirds when nests are active

(Oct–Nov) during several years of work in both field sites.

Hummingbirds have been reported eating calcium-rich sand and soil (Verbeek 1971, Adam and des Lauriers 1998). Ash-eating behavior had been previously described for some North American hummingbirds (des Lauriers 1994) but, to our knowledge, there are no reports of this behavior for the Giant Hummingbird or any other hummingbird in the Southern Hemisphere. We believe the record of the consumption of slaked lime is the first for a hummingbird, and probably the second for a bird, after the observation reported by Richmond (1953) of Purple Martins (*Progne subis*) ingesting slaked lime from the ground in Oregon.

#### ACKNOWLEDGMENTS

We appreciate the comments of two anonymous referees.

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*The Wilson Journal of Ornithology* 120(3):653–654, 2008

## Nocturnal Foraging Observations of the Blue-crowned Motmot (*Momotus momota*) in San José, Costa Rica

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**ABSTRACT.**—We provide documentation on the first observations of nocturnal foraging by the Blue-crowned Motmot (*Momotus momota*). The motmot we observed mainly fed on sphinx (Sphingidae) moths; the capture rate seemed low for this fairly large prey. Received 27 April 2007. Accepted 26 October 2007.

Nocturnal foraging has only been reported once (Thurber and Komar 2002) for the neotropical Momotidae: Coraciformes, despite many hours of field observations (Skutch 1945, 1947, 1964, 1971; Orejuela 1980, Remsen et al. 1993, Chacón-Madrigal and Barrantes 2004, García-C and Zahawi 2006). The Thurber and Komar (2002) report involved a

single Turquoise-browed Motmot (*Eumomota superciliosa*) in the Republic of El Salvador, which for 2 consecutive years (1975–1976) fed on insects attracted to an artificial light source in a residential yard. We provide documentation in this note of the first known observations of nocturnal foraging by the Blue-crowned Motmot (*Momotus momota*).

#### OBSERVATIONS

We report opportunistic observations of a single Blue-crowned Motmot nocturnally foraging on aerial insects in the vicinity of an electric street lamp at Coopecabañas, San José, Costa Rica (09° 55' N, 84° 12' W; 910 m elevation). Our first observation was on 5 December 2004 at 2128 hrs when we observed a motmot on the lawn of a residence feeding on a fairly large sphinx moth (Sphingidae). The bird perched 2 m above the ground, after

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consuming the moth, on an almost vertical branch of a fallen tree in the hilly terrain next to the artificial light source. This perch seemed to provide the bird with cover from direct light while allowing an ample vantage point. The observed bird performed five successful foraging sallies in 30 min of observation; all captured prey appeared to be sphinx moths. On two other occasions, we found presumably the same bird feeding near the same street light: 18 December 2004 and 1 January 2005. The bird used the same foraging method each time, usually sallying upwards or horizontally from its perch to attempt prey capture. Only on two occasions did the motmot succeed in direct aerial capture. In the remaining foraging attempts (40), it had problems capturing prey in the air and usually would have a vertical downward chase to the lawn, where it occasionally succeeded and proceeded with feeding. We checked the area during six nights in August 2006 but did not find any motmots feeding in the area.

The inferred capture efficiency was quite low. However, the large size of prey may compensate, as we observed the motmot did not need many feeding events to be apparently satiated as it left the scene. The capture rate could reflect the lack of adaptative response, which a more specialized bird would have to couple with its new foraging behavior.

Artificial lights and motmots are common in suburbs around San Jose and other nearby Costa Rican provinces. However, diurnal in-

sectivorous birds attracted to artificial light sources during the night have not previously been recorded for Costa Rica.

#### ACKNOWLEDGMENTS

We thank Julio Sánchez and Gilbert Barrantes for encouraging preparation of this note. We also thank Christopher Canaday, Oliver Komar, and an anonymous reviewer for helpful comments which greatly improved this manuscript.

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