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NOTES ON THE BREEDING BIOLOGY, HUNTING BEHAVIOR, AND ECOLOGY OF THE TAITA FALCON IN ZIMBABWE

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ABSTRACT.—Six pairs of Taita Falcons (*Falco fasciinucha*) were studied during the breeding season from 1989–1991 in four areas of Zimbabwe. Observations during copulation, incubation, provisioning of young, and hunting were made for 136.6 hr; vocalizations and their contexts were also recorded. The males were more strikingly colored than the females. The nests were in cliff holes protected from direct sunlight on cliffs from 15–290 m in height. Incubation started from late August to early September. In nine years eight fledglings were produced, giving a productivity of 0.88 fledglings per reproductive attempt. Three 10 d old chicks were fed every 1.8 hr with feeding sessions averaging 10 min. Taita Falcons employed five hunting methods: still hunting from a high vantage point; speculative hunting; stooping from a high aerial position; aerial hawking of insects, and cooperative hunting. Hunting success was 20.7% where most of the hunting was carried out within 1 km of the nest site. Prey consisted primarily of small- to medium-sized birds with an average weight of 36.4 g; they were caught mainly in woodland and the cliff habitats close to the nest. Food caching occurred at each site. Vocalizations included a raspy "heechuck" during mutual interactions; a croaky wail when soliciting food and for less intense interactions; a whining call from the female and a chitter from the male during copulations; a shriek "chew-wee" from the male when he delivered food and the alarm "kek" from either sex when they defended the nest. Although very secretive around their nests, when other raptors and also Trumpeter Hornbills (*Bycanistes bucinator*) ventured within 200 m, the Taita Falcons attacked them vigorously.

Notas sobre la biología reproductiva, conducta de caza y ecología de *Falco fasciinucha* en Zimbabwe

RESUMEN.—Seis pares de *Falco fasciinucha* fueron estudiados durante la estación reproductiva de 1989–91 en cuatro áreas de Zimbabwe. Observaciones sobre copulación, incubación, aprovisionamiento de juveniles y caza, se hicieron durante 136.6 hr; las vocalizaciones y su contexto también fueron registradas. Los machos eran llamativamente más coloridos que las hembras. Los nidos see encontraban ubicados en cavidades existents en riscos y protegiodos de los rayos solares directos; la altura de los riscos variaba entre 15 y 290 m. La incubación comenzó dentro de un período de dos semanas entre fines de agosto y comienzos de septiembre. En nueve pares anuales, ocho volantones fueron producidos, dando una productividad de 0.88 volantones por intento reproctuctivo. Tres polluelos de 10 días comían cada 1.8 hr, en sesiones de 10 min en promedio. *Falco fasciinucha* empleaba cinco métodos de caza: caza silenciosa desde un punto alto y favorable; caza especulativa; inclinado en alerta con una posición de espera; caza aérea de insectos; y caza cooperativa. El éxito de caza en uno de estos sitios fue de 20.7%, donde la mayoría de la caza fue realizada a más de un km del sitio de nidificación. Las presas consistieron principalmente en aves de talla pequeña a mediana con un peso promedio de 36.4 g. Ellas fueron capturadas principalmente en bosques abiertos y en hábitats de riscos cercanos al nido. La captura de presas ocurrió en cada uno de los sitios. Las vocalizaciones incluyeron un sondido raspado "heechuck" durante interaciones mutuas; un graznido de lamento cuando se solicita comida y para interacciones menos intensas; un gemido de la hembra y un chillido del macho durante la copula; un chillido "chew-wee" del

macho cuando entregaba comida y uno de alarma "kek" por cada uno de los sexos cuando defendían el nido. Aunque los alrededores del nido eran muy discretos, cuando otras rapaces y también *Bycanistes bucinator* se acercaban a menos de 200 m, *F. fasciinucha* atacaba en forma violenta.

[Traducción de Ivan Lazo]

The Taita Falcon (*Falco fasciinucha*) is a small and rare raptor which has been little studied (Brown et al. 1982, Cade 1982, Steyn 1982). Although less than half the size, it is similar to the African Peregrine Falcon (*Falco peregrinus minor*; Cade 1982) with which it is sympatric (Hunter et al. 1979, Thomsett 1988, Moller 1989, Hustler 1989, Jenkins et al. 1991).

Although aspects of the breeding biology have been studied by Holliday (1965), Colebrook-Robjent (1977) and Dowsett (1983) in Zambia, Hunter et al. (1979) in Malawi and Moller (1989) in Uganda, these amount only to observations on four nest sites. There are few data on laying dates (Brown et al. 1982, Irwin 1981, Steyn 1982, Maclean 1985), hunting behavior and specific prey species, especially in southern Africa. Our study includes information on nest site characteristics, copulation, laying dates, provisioning of young, productivity, hunting, prey, vocalizations and their contexts, and interspecific behavior of six pairs obtained during different parts of the breeding cycle.

STUDY AREA

The study was conducted in the Middle Zambezi Valley and in the Eastern Highlands of Zimbabwe. All of the nests were located in zones of dry deciduous woodland with a mean annual rainfall of 400–712 mm falling between November and March (Dept. Meteorological Services 1977). The maximum mean monthly temperatures were 32–36°C in October and the mean annual temperature range was 9°C (Torrance 1965). The altitude of nests ranged from 460–1050 m.

The scree slopes below the basaltic nesting cliffs were covered with mixed deciduous woodland and grassland. Riverine thickets and forest extended along sections of the Zambezi River and its tributaries that contained permanent pools. The plateau is at 880 m and was covered by mopane (*Colophospermum mopane*) woodland. The hillslopes at one site were covered with miombo woodland (dominated by *Brachystegia glaucescens*) and the sandstone plateau (1050 m) by *B. boehmii* and *Julbernadia globiflora* woodland. The riparian forest was characterized by *Combretum* sp. thicket, *Trichelia emetica*, *Diospyrus mespiliformis* and *Tamarindus indica*. The lower-lying areas consisted of undulating to rugged terrain with a variety of habitat from mixed deciduous woodland dominated by *Brachystegia* sp. on the sandstone hilltops and scree slopes to a mixture of riverine bush and grassland near the streams and stands of *C. mopane* woodland along the interfluves.

METHODS

The sites were studied by teams of two or more observers, each using 10 × 40 binoculars and a 20× spotting scope in 1990 and 1991. Nests were designated as N1–N6.

Productivity was based on all chicks seen including four that were 10–23 d old taken for a captive breeding program Age of young and estimated commencement of incubation were based on 31–33 d incubation and 42 d fledging age (Moller 1989, pers. obs.). Incubation normally starts with the second or penultimate egg and eggs are normally laid 2–4 d apart (Dowsett 1983).

A total of 136.6 hr of observation were carried out at all sites combined. As the falcons are most active from dawn until mid-morning and then again after mid- to late-afternoon (Moller 1989, pers. obs.), observation times were often coordinated to fit into this regime, except for two dawn-to-dusk watches at two nests when the chicks were 10 d old, and had fledged young, respectively. Visits were made from August–December.

A foray was defined as a flight in which prey capture appeared to be the main objective and it may have included any number of capture attempts. A stoop was any kind of dive during a hunting foray that appeared to be directed toward a prey item. A chase was a direct flapping flight at a prey item.

Prey was identified from pluckings, remains (particularly feet and beaks), and pellets collected from nests and from observations at all sites.

RESULTS

Plumage of Adults. At all sites except N5 the adult male was a rich cinnamon, almost a peachy hue on the chest (see photo in Hartley 1991). This male's crop bore brighter cream-colored feathers with its normal cinnamon wash as well. His nape patches, fringes of the malar stripes, and auricular area were a matching rich cinnamon, contrasting with his cream-colored cheeks and black helmet.

