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## 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, Kempenaers 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.

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

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**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 (Fjeldsø 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 (Fjeldsø 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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