

TAXONOMY, PHYLOGEOGRAPHY & MOLECULAR MARKERS



Collared Forest Falcon *Microhierax caerulescens*

Morphometric Measures of male and female Spot-winged Falconets *Spizapteryx circumcinctus* sexed using PCR Amplification Methods

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ABSTRACT

The Spot-winged Falconet *Spizapteryx circumcinctus* is a little-known Neotropical falconid endemic to southern South America. The classification of the species has been controversial due to a lack of information on the species' morphology. Only a handful of specimens have been obtained to take morphometric measurements and to determine the degree to which sexual dimorphism has developed in the species. In an effort to provide such data, we captured 22 falconets using bal-chatri traps with various mouse and bird lures in La Pampa, Argentina, between 1998-2001. We measured body mass, wingspan, wing chord, tail length, total length, culmen length and hallux length, and obtained blood samples using standard techniques. Body mass, wingspan, wing chord, tail length, total length, culmen length and hallux length averaged 173.5 ± 29.82 g (\pm SD), 542.5 ± 23.60 mm, 176.6 ± 5.7 mm, 146.4 ± 6.0 mm, 290.7 ± 9.0 mm, 15.2 ± 1.0 mm, and 13.6 ± 0.77 mm, respectively. We sexed 8 captured falconets using PCR amplification of the CDH gene intron of DNA extracted from blood samples. All of the measures taken, except culmen and hallux lengths, were found to be significantly larger in females than in males ($P < 0.05$) indicating that, like other falconids, the Spot-winged Falconet has developed reversed sexual dimorphism with females averaging 8.4% larger than males for the measurements we obtained. While the diet of the species is poorly documented, the degree of sexual dimorphism that has developed in the bird indicates that the Spot-winged Falconet is probably rather omnivorous, eating a variety of prey species ranging from insects to lizards and birds.

INTRODUCTION

The Spot-winged Falconet *Spizapteryx circumcintus* is a relatively-rare and little-studied species in a monotypic genus of the family Falconidae that is endemic to central-northern Argentina and southern Paraguay (Olrog 1959). In the southern portion of its range, the Spot-winged Falconet occurs where dry, semi-desert, and savanna conditions create expanses of caldén or mesquite forests (*Prosopis* spp., Brown & Amadon 1968; del Hoyo *et al.* 1994). Its ecology in these dry forests is poorly studied but it appears that spot-wings are frequently found in close association with colonies of the Monk Parakeet *Myiopsitta monachus* and they use abandoned and occupied parakeet nests for roosting in winter and breeding in summer (Hoy 1980; Martella & Bucher 1984). The use of the large thorny nests of Monk Parakeets by spot-wings is analogous to the nesting niche of the African Pygmy Falcon *Polihierax semitorquatus* which uses the communal nests of Sociable Weavers *Philetairus socius* (Maclean 1970). Also like pygmy falcons, besides utilizing the nests of their host species for roosting and breeding, Spot-winged Falconets apparently exploit Monk Parakeets by depredating their nests and eating both young and adults (Martella & Bucher 1984).

The classification of the Spot-winged Falconet within the family Falconidae has been controversial due to limited information on the species' morphology and genetics. Classification of the caracara and falcon genera within the family is well established but classification of the remaining falconid genera has been less stable with the controversy centreing on the genera *Polihierax*, *Mircohierax*, *Micrastur*, *Herpetotheres* and *Spizapteryx*. Studies based on osteological data and morphometric measures taken from museum specimens and the literature have found the genus *Spizapteryx* to be basal to the two clades that include the pygmy falcons, falconets, and true falcons of the genus *Falco*. All of these are derived from a common caracara ancestor and the genera *Micrastur* and *Herpetotheres* are basal in the cladogram (Becker 1987; Kemp & Crowe 1990). The phylogeny inferred from syringeal morphology also shows *Spizapteryx* to be closely related to the true falcons, falconets and African Pygmy Falcon, but it places the White-rumped Pygmy Falcon *Polihierax insignis* basal to this group and the species is indicated as having diverged from the genus *Herpetotheres*. The caracara group is basal to the genus *Herpetotheres* and the genus *Micrastur* is basal to it (Griffiths 1994). Finally, the phylogeny inferred from differentially-weighted cytochrome-*b* sequences shows *Spizapteryx* to be most closely related to the *Falco* clade which is derived directly from the caracaras, and *Herpetotheres* and *Micrastur* are considered to be sister genera, both of which are basal to the caracaras (Griffiths 1997). Obviously, there is a need for further analysis of molecular and morphological data to clarify the classification of problematic genera such as *Spizapteryx* within the family.