By contrast the female was a duller, more pastel hue, her chest flanks and flags more heavily streaked with dark brown than the male's, which appeared almost unmarked. The nape and upper back areas were dark on both sexes, contrasting with the lower wing coverts, scapulars and rump which were a lighter grey.

At N5 both adults were very pale colored on the chest, tending to buff, but again the male had a slightly richer hue than the female (see also Holliday 1965, Dowsett 1983, Moller 1989).

Nest Sites. Four of the sites were on high cliffs, and three (Table 1) were on very low cliffs, all near permanent water. N1–N3 were located in convoluted gorges. N4b and N5 were on mesas overlooking dry streambeds with occasional pools of permanent water. N4a was in a small gorge system. N6 was on a mesa some 600 m above a perennial river.

Table 1.   Nest site characteristics of Taita Falcons in Zimbabwe. (Distance to top is the distance from the nest to the top of the nesting cliff. Cliff ratio is the relative distance of the nest from the bottom of the nesting cliff.)

SITE[a]	ROCK	CLIFF HEIGHT (m)	DISTANCE TO TOP (m)	CLIFF RATIO	ASPECT	HEIGHT ABOVE VALLEY (m)	DISTANCE TO WATER (km)	NEST DIMENSIONS (cm)[b]			
								W	H	D	O
N1 (H–G)	basalt	135	20	0.85	NNE	140	0.15	50	30	85	0
N1 (L–G)	basalt	135	25	0.81	NNE	140	0.15	—	—	—	—
N2 (H–G)	basalt	57	10	0.82	NNW	150	0.16	100	46	60	200
N3 (H–G)	sandstone	290	66	0.77	WNW	295	0.24	—	—	—	—
N4a (H?–G)	sandstone	15	?	?	N/S?	27	0.20	—	—	—	—
N4b (H?–M)	sandstone	22	?	?	SW	30	1.00	—	—	—	—
N5 (H–M)	sandstone	22	9	0.59	E	45	1.00	85	92	83	0
N6 (H–M)	dolerite	140	40	0.71	SW	420	3.00	70	30	50	175
Mean		97	22	0.78		156	0.74	76	50	70	75

[a] H = hole; L = ledge; G = gorge; M = mesa; ? = suspected nest.
[b] W = width; H = height; D = depth; O = overhang.

At N6 the pair used a White-necked Raven (*Corvus albicollis*) nest, which had probably been used by the ravens the previous year. This is the first time that Taita Falcons have been recorded as using an old stick nest.

Nests did not face due west and thus partially avoided the full extent of the afternoon sun. Although N3 had an unfavorable aspect, the opposite side of the gorge shaded the cliff from 1600 H. Cliff holes were therefore protected for most of the day, while the ledge used at N3 in 1988 was shaded behind a Black Eagle (*Aquila verreauxii*) nest (Hartley and Mundy 1990). Also on a west facing cliff the nest slit of N6 faced south-southwest. The narrowness of the opening minimized penetration by the afternoon sun as well.

Copulation and Egg Laying. Copulations took place mainly in the morning (80.0%, N = 24) from 0617–1007 H, with 20.0% (N = 6) being seen from 1517–1748 H. Fourteen copulations took place in 3.8 hr during a dawn to mid-morning watch on 2 September. Copulations lasted from 5–8 sec, much shorter than recorded by Holliday (1965) and Colebrook-Robjent (1977) and the shortest interval between them was 30 sec. Copulations took place on favorite perch points within 100 m of the nest, including ledges (N = 16) and trees (N = 14) also used for plucking and eating.

Copulations were not preceded with any discernible courtship behavior; however, on three occasions the female bowed perceptibly, possibly an invitation for copulation. Once copulation followed a territorial defense (also see Moller 1989) by the male against a

Black Eagle. Copulation also occurred while the female was feeding (also see Holliday 1965). In each case the male flew to the female.

Four eggs were laid at N2 and at least two eggs at each of N1 and N5. One broken egg at N5 was addled. One addled egg from N1 weighed 16.3 g and measured 38.52 × 31.94 mm, smaller than eggs in two clutches in Steyn (1982) and 13 eggs ($\bar{x}$ = 45 × 34 mm) laid by captive Taita Falcons at The Peregrine Fund. The freshly laid eggs at N2 were richly marked with red brown, particularly the first egg.

At N2 the first egg was seen on 31 August. There were 30 bouts of copulation during 22.3 hr observation over 4 d, during which time a second egg was laid on the night of 2 September. The first egg was attended by both birds, particularly the female who turned it and maintained the scrape. She was also standing over it by the time it was nearly dark. Once the second egg was laid she spent 50.2% of the 5.2 hr observed either sitting or standing over them.

Incubation. During 10.3 hr observation at N2 on 5–6 October, close to the hatching date, the female incubated for 78.1%, the male for 18.3%, and the eggs were unattended for 3.6% of the time. The male's shifts varied from 8–36 min and averaged 23 min. The female was seen on the eggs at dusk and presumably incubated at night. Commencement of incubation was about 24 August for N1, 5 September for N2, 9 September for N5 and 12 September for N3.

Productivity. A total of eight fledglings were produced in nine pair years, yielding 0.88 fledglings per
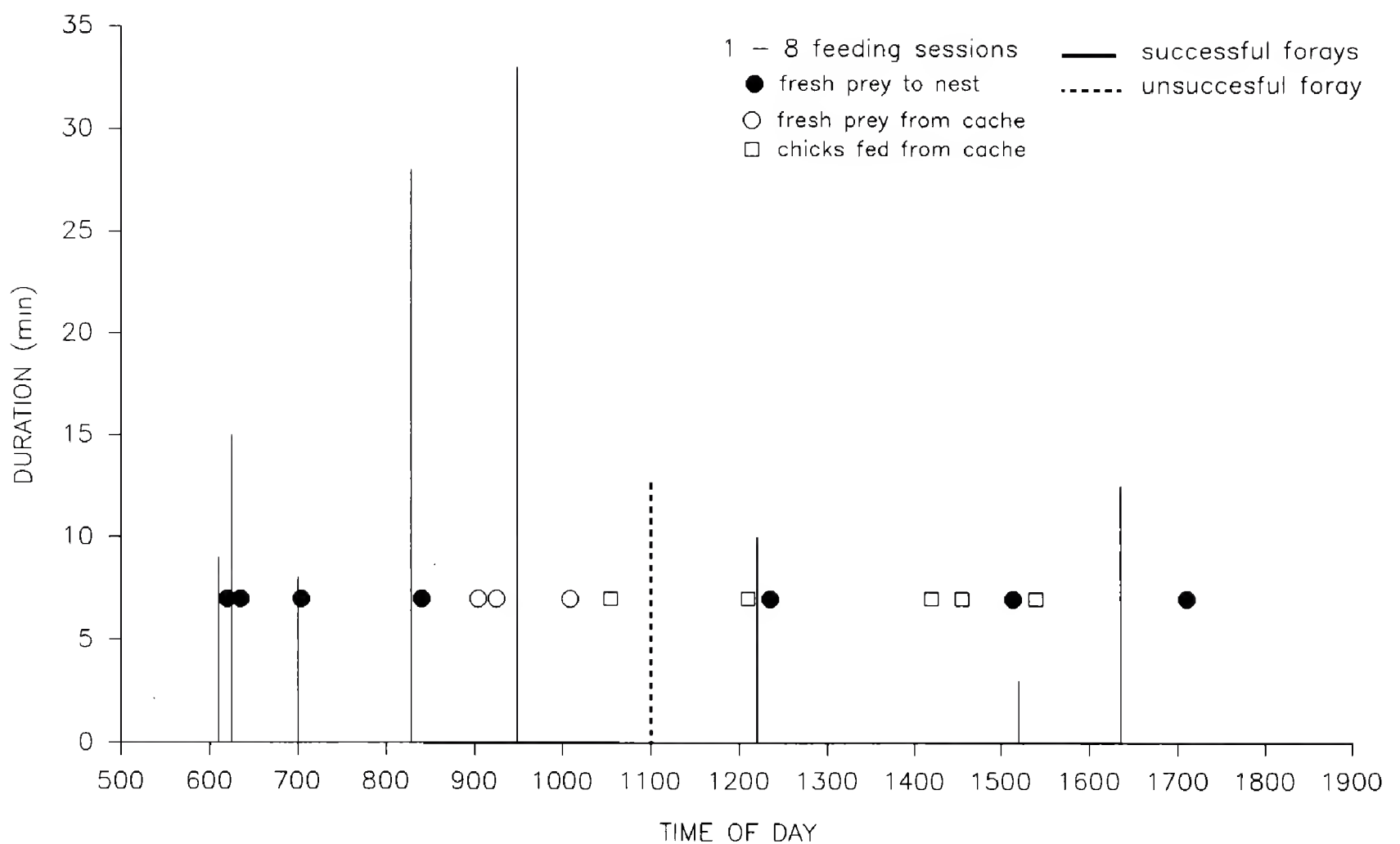
Figure 1.   Timing, frequency, and duration of hunting forays for 1 d at N2 when the chicks were about 10 d old.

reproductive attempt. No young were produced at the two southwest facing sites, which also experienced the hottest afternoon temperatures.

Prey Deliveries. During courtship at N2, the male was seen to deliver nine birds to the female. Freshly killed birds were delivered unplucked, while those from food caches were either partially or mainly plucked. While it was clear that some of these had their heads removed, insufficient attention was paid to this aspect. Only three prey items were taken by the female, despite the fact that four were delivered to her in the nest. Twice the male left the nest with the prey when the female approached him, once leading to an aerial prey exchange nearby. Twice she took the prey from him at a tree perch. She also retrieved a carcass from a cache.

During the dawn-to-dusk watch at N2 the male provided 10 birds, 70% of these by 1015 H (Fig. 1). Three birds were cached, two after deliveries to the nest had not been taken by the female. The female brought food to the nest three times: twice from a cache and once from a food exchange with the male away from the nest. Twice the male fed the chicks, with the female (perched 0.3 m away) taking over on one oc-

casion. Food was provided at an average interval of 1.8 hr and the sessions lasted an average of 10 min (SD = 4.33, N = 8). Three Red-billed Queleas (*Quelea quelea*) were brought in succession, one of them still alive. The other prey consisted of similar-sized birds which were estimated to weigh about 20–30 g each.

Hunting and Prey. Five methods of hunting were observed. Still hunting (28.1%; N = 18) from a high vantage perch (also see Moller 1989) involved the bird chasing prey directly, either in a stoop or in direct pursuit, the follow-chase described by Meinertzhagen (1959). Speculative hunting (31.3%; N = 20) while quartering the cliff top or flying directly over an area involved either a brisk flight along the side of the cliff just below the summit, or a direct flight over an area before looping back to the cliff. Sometimes the bird used the updraft against the cliff to soar, otherwise it stooped or pursued quarry directly. Stooping from a high aerial position (35.9%; N = 23; also see Madge 1971, Dowsett 1983, Moller 1989) took place after the bird first climbed to a height of about 200–300 m where it circled in anticipation of finding prey. Cooperative hunting (10.9%; N = 7) took place when the pair of adults flew out together and attacked quarry as a team,

stooping one behind the other. Finally, Taita Falcons hawked insects (4.7%; N = 3), usually aloft while soaring (also see Hunter et al. 1979). Twenty-one percent (N = 29) of individual stoops and chases were successful; seven successful attempts were launched from the cliff and were concluded in less than a minute, and 71.4% of forays were successful (N = 32).

At two gorge sites the males spent an average of 11.7 min (SD = 7.96; N = 41) per hunting foray and the females just 2.4 min (SD = 3.22; N = 23). The females hunted mainly in front of the cliff and remained nearby, presumably to defend it.

Most of the observed hunting was carried out within 1 km of the nest at N2 and N3 (see Hunter et al. 1979, Moller 1989). At N2 the birds were not seen to pass an observer located just over 1 km upstream. The male was seen heading in this direction up the gorge on 90.6% (N = 29) of the observations.

Most of the prey captured were birds less than 50 g in mass (83.2%; N = 79), birds from 51–140 g (10.5%; N = 10), and insects (11.1%; N = 6; Table 2). These were derived mainly from the woodland (55.6% by number and 42.2% by weight; N = 30) and cliff habitats (29.6% by number and 54.9% by weight; N = 16) with an average weight of 36.4 g (N = 48).

Although both male and female Taita Falcons stooped at Trumpeter Hornbills (*Bycanistes bucinator*) these were regarded as interspecific aggressive encounters; the falcons gave the antagonistic "kek-kek" vocalization, driving off the hornbills with a series of powerful stoops. The same may have applied in the case of a stoop at a Rock Pigeon (*Columba guinea*), although no vocalizations were made. Rock Pigeons (347 g; Maclean 1985) breed in holes and on ledges on cliffs and may compete with the Taita Falcons for some of these spots. However, both the Purple-crested Lourie (*Gallirex porphyreolophus*) and the Green Pigeon (*Treron australis*) are similar in size to the Rock Pigeon and were taken as prey.

Food Caching. This was a feature at each site during each phase of the breeding cycle, and was most frequent during the nestling period. Caching permitted the falcons to make the best possible use of optimum hunting times and gather extra food for storage (Fig. 1). Cached food ensured that a steady supply was delivered during the nestling period when larger amounts of food are necessary for the chicks.

Vocalizations. When at close quarters such as in the nest both birds uttered a slow deliberate and raspy "heechuck" call, usually accompanied by the head-low bow posture typical of peregrine and other large falcons

(Cade 1982). Each time the male arrived with food he uttered a croaky wail. Sometimes the female responded with the same call. This call was also used by dependent young that were begging for food. When perched in a tree with prey the male sometimes uttered a harsh bisyllabic shriek "chew-wee," like a parrot. All copulations were accompanied by a whining call uttered by the female, the faint chitter call of the male could be heard only when the observer was nearby. Occasionally a series of "eechip" calls was heard at the end of a session. Other vocalizations included softer solicitation calls of "kree kree" from the chicks in the nest, some croaky "heechips" from the male when he fed chicks in the nest and the usual falcon "kek kek" from both adults when they defended the territory.

Interspecific Behavior. The Taita Falcons defended their nests vigorously against other raptors, particularly Black Eagle, Augur Buzzard (*Buteo rufofuscus*), Brown Snake Eagle (*Circaetus cinereus*) and Black Kite (*Milvus migrans*). They also chased peregrines, African Fish Eagle (*Haliaeetus vocifer*), African Hawk-eagle (*Hieraaetus fasciatus*), Common Buzzard (*Buteo buteo*), African Goshawk (*Accipiter tachiro*), Trumpeter Hornbill, and Broad-billed Roller (*Eurystomus glaucurus*). These were driven off with powerful aerial displays, and the Taita Falcons sometimes made contact with the intruders after stooping. An Augur Buzzard and a Brown Snake Eagle were grounded by attacking Taita Falcons.