In an effort to provide more information on the Spot-winged Falconet, we began a study of the species in Argentina. Our goal was to conduct a long-term study of the species in order to obtain needed morphometric measures of adults and DNA samples for molecular analysis to clarify the relationship of the species within the family Falconidae. We also wanted to obtain further

information on the diet and nesting habits of the species to better understand the ecological relationship between spot-wings and Monk Parakeets.

STUDY AREA AND METHODS

The study area was located in south-central Argentina in the provincial park Parque Luro which is situated approximately 45km south of the city of Santa Rosa, La Pampa. The park measures approximately 10 X 10km. In addition to its convenient location, the park is criss-crossed by roads which facilitates surveys and data collection. Except for a small area that has been cleared and planted with exotic grasses to support red deer (*Cervus elaphus*), the park consists of the native dry savanna habitat that has a dominant forest overstory of caldén (*Prosopis caldenia*) trees interrupted by large salt pans. The area in which the park is situated is typical Espinal habitat (Cabrera 1976). Espinal habitat is savanna and is dominated by caldén trees in the overstory and grasses such as *Elyonurus muticus* and *Aristida* spp. in the understory. Del Monte habitat is shrubland dominated by various species of creosote bush (*Larrea* spp.) with isolated caldén woodlots in depressions and ravines. The climate of the area is semiarid and highly seasonal (Cabrera 1976) with a distinct dry season in fall and winter (April-September) and a wet, warm season in spring and summer (October-March). Mean annual temperature is 15° C with a mean maximum temperature in January of 24° C and mean minimum temperature in July of 8° C. Mean annual precipitation is between 400-600mm, about 80% of which falls between October and March, although year-to-year variation in rainfall can be high (Cano 1980). Fire is a common natural disturbance and often occurs during summer months and a single fire can burn thousands of hectares of native habitat.

We surveyed the park for raptors four times each year during each of the four seasons by driving all of the roads. This enabled near-complete coverage of the park. We attempted to capture, measure, individually mark and obtain blood samples from as many species of raptors as possible during the breeding season (November-February). Most individuals were captured using bal-chatri traps with various mouse and bird lures in and near the park (Berger & Mueller 1959). Each trapped bird was banded with an individually-numbered leg band and its body mass, wingspan, wing chord, total length, tail length, culmen length (without the cere) and hallux length was measured using standard methods (Biggs et al. 1978). Falconets were weighed with a 300g Pesola scale to the nearest 2g. Wing chord, wingspan, tail length and total length were measured with a plastic rule to the nearest 1mm, and the lengths of culmen and hallux were measured using a caliper to the nearest 0.05mm. Blood samples were obtained in capillary tubes via vena puncture of the brachial vein and preserved in either EDTA buffer solution or 80% alcohol (Burgoyne et al. 1994). We sexed individual Spot-winged Falconets using PCR amplification of chromohelicase-DNA genes located on the two sex chromosomes (Griffiths et al. 1998) and we tested for differences in morphometric measures between the two sexes using two-tailed *t*-tests (Zar 1996). To compare the morphometric measurements we obtained for male and female Spot-winged Falconets to other raptor species, we obtained similar measurements from the literature for male

and female American Kestrels (*Falco sparverius*, Smallwood & Bird 2002), Sharp-shinned Hawks (*Accipiter striatus*, Bildstein & Meyer 2000), Merlins (*F. columbarius*, Sodhi *et al.* 1993), Barred Forest Falcons (*Micrastur ruficollis*, del Hoyo *et al.* 1994), and African Pygmy Falcons (*Polihierax semitorquatus*, del Hoyo *et al.* 1994). For each species used in this comparison, we calculated a dimorphism index using the equation $(1 - \text{male measurement}/\text{female measurement}) \times 100$.

RESULTS AND DISCUSSION

Our road surveys recorded a total of 14 species of raptors with an average of 85 individuals of eight species observed during any season (Table 1). Most common species observed were the American Kestrel *Falco sparverius*, Chimango Caracara *Milvago chimango* and Crested Caracara *Caracara plancus*, but other species, such as Turkey Vulture *Cathartes aura*, Black Vulture *Coragyps atratus*, Spot-winged Falconet *Spizapteryx circumcinctus*, Aplomado Falcon *Falco femoralis*, Red-backed Hawk *Buteo polyosoma*, Black-chested Buzzard-Eagle *Geranoaetus melanoleucus* and Burrowing Owl *Speotyto cunicularia*, were routinely seen in smaller numbers.

Table 1. Average number of raptors observed during quarterly road surveys conducted in spring, summer, fall, and winter months in Parque Luro, La Pampa, Argentina.