Most flights were initiated once the intruder was within 200 m of the nest, at cliff top height or below. However, an African Hawk Eagle was chased at a distance of 800 m. High-flying intruders were ignored and the Taita Falcons did not chase intruders that appeared to pose no potential threat to the nest such as a Black Eagle carrying prey. Once the Taita Falcons had young the intensity of territorial defense increased markedly. Both adults engaged intruders, either individually or cooperatively.

Peregrine Falcons were not always attacked. Once a female Taita Falcon continued hunting above a circling peregrine within 500 m of an occupied Taita Falcon site with fledged young. At one gorge site located 300 m from an occupied peregrine site, the Taita Falcons generally avoided the peregrine site. However, once when an adult Taita Falcon initiated an encounter with four recently fledged peregrines, the peregrines were able to drive the Taita Falcon away.

Attacks against Trumpeter Hornbills suggest that the hornbills may prey upon eggs and nestlings. This is supported by observations on captive hornbills (A.

Table 2. Prey remains (A), prey captured (B), and prey pursued (C) by Taita Falcons at six sites in Zimbabwe. Prey items from published literature sources are included. All weights from Maclean (1985), except Red-winged Starling (Jackson 1988), Green Pigeon (Hartley and Mundy in press) and Rock Pratincole (Natural History Museum, Bulawayo). Cl = cliff; W = woodland; O = other.

| SPECIES | HABITAT[a] | NUMBER TAKEN | | | | MASS (g) | REFERENCE[b] |
		A	B	C	TOTAL		
Birds		(38)	(38)	(13)	(89)		
Black Swift							
(*Apus barbatus*)	Cl	1	2		3	42.9	1
Unidentified swifts							
(*Apus* sp.)	Cl					10–88	2
Unidentified swallows							
(*Hirundo* sp.)	Cl					7–43	2
Lesser Striped Swallow							
(*Hirundo abyssinica*)	Cl					17.0	3
Rock Martin							
(*Hirundo fuligula*)	Cl	1	1	6	8	22.4	1, 4
Unidentified martins							
(*Hirundo* sp.)	Cl					16–30	2
Red-winged Starling							
(*Onychognathus morio*)	Cl			5	5	130.3	1, 5
Green Pigeon							
(*Treron australis*)	W					271.0	2
Green-spotted Dove							
(*Turtur chalcospilos*)	W		1		1	63.5	2
Purple-crested Lourie							
(*Gallirex porphyreolophus*)	W					278.0	5
Black Cuckoo Shrike							
(*Campephaga flava*)	W	1			1	33.0	1
Black-eyed Bulbul							
(*Pycnonotus barbatus*)	W	2			2	38.9	2, 6, 7, 8
Yellow-bellied Bulbul							
(*Chlorocichla flaviventris*)	W		1		1	43.0	1
Miombo Rock Thrush							
(*Monticola angolensis*)	W	1			1	44.7	1, 3
Familiar Chat							
(*Cercomela familiaris*)	W	2			2	20.8	1
Mocking Chat							
(*Thamnolaea cinnamomeiventris*)	W	1			1	47.7	1
Green-capped Eremomela							
(*Eremomela scotops*)	W		1		1	9.2	1
Black Flycatcher							
(*Melaenornis pammelaina*)	W	1			1	31.5	1
Chin-spotted Batis							
(*Batis molitor*)	W	2			2	11.0	1
Scarlet-chested Sunbird							
(*Nectarinia senegalensis*)	W	1			1	15.0	1
Rattling Cisticola							
(*Cisticola chiniana*)	W					17.9	9
Unidentified weavers							
(*Ploceus* sp.)	W	3			3	20–40	1, 2
Red-billed Quelea							
(*Quelea quelea*)	W	4	3		7	19.5	1, 10, 11

Table 2. Continued.

SPECIES	HABI-TAT[a]	NUMBER TAKEN				MASS (g)	REFERENCE[b]
		A	B	C	TOTAL		
Blue Waxbill							
(*Uraeginthus angolensis*)	W	1			1	10.4	1
Unidentified widowfinches							
(*Vidua* sp.)	W	2			2	12–14	1
Unidentified canaries							
(*Serinus* sp.)	W	2			2	12–14	1
Golden-breasted Bunting							
(*Emberiza flaviventris*)	W		1		1	19.4	1
Rock Pratincole							
(*Glareola nuchalis*)	O					53.0	4
Richard's Pipit							
(*Anthus novaeseelandiae*)	O	1			1	24.1	1
Anthus sp.	O					25.0	12
Red-capped Lark							
(*Calandrella cinerea*)	O	1			1	25.9	1
Unidentified small to medium-sized birds		11	28	2	41	10–50	1, 4, 7
Insects		(6)			(6)		
Dung beetle							
(*Aphodius* spp.)		2			2		1
Wasp							
(Hymenoptera sp.)		1			1		1
Locusts/large grasshoppers							
(Orthoptera)		3			3		1
Butterflies							
(Lepidoptera)							13
Total prey		44	38	13	95		

[a] Cl = cliff; W = woodland; O = other.

[b] Data sources are: 1 = this study, 2 = Moller 1989, 3 = Hartley and Mundy 1990, 4 = Dowsett 1983, 5 = Woodall 1971, 6 = Benson and Smithers 1958, 7 = Holliday 1965, 8 = Black 1983, 9 = Brooke and Howells 1971, 10 = Madge 1971, 11 = Dowsett 1977, 12 = Benson 1961, 13 = Hunter et al. 1979.

Dare pers. comm.). Broad-billed Rollers are known to be aggressive toward other birds, especially raptors (Dean 1989), and so it is likely that the attacks by the Taita Falcons were aggressive rather than predatory.

DISCUSSION

This is the first time that Taita Falcons have been confirmed breeding in northern Zimbabwe, although breeding has been suspected (Irwin 1981). Taita Falcons have been found breeding on small granite inselbergs in Malawi and Zambia by Hunter et al. (1979) and J.D. Weaver (unpubl.), respectively. Black (1983) reported a 15 m southwest-facing sandstone cliff, where breeding had been recorded for 3 yr by D. Cumming (in Hustler 1989) and also in 1978 and 1979 (K.

Worsley and G. Sharp pers. comm.). This site was similar to N4, a nest hole 1 m below the summit. Cliff hole sites are normal (Colebrook-Robjent 1977, Moller 1989), although sheltered ledges have been recorded as well (Benson and Smithers 1958, Hartley and Mundy 1990, Jenkins et al. 1991, J.D. Weaver unpubl.) and in this respect the Taita Falcon most likely competes with the Peregrine Falcon (Thomson 1984, Moller 1989, Hustler 1989, pers. obs.), *contra* the report in Dowsett (1983).

The laying period is in accordance with other published accounts for the Taita Falcon in southern Africa, namely Colebrook-Robjent (1973) with two for September, Dowsett (1983) with one for August–September and Jenkins et al. (1991) with one for September.

While Hunter et al. (1979) estimated correctly that a pair in Malawi laid at the end of August contrary to the skepticism of Dowsett (1983), the two July dates given by Benson et al. (1971) either appear to have been incorrectly assigned or the original sources are lacking, based as they were on Benson and Smithers (1958) and Holliday (1965). Together with the five records supplied in this account, plus another five from R.R. Hartley (unpubl.), dates are summarized as one for late August, one for August–September, 14 for September, and one for October.

Timing of laying may be due to the presence of peregrines, always found breeding nearby. In this study Taita Falcons laid, on average, 21 d later (range 13–32 d, $N = 5$) than peregrines nesting in the same vicinity. The peregrine is some 60% larger and the presence of Peregrine Falcons may explain why Taita Falcons are more discreet around the nest, especially during courtship. Consequently, Taita Falcons may lay shortly after the peregrines to avoid any contact when the peregrines are displaying. Peregrines are aggressive around the nest at this time and they will hunt smaller raptors (pers. obs.). The Taita Falcons then intensify their breeding activity when the peregrines are incubating, a period when the latter are also discreet and unobtrusive.

At Mt. Elgon (Moller 1989) and in two intensively surveyed areas of Zimbabwe, Taita Falcons were outnumbered by peregrines, the latter tending to occupy the more dominant cliffs. In Zimbabwe peregrines used cliffs with a more extensive outlook (pers. obs.). For example, at N3 peregrines nested at the outlets of the gorge, while at N4 and N5 they were on the highest outliers. Also peregrines mainly chose the more shaded south-facing slopes (pers. obs.), while the Taita Falcons sometimes were left to accept faces with a less favorable westerly aspect. This accords with Moller (1989), Hustler (1989) and J.D. Weaver (unpubl.) who concluded also that Taita Falcons have been forced to accept less favorable nest sites.

Utilization of a small home range (Hunter et al. 1979) may be also a factor influencing the Taita Falcon's relative rarity compared with the peregrine. By contrast, the peregrine uses a much larger home range—up to 12 km from the nest site (pers. obs.), and it can take a much wider range of avian prey (Mendelsohn 1988, pers. obs.). Prey overlap between the two falcons includes swifts (*Apus* sp.), swallows and martins (*Hirundo* sp.; Hustler 1989, pers. obs.), Green Pigeons, Red-winged Starlings (*Onychognathus morio*), Green-spotted Doves (*Turtur chalcospilos*) and Red-billed Que-

leas (pers. obs.). Both Taita and Peregrine Falcons employ similar methods of hunting and potentially all of the prey taken by the Taita can be taken by the peregrine. Consequently there must be some competition for prey (Hustler 1989) *contra* Moller (1989). Despite these constraints, the proximity of breeding peregrines 300 m away did not appear to have affected the success of the Taita Falcons at N1, contrary to the suggestion of Hustler (1989).

Productivity was low for a species of this size, comparing unfavorably with 1.63 young fledged per site ($N = 8$) by the peregrines found in the same zones over the same period (R.R. Hartley unpubl.). Although the Taita Falcons appeared to have no difficulty in obtaining prey at the gorge sites, it is possible that the other sites were not as well provisioned, while two of these with an adverse aspect did not produce young.

Prey size accords with Dowsett (1983) and Moller (1989) for birds and with Hunter et al. (1979) for insects, and the taking of larger prey (above 50 g) must be regarded as unusual (Dowsett 1983). It is not inconceivable, however, for a Taita Falcon to kill prey slightly larger than itself such as a Green Pigeon or Purple-crested Lourie. However, Mathews (1986) presented a questionable record of a young Helmeted Guineafowl (*Numida meleagris*) being carried by a Taita Falcon. This may have resulted from the misidentification of a juvenile female peregrine as a Taita Falcon. Even a large Taita female (346 g; Hartley and Heinrich 1991) would find it impossible to carry a juvenile guineafowl. By contrast female peregrines weigh 650 to 800 g (pers. obs.) and have taken male Swainson's Francolin (*Francolinus swainsonii*; Hustler 1983) and guineafowl (R.R. Hartley unpubl.). Meinertzhagen (1959) recorded a juvenile Taita Falcon (confirmed by Benson [1960]) chasing a tame pigeon. It is not unusual amongst raptors for young juveniles to chase larger prey items before they gain sufficient experience (Sherrod 1983, pers. obs.).

During the breeding cycle Moller (1989) recorded mainly cliff dwelling birds as prey. However, he also recorded a significant number of seed-eaters such as weavers (*Ploceus* sp.) which in this study comprised 33.3% of the prey. Food caching by Taita Falcons has been reported by Dowsett (1983) and Moller (1989) and it has been explained for falcons in general by Cade (1982) and Gleason and Bolland (1991).

Only the "kree kree" vocalization of the small chicks (Dowsett 1983) and the aggressive "kekking" (Colebrook-Robjent 1977) calls have been recorded before. Vocalizations are very similar to the Peregrine Falcon

(Cade 1982, pers. obs.) and we agree with Cade's statement: "There seems to be an exact homolog for each of the peregrine's calls, and I take this fact as strong evidence of close phylogenetic affinity between the two species."

ACKNOWLEDGMENTS

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OBSERVATIONS ON THE COMPARATIVE BEHAVIORAL ECOLOGY OF HARRIS' HAWK IN CENTRAL CHILE

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ABSTRACT.—Throughout one year we observed the behavioral ecology of Harris' Hawks (*Parabuteo unicinctus*) in central Chile. The hawks' activity period lacked diel or annual variation. Their most common flight mode was soaring in thermals and wind updrafts, rarely using flapping flight, and never hovering. Harris' Hawks appeared to select physiographic features that favored the presence of updrafts, particularly north- and west-facing slopes and ridgetops, but were also commonly seen flying over ravines (where they perched frequently). Prey were primarily small- and medium-sized mammals, and secondarily medium-sized birds. Although not aggressive, Harris' Hawks were nonetheless attacked by two other sympatric raptors, Black-chested Eagles (*Geranoaetus melanoleucus*) and Red-backed Hawks (*Buteo polyosoma*). These three species, which were studied over the same period and with the same techniques, were similar in activity and behavior, although Harris' Hawks were slightly more different than the latter were between themselves.

Observaciones sobre la ecología conductual comparativa de peucos en Chile central

RESUMEN.—Por un año observamos la ecología conductual del peuco (*Parabuteo unicinctus*) en Chile central. El período de actividad de los peucos no difirió ni dentro del día ni a lo largo del año. Su modo de vuelo más común fue el planeo en corrientes térmicas y de obstrucción, raramento usando el vuelo batido y nunca el revoloteo. Los peucos parecieron seleccionar características fisiográficas que favorecían la presencia de corrientes ascendentes, particularmente las laderas de exposición norte y oeste y las cimas, pero también se los veía volando sobre quebradas (en donde también se posaban). Sus presas eran principalmente mamíferos de tamaños pequeño y mediano, y secundariamente aves de tamaño mediano. Aunque los peucos eran poco agresivos, eran atacados por otras dos especies simpátridas de rapaces, el águila (*Geranoaetus melanoleucus*) y el aguilucho (*Buteo polyosoma*). Estas tres especies, que fueron estudiadas en el mismo período y con las misma técnicas, eran similares en actividad y conducta, aunque los peucos eran ligeramente más diferentes que las otras dos entre ellas.

[Traducción Autores]

The Harris' Hawk, *Parabuteo unicinctus,* is distributed from the southwestern United States in the north through Central and South America to central Chile and Argentina (Brown and Amadon 1968). The species has been relatively well studied in North America (e.g., Mader 1975a, Bednarz et al. 1988 and references therein). By contrast, little has been published about the species elsewhere in Central and South America. To our knowledge, the only reports come from Chile and cover its diet (Jaksić et al.

1980), food-niche relationships with other sympatric predators (Jaksić et al. 1981), and conservation status (Jaksić and Jiménez 1986). Here we report on aspects of the behavioral ecology of the Harris' Hawk near its southernmost distributional limit. This study is based on one year of observations made in central Chile concurrent with those made on two other sympatric raptors: Black-chested Eagle (*Geranoaetus melanoleucus*; Jiménez and Jaksic 1989) and Red-backed Hawk (*Buteo polyosoma*; Jiménez and Jaksić 1991). Because this is the last report of this series, we take the opportunity to make comparisons between the behavioral ecology of the Harris' Hawk and the two other species.