Taxon	Average Number Individuals	
	Observed	Range
<i>Falconiformes</i>		
American Kestrel (<i>Falco sparverius</i>)	21	13-30
Chimango Caracara (<i>Milvago chimango</i>)	21	10-25
Crested Caracara (<i>Caracara plancus</i>)	19	13-23
Turkey Vulture (<i>Cathartes aura</i>)	6	2-12
Black Vulture (<i>Coragyps atratus</i>)	5	3-6
Spot-winged Falconet (<i>Spizapteryx circumcinctus</i>)	2	0-3
Aplomado Falcon (<i>Falco femoralis</i>)	2	0-3
Red-backed Hawk (<i>Buteo polyosoma</i>)	2	0-3
White-tailed Kite (<i>Elanus leucurus</i>)	1	0-2
Cinereus Harrier (<i>Circus cinereus</i>)	1	0-1
Black-chested Buzzard-Eagle (<i>Geranoaetus melanoleucus</i>)	0	0-1
Peregrine Falcon (<i>Falco peregrinus</i>)	0	0-1
<i>Strigiformes</i>		
Ferruginous Pygmy Owl (<i>Glaucidium brasillianum</i>)	3	1-4
Burrowing Owl (<i>Speotyto cunicularia</i>)	2	1-3

We trapped over 170 individuals of eight species, most of which were American Kestrels and Spot-winged Falconets. We captured a total of 22 different Spot-winged Falconets, three of which were subsequently recaptured on one or more occasions (Table 2). Recaptures occurred from two months to

one year after the initial capture and all occurred <500m from the location where the falconet was first captured, indicating that Spot-winged Falconets are year-round residents of the park and probably remain close to their nesting areas throughout the year. Body mass ranged between 149-249gm ($\bar{x} = 173.5 \pm 29.82$) and wingspan and wing chord averaged 542.5 ± 23.60 (range = 474-575) and 176.6 ± 5.7 (range = 166-188) mm, respectively. The respective measures of tail length, total length, culmen length and hallux length averaged 146.4 ± 6.0 (range = 137-162), 290.7 ± 9.0 (range = 259-303), 15.2 ± 1.0 (range = 9.9-16.9), and 13.6 ± 0.77 (range 12.4-14.2) mm.

Table 2. Morphometric measurements obtained from 22 Spot-winged Falconets captured in and near Parque Luro, La Pampa, Argentina from 1998-2001.

<i>Mass (gm)</i>	<i>Wingspan (mm)</i>	<i>Wing Chord (mm)</i>	<i>Tail Length (mm)</i>	<i>Total Length (mm)</i>	<i>Culmen Length (mm)</i>	<i>Hallux Length (mm)</i>
177	525	175	155	284	10.3	13.5
203	568	183	151	300	15.4	13.7
172	546	173	162	290	15.5	14.2
183	534	170	146	278	14.3	14.0
211	565	175	147	286	15.6	13.7
249	568	188	153	303	16.3	14.6
164	545	178	137	287	15.0	12.5
205	575	182	153	291	16.9	14.6
185	575	184	157	294	15.4	14.2
182	571	181	147	283	15.6	13.9
198	569	184	157	302	16.4	14.2
165	538	181	149	293	14.4	13.7
186	559	185	144	286	16.2	13.7
203	565	184	151	293	16.0	14.2
154	474	178	137	259	9.9	13.3
157	529	169	146	275	14.0	12.9
155	539	173	143	286	14.1	13.1
149	531	171	147	282	14.8	12.4
152	513	170	138	279	14.5	13.5
173	537	175	141	285	15.7	12.6
149	521	166	145	281	15.0	12.9
157	516	168	145	283	14.5	13.6

We randomly selected eight of the Spot-winged Falconets that we captured and sexed them using PCR amplification of DNA obtained from blood samples and compared the morphometric measurements between the two genders (Table 3). Four of the sexed individuals were females and four were males. We found body mass ($t = 3.03$, $P = 0.023$), wingspan ($t = 4.12$, $P = 0.006$), wing chord ($t = 6.49$, $P = 0.001$), tail length ($t = 2.51$, $P = 0.046$), and total length ($t = 3.26$, $P = 0.017$) to be significantly smaller in males than in females, but there was no difference in either the culmen length ($t = 1.59$, $P = 0.162$) or hallux length ($t = 2.05$, $P = 0.085$) between the two sexes.

Table 3. Mean values (\pm SD) of morphometric measurements of four male and four female Spot-winged Falconets sexed using PCR amplification techniques and test results of gender differences. All measurements, except body mass (g), are in millimetres.