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STUDY SITE AND METHODS

The study site is described in Jiménez and Jaksić (1989). Briefly, San Carlos de Apoquindo (33°23'S 70°31'W) is a rugged area 20 km E of Santiago in the Andean foothills with elevations ranging from 1050–1915 m. The physiography includes both flat areas and numerous ridges dissected by deep ravines. The climate is mediterranean, with cool, rainy winters and dry, hot summers. The wind blows westwardly from the valley to the mountains during the daytime. The dominant vegetation is an evergreen scrub (very similar to the California chaparral) that changes physiognomy depending on topography and orientation.

Based on the number and duration of sightings, the Black-chested Eagle was the most common raptor at the site, having been sampled (timed with a stopwatch) for nearly 93 hr over a calendar year (Jiménez and Jaksić 1989); the second most common raptor was the Red-backed Hawk, observed for nearly 29 hr timed (Jiménez and Jaksić 1991). Harris' Hawk ranked third in this respect, having been monitored for 13 hr over the same sample period.

Following the same protocol used for the other two species, for each Harris' Hawk observed we recorded: 1) time of observation and duration of activity, 2) activity type, and 3) habitat beneath bird. We recognized the following activity types (cf. Jiménez and Jaksić 1989 for detailed description): thermal soaring, wind soaring, cruising, hovering, harassing, perching, and miscellaneous behavior. We recognized the following habitat types (cf. Jiménez and Jaksić 1989 for detailed description): flatlands, ravines, ridgetops, and slopes (east-, west-, south-, and north-facing). We mapped these habitats and calculated their surface areas (slope-corrected) with a digital planimeter from a high-resolution aerial photograph. The physiognomy of each habitat type, in terms of the vegetative cover represented by trees, shrubs, herbs, bare ground, and rocks, as well as estimated prey numbers, were reported in Jiménez and Jaksić (1989).

We made observations with binoculars from the top of a hill, from dawn to dusk, with the day divided into six equal-time intervals (see Jiménez and Jaksić 1989). Observations took place during one entire day every other week between 1 August 1984 and 1 August 1985. We pooled a total of 780 min of sampling into four seasons: spring (1 August to 30 October), summer (1 November to 31 January), fall (1 February to 30 April), and winter (1 May to 31 July). We used one- or two-way ANOVA for unequal sample sizes (Sokal and Rohlf 1981:210, 360), with PROC GLM in SAS (1985), and the Student-Newman-Keuls test for a posteriori contrasts (SAS 1985:444). For analyzing frequency data, we used the G statistic (Sokal and Rohlf 1981:695). It should be noted that the assumption of independence of data is violated in behavioral studies, because what a bird does one minute is very likely to influence what it will be doing the next minute. However, this should affect more strongly comparisons made within a season than between seasons. Still, the P-values calculated should be considered imprecise and our interpretations of differences and similarities taken cautiously.

We identified prey remains found under perches and one nest, and from regurgitated pellets. Prey were identified with standard procedures (Marti 1987), as exemplified by Jiménez and Jaksić (1989) and Pavez et al. (1992) for sympatric Black-chested Eagles.

RESULTS AND DISCUSSION

Activity levels (measured in minutes) did not differ among times of the day ($F = 1.74$, df $= 5$, $P > 0.12$), nor with season ($F = 1.73$, df $= 3$, $P > 0.16$); the interaction between these variables was significant ($F = 1.91$, df $= 15$, $P < 0.03$). Indeed, Harris' Hawks were observed throughout the day with no clear peaks of activity in any interval of the day, or in any particular season. Thus, Harris' Hawks differed from sympatric Black-chested Eagles, which had a bimodal activity period throughout the year, and from Red-backed Hawks, which were more active during summer and least active during winter.

Thermal soaring was the most common flight mode throughout the year, ranging from 47% (winter) to 16% (summer) of the observed time (Table 1). Wind soaring was the second most prevalent flight mode, accounting for 37% (fall) to 16% (summer) of the activity time. Harris' Hawks spent most of their time perched during summer (64%), but very little during winter (4%). The remaining activities (Table 1) accounted at the most (during winter) for 19% of the daily activity period, and for less than 7% during the remaining seasons. It should be noted that our sampling technique (observing from a hilltop) may have biased our detections toward soaring birds and away from perching Harris' Hawks and those making short low flights. Unlike sympatric Black-chested Eagles (Jiménez and Jaksić 1989) and Red-backed Hawks (Jiménez and Jaksić 1991), Harris' Hawks apparently did not hover, and spent little time in agonistic interactions (Table 1).

Observed occurrences of Harris' Hawks (in minutes) differed both among habitat types ($F = 18.06$, df $= 6$, $P < 0.0001$) and among seasons ($F = 3.53$, df $= 3$, $P < 0.02$); there was a significant interaction between these variables ($F = 2.13$, df $= 18$, $P < 0.004$). Throughout the year, Harris' Hawks flew more often over north-facing slopes (from 59% in summer to 19% in winter), secondarily over west-facing slopes, ravines, and ridgetops (from 35% to 3% in different seasons), and very little over flatlands, south- and east-facing slopes (Table 2). Except for the latter three, there were clear seasonal shifts in the use of the remaining four habitat types (SNK a posteriori test, $P < 0.05$ in all cases). West-facing slopes were used more during fall and winter

Table 1.   Time (in minutes) spent by Harris' Hawks in different activities in central Chile, 1984–1985.

ACTIVITY	SPRING[a] $N = 12$ d	SUMMER $N = 12$ d	FALL $N = 6$ d	WINTER $N = 7$ d
Thermal soaring	8.3 ± 4.8[b]	3.5 ± 1.9	8.4 ± 7.7	5.2 ± 3.9
% time	34.4	15.8	34.3	47.3
Wind soaring	5.8 ± 3.3	3.5 ± 2.1	9.1 ± 4.1	3.3 ± 1.9
% time	24.2	15.8	37.1	30.0
Cruising	1.5 ± 1.0	0.8 ± 0.5	1.3 ± 1.0	2.1 ± 1.3
% time	6.2	3.6	5.3	19.1
Hovering	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0
% time	0.0	0.0	0.0	0.0
Harassing	0.0 ± 0.0	0.1 ± 0.1	0.1 ± 0.1	0.0 ± 0.0
% time	0.0	0.4	0.4	0.0
Perching	8.3 ± 5.9	14.3 ± 14.5	5.4 ± 8.1	0.4 ± 0.5
% time	34.4	64.4	22.1	3.6
Other	0.2 ± 0.2	0.0 ± 0.0	0.2 ± 0.2	0.0 ± 0.0
% time	0.8	0.0	0.8	0.0
Total time/period	24.1 ± 10.6	22.2 ± 13.9	24.5 ± 16.0	11.0 ± 5.2
Total time/season	289.2	266.4	147.0	77.0

[a] See Methods section for periods involved.
[b] Mean number of minutes this activity was observed per day ± two standard errors.

than in other seasons, while the reverse happened with regard to north-facing slopes (Table 2).

Jiménez and Jaksić (1989) showed that the areal representation of different habitat types in the study site was as follows: north-facing slope (26%), south-facing slope (19%), ridgetop (18%), west-facing slope (14%), flatland (9%), ravine (7%), and east-facing slope (7%). Harris' Hawks thus appeared to avoid flying over south-facing slopes and flatlands, while they concentrated on ravines (Table 2). The near

Table 2.   Time (in minutes) spent by Harris' Hawks on seven habitat types in central Chile, 1984–1985.