	<i>Female</i>	<i>Male</i>	<i>t-value</i>	<i>P</i>
Mass	188.00 \pm 16.91	157.75 \pm 10.68	3.02	0.023*
Wingspan	557.75 \pm 13.79	521.75 \pm 10.68	4.12	0.006*
Wing chord	183.50 \pm 1.73	169.75 \pm 3.86	6.49	0.001*
Tail length	150.25 \pm 5.37	142.25 \pm 3.40	2.51	0.046*
Total length	293.50 \pm 6.55	282.00 \pm 2.58	3.26	0.017*
Culmen length	15.77 \pm 0.90	14.92 \pm 0.56	1.59	0.162
Hallux length	13.9 \pm 0.38	13.28 \pm 0.44	2.05	0.085

* $P < 0.05$

Table 4. Comparison of morphometric measurements across Falconiform genera.

	<i>Spot-winged Falconet</i>	<i>American Kestrel</i>	<i>Sharp-shinned Hawk</i>	<i>Merlin</i>	<i>Barred Forest Falcon</i>	<i>African Pygmy Falcon</i>
Body Mass (g)						
male	157.7	111.0	101.0	166.9	165.5	40.0
female	188.0	120.0	178.0	255.5	232.5	57.0
DI	16.5%	8%	43%	35%	29%	30%
Wing Chord (mm)						
male	169.7	188.5	171.0	199.4	180.0	115
female	183.5	195.3	203.0	221.9	180.0	116
DI	6%	4%	26%	10%	0%	0%
Tail Length (mm)						
male	142.2	129.4	131.0	121.6	176.0	69.0
female	150.2	129.5	156.0	136.0	183.0	74.0
DI	5%	0%	26%	11%	4%	7%
Culmen Length (mm)						
male	14.9	11.1	9.8	12.4	14.5	-
female	15.8	12.2	12.1	14.8	14.5	-
DI	6%	7%	19%	19%	0%	-
Mean DI	8.4%	4.75%	28.5%	18.75%	8.25%	9.25%

DI = 1 - (male/female) X 100

Our comparison of morphometric measurements for Spot-winged Falconets with other raptors showed that the body mass of Spot-winged Falconets was larger than that of the American Kestrel, Sharp-shinned Hawk and African Pygmy Falcon, but was comparable to that of the Merlin and Barred Forest Falcon (Table 4). Wing chord of the Spot-winged Falconet was again much larger than that of the African Pygmy Falcon, but much shorter than that of any of the three *Falco* genera we used in the comparison. Only the Sharp-shinned Hawk had a comparable wing chord. Likewise, the tail length of the Spot-winged Falconet was most similar to that of the sharp-shin but the culmen

length most closely matched that of the Barred Forest Falcon. The dimorphism indexes we obtained showed that Sharp-shinned Hawks and Merlins, two bird-eating species, had the greatest amount of sexual dimorphism. The omnivorous American Kestrel showed the least sexual dimorphism with an average dimorphism index of only 4.75%. The dimorphism indexes we obtained for Spot-winged Falconets, Barred Forest Falcons, and African Pygmy Falcons were intermediate ranging from 8.25-9.25%. The diet of the Spot-winged Falconet is not well described but it apparently eats a variety of birds and insects (Martella & Bucher 1984), as well as lizards (pers. obs.). Barred Forest Falcons have a diverse diet that consists of lizards and a variety of birds (del Hoyo *et al.* 1994) as do African Pygmy Falcons which also eat insects, reptiles, and small birds (del Hoyo *et al.* 1994). Based on these findings, we concluded that, with an average dimorphism index of only 8.4%, Spot-winged Falconets are probably rather omnivorous, eating a variety of prey species ranging from insects to lizards and birds. Nevertheless, more studies of the dietary habits of the species are warranted to better establish its diet and how it relates to the degree of sexual dimorphism that has developed in the species.

Only a few nests of the Spot-winged Falconet have been described. It has been found using the old nests of Ovenbirds (*Pseudoseisura lophotes*, Dean 1971; Narosky *et al.* 1992) but apparently it more typically uses the occupied and unoccupied nests of Monk Parakeets (Hoy 1980; Straneck & Vasina 1982; Martella & Bucher 1984; Martella *et al.* 1985). In addition to falconets, several other species of birds also utilize the large stick nests constructed by Monk Parakeets, including Guira Cuckoos *Guira guira*, Bay-winged Cowbirds *Molothrus badius*, Screaming Cowbirds *M. rufoaxillaris*, and White Monjitas *Xolmis irupero* (Martella *et al.* 1985). Monk Parakeets, therefore, appear to play a key role in the ecology of a variety of birds by provisioning them with common nesting and roosting sites. Parque Luro supports a large number of nest colonies of Monk Parakeets. We believe that by constructing their large communal nests, Monk Parakeets play an essential role in the ecology of the park by providing suitable habitat not only for Spot-winged Falconets but also for the other species of birds that congregate at these large stick nest structures.

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