ACTIVITY	SPRING[a] $N = 12$ d	SUMMER $N = 12$ d	FALL $N = 6$ d	WINTER $N = 7$ d
Flatland	0.1 ± 0.2[b]	0.4 ± 0.5	0.4 ± 0.5	0.7 ± 1.3
% time	0.4	1.8	1.6	6.4
Ravine	7.9 ± 3.9	4.7 ± 4.3	3.5 ± 2.6	0.7 ± 0.6
% time	32.8	21.2	14.3	6.4
Ridgetop	4.0 ± 3.7	2.1 ± 2.1	5.6 ± 5.8	1.8 ± 2.2
% time	16.6	9.4	22.9	16.3
North slope	9.2 ± 5.5	13.1 ± 14.9	4.8 ± 4.9	2.1 ± 1.6
% time	38.2	59.0	19.6	19.1
South slope	0.5 ± 0.4	1.2 ± 1.2	2.9 ± 1.9	1.1 ± 1.8
% time	2.1	5.4	11.8	10.0
East slope	0.0 ± 0.0	0.0 ± 0.0	0.1 ± 0.1	0.8 ± 1.0
% time	0.0	0.0	0.4	7.3
West slope	2.4 ± 3.1	0.7 ± 0.8	7.2 ± 9.9	3.8 ± 2.6
% time	9.9	3.2	29.4	34.5
Total time/period	24.1 ± 10.6	22.2 ± 13.9	24.5 ± 16.0	11.0 ± 5.2
Total time/season	289.2	266.4	147.0	77.0

[a] See Methods section for periods involved.
[b] Mean number of minutes this activity was observed per day ± two standard errors.

Table 3. Prey of Harris' Hawks in central Chile, based on prey remains and pellets found under several perches and one nest, 1984–1985. Integer numbers are the absolute numerical representation of each prey item; numbers in parentheses are the percent numerical representation of major prey classes. Prey weights in grams.

PREY	WEIGHT	PELLETS	REMAINS	TOTAL
Mammals	—	(67.4)	(66.7)	(67.3)
Rodentia				
Abrocoma bennetti (Bennett's chinchilla rat)	231	5	1	6
Akodon longipilis (Hairy field mouse)	63	1	0	1
Akodon olivaceus (Olivaceous field mouse)	44	1	0	1
Octodon degus (Fence degu rat)	184	20	3	23
Oryzomys longicaudatus (Long-tailed rice rat)	36	3	0	3
Lagomorpha				
Oryctolagus cuniculus (European rabbit)[a]	1300	18	12	30
Mammals unidentified	—	47	0	47
Birds	—	(19.8)	(29.1)	(21.2)
Tinamiformes				
Nothoprocta perdicaria (Chilean Tinamou)	400	1	1	2
Columbiformes				
Zenaida auriculata (Eared-dove)	125	0	1	1
Galliformes				
Callipepla californica (California Quail)	200	0	1	1
Piciformes				
Unidentified	100	1	0	1
Passeriformes				
Mimus thenca (Chilean Mockingbird)	65	1	2	3
Curaeus curaeus (Austral Blackbird)	90	1	1	2
Sturnella loyca (Red-breasted Meadowlark)	110	1	0	1
Anairetes parulus (Tufted Tit-tyrant)	11	1	0	1
Birds unidentified	—	21	1	22
Bird egg	—	1	0	1
Reptiles	—	(7.8)	(4.2)	(7.3)
Sauria				
Liolaemus sp. (Unidentified lizard)	15	4	0	4
Callopistes palluma (Chilean racerunner)	65	4	1	5
Serpentes				
Philodryas chamissonis (Long-tailed snake)	150	3	0	3
Insects		(5.0)	(0.0)	(4.2)
Coleoptera				
Buprestidae	<1	1	0	1
Scarabaeidae	<1	5	0	5
Insects unidentified	<1	1	0	1
Total number of prey	—	141	24	165

[a] Both adults and juveniles; the weight indicated is for adults.

proportional use of north-facing slopes and ridgetops may be explained because these habitat types receive more direct solar radiation, and thus probably generate more thermal drafts. Similarly, west-facing slopes receive radiation from the setting sun, and are swept by the prevailing westerly wind (Jiménez and Jaksić 1989). In contrast, south-facing slopes and flatlands received relatively low amounts of incident radiation and were sheltered from prevailing winds. Harris' Hawks behaved similarly to Black-chested

Eagles (Jiménez and Jaksić 1989) and Red-backed Hawks (Jiménez and Jaksić 1991), except for flying much more often over the cool and windless ravines.

The amount of time perching in different habitat types was not related to their relative availability (G = 20.0, df = 4, P < 0.001). In 42% of 45 sightings, Harris' Hawks were perched in north-facing slopes, 33% were perched in ravines, 11% in ridgetops, 9% in west-, and 5% in south-facing slopes. We never saw Harris' Hawks perching in flatlands or east-facing slopes. These findings are similar to those reported for Black-chested Eagles (Jiménez and Jaksić 1989) and Red-backed Hawks (Jiménez and Jaksić 1991), except for perching in ravines. Note that order of preference for habitat types used for perching by Harris' Hawks was the same as for flying over. The apparent preference for perching on north-facing slopes may be because they afford easy access to updrafts. The preference for perching in ravines may be associated to the higher densities of mammalian prey in those areas (cf. data in Jiménez and Jaksić 1989).

Perch substrates were not used homogeneously (G = 48.0, df = 8, P < 0.001). In decreasing order, perches used were standing dead trees (33%), live trees of *Quillaja saponaria* (29%), live trees of *Lithraea caustica* (16%), boulders (9%), standing dead bromeliads (7%), live trees of *Kageneckia oblonga* (2%), of *Porlieria chilensis* (2%), and live columnar cacti (2%). Sympatric Black-chested Eagles (Jiménez and Jaksić 1989) and Red-backed Hawks (Jiménez and Jaksić 1991) displayed roughly the same perching preferences. All these structures were above the general level of the scrub canopy, and probably provided good visibility and easy access to updrafts.

Aggressive encounters (harassment) were observed only during summer and fall, and occupied less than 1% of the Harris' Hawks' time (Table 1). Red-backed Hawks (weight = 975 g) initiated 53 attacks on Harris' Hawks and received 48 attacks (Jiménez and Jaksić 1991), Black-chested Eagles (weight = 2378 g) perpetrated 49 and received 62 attacks (Jiménez and Jaksić 1989), and conspecifics (weight = 876 g) initiated 13 and received 7 attacks throughout the same observation period. Black-chested Eagles were about as frequently harassed by conspecifics as by other species (49% of attacks on Black-chested Eagles were allospecific; cf. Jiménez and Jaksić 1989), whereas Red-backed Hawks were slightly more frequently harassed by other species than by conspecifics (55% of allospecific attacks; cf.

Jiménez and Jaksić 1991). Harris' Hawks were infrequently harassed by conspecifics (23% of the attacks) and primarily by Red-backed Hawks (46%) and Black-chested Eagles (31%) which are larger. None of these agonistic encounters involved prey, unlike the situation reported by Bildstein (1987) for sympatric Red-tailed Hawks (*Buteo jamaicensis*) and Rough-legged Hawks (*B. lagopus*) in Ohio.

Because pellets found under perches and remains found under the one nest sampled were collected in the same habitat and time of the year, a comparison is warranted. Mammalian prey were equally represented among pellets and nest remains, avian prey were comparatively underrepresented among pellets, and the reverse occurred with both reptilian and insect prey (Table 3). Overall, the differences in prey composition were not dramatically different between pellets and nest remains. Harris' Hawks in this locality consumed primarily small- (rodents) and medium-sized mammals (rabbits), and secondarily medium-sized birds (several orders). Lizards and snakes were minor components of their diet, and insects were almost insignificant in biomass. No comparable data are available for sympatric Red-backed Hawks (Jiménez and Jaksić 1991), but for Black-chested Eagles Jiménez and Jaksić (1989) and Pavez et al. (1992) showed that their diet in the same locality is similar to that reported here for Harris' Hawks. Major differences are the lack of insect consumption by the eagles, the relatively higher consumption of reptiles, and the lower consumption of birds.

It is noteworthy that throughout the study period, no evidence was observed of cooperative breeding and/or hunting, as is common in North America (Mader 1975b, 1979, Bednarz 1987, 1988).

In summary, Harris' Hawks were slightly more different in terms of activity and behavior than were Black-chested Eagles and Red-backed Hawks. Among the most remarkable differences between Harris' Hawks and the others were: (a) they lacked diel or annual differences in activity levels, (b) they did not use hovering as a flight mode, (c) they spent more time flying over ravines, (d) they used perches in ravines more often, and (e) they showed lesser aggressiveness.

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DO PEREGRINE FALCON FLEDGLINGS REACH INDEPENDENCE DURING PEAK ABUNDANCE OF THEIR MAIN PREY?

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Abstract.—Peregrine Falcons (*Falco peregrinus*) in southeast Australia are said to hatch their young when prey is most abundant. Fledgling and adult prey numbers, however, peak after Peregrine Falcon young fledge and not while they are in the nest. This may increase survival of young Peregrine Falcons by allowing them time to learn to hunt difficult prey.

¿Los volantones de *Falco peregrinus* alcanzan su independencia durante el máximo de abundancia de su presa principal?

Resumen.—Se ha documentado que *Falco peregrinus*, en el sudeste de Australia, independiza a los juveniles cuando la presa principal es más abundante. Sin embargo, la máxima abundancia de volantones y adultos de la presa ocurre después de que los juveniles de *F. peregrinus* dejan el nido, y no mientras ellos stán en él. Esto podria incrementar la supervivencia de los juveniles de *F. peregrinus*, por un aumento del tiempo disponible para aprender a cazar presas difíciles.

[Traducción de Ivan Lazo]

Two major studies of the diets of Peregrine Falcons (*Falco peregrinus macropus*) in southeast Australia have established that Peregrine Falcons prey almost exclusively on birds. In Victoria, Galah (*Cacatua roseicappila*), Crimson Rosella (*Platycercus elegans*), Eastern Rosella (*Platycercus eximius*), Rock Dove (*Columba livia*), and European Starling (*Sturnus vulgaris*) were the main prey during the breeding season (60.75% by number, ca. 90% by weight; Pruett-Jones et al. 1980). Peregrine Falcons near Canberra showed similar tendencies in a year-round study of diet (P. Olsen, J. Olsen and I. Mason unpubl.). Ninety-six percent of prey items were birds and, as in Victoria, Galahs, Crimson Rosellas, Eastern Rosellas, Rock Doves and European Starlings were the main prey (66% of the breeding and non-breeding diet by number). In both studies, these five main prey species made up about 90% of the diet by weight, and parrots made up about 50% of the diet by weight.

Rock Doves are available year round as prey in southeast Australia because they breed year round (Frith 1982) and some are used throughout the year for pigeon racing. The other four species breed seasonally, but nest in tree cavities so nestlings are not readily available as prey. However, their fledged young, which have a pronounced peak in abundance each year, are available to Peregrine Falcons as prey.

Lack (1966) surmised that breeding seasons of single-brooded species had evolved so their young normally hatch in the most favorable period for parents to raise them, usually when food is most abundant. However, it is not clear whether Peregrine Falcons breed when peak food abundance and availability coincide with: 1) peak demand for food by the female when preparing her eggs, 2) when parents are feeding young in the nest, 3) when the young have fledged but are still dependent on food gathered by the parents, or 4) after young reach independence. Newton (1979) applied Lack's ideas to raptors and concluded that raptors are feeding young during the period of peak food supply. The prey most easily captured are fledglings and juveniles that have just left the nest and can move around but cannot fly strongly. Newton (1986) found that the first appearance of prey fledglings ended the season of lowest food supply for Sparrowhawks (*Accipiter nisus*), and that the hawks first laid eggs 5–10 days after fledglings of prey species first appeared. He also found that the majority of the hawks had young when prey fledgling supply peaked. Fledglings formed more than half of all prey eaten by Sparrowhawks at this time.

Young of arctic Peregrine Falcons (*F. p. tundrius*) are also said to hatch when prey is most abundant (Cade 1960, Harris 1981). This finding is supported

by studies in South Greenland where the first fledg-
ing passerines—Wheatears (*Oenanthe oenanthe*),
Redpolls (*Carduelis flammea*), Lapland Longspurs
(*Calcarius lapponicus*) and Snow Buntings (*Plectro-
phenax nivalis*)—emerge when Peregrine Falcons are
hatching their young. These species are primary
prey of Peregrine Falcons in this region (Falk and
Moller 1988).

Pruett-Jones et al. (1980, p. 261) suggested that,
for Peregrine Falcons in southeastern Australia, ". . .
the young hatch when other species that act as prey
ought to be most abundant" and Olsen (1982, p.
288) states ". . . the main flush of adult and fledgling
prey coincides with the nestling and fledgling periods
of the peregrine." However, the breeding times of
prey species were not examined in either of these
papers.

An alternative view is that just-fledged Peregrine
Falcons in southeast Australia have fledgling Galahs
and other parrots available so they can learn to hunt
this easier prey instead of more experienced prey
(Olsen 1974, Sherrod 1983). The Peregrine Falcon
nestling period would occur before the peak in prey
abundance.

In this study we compare Peregrine Falcon breed-
ing phenology in Victoria and near Canberra with
the seasonal abundance of nestling, fledgling, and
adult Galahs, Crimson Rosellas, Eastern Rosellas
and European Starlings. We examined the two hy-
potheses developed above which predict either a close
match between a peak in prey abundance and a peak
in food needs during the nestling period or shortly
after fledging or, alternatively, a peak in prey abun-
dance after Peregrine Falcon young have fledged and
are reaching independence.

MATERIALS AND METHODS

We based our analysis on four separate data sets: banded
nestlings, the Australian Nest Record Scheme, a survey
of fledged dependent young, and a survey of monthly bird
numbers.

Banding Records. Nestling Peregrine Falcons and their
prey are typically banded about 1–2 wk before fledging
when their legs are full grown but before there is a risk
of premature fledging through disturbance. Because of this
it is possible to use banding records to estimate the fledging
dates of Peregrine Falcons and their main prey. In our
first analysis, we used banding dates for nestling Galahs,
Eastern Rosellas, Crimson Rosellas and European Star-
lings from southern Australia. We compared these data
to banding dates for Peregrine Falcons in Victoria (Emison
and Bren 1980). Statistical analysis follows Sokal and
Rohlf (1969).

Nest Record Scheme. We extracted from the Nest Rec-

ord Scheme the months from 1975–83 when nestling Ga-
lahs, Crimson Rosellas, Eastern Rosellas and European
Starlings were found in nests in Victoria and near Can-
berra. This data set consists of records submitted by am-
ateur and professional ornithologists around Australia of
any nests visited that contain eggs or nestlings. Where they
recorded more than one visit to a single nest, only the last
record of nestlings was used. Thus, in our analysis, these
data are of older nestlings just before fledging. We com-
pared these records, by month, to data for 5-wk-old Per-
egrine Falcon nestlings (peregrines fledge at about 6 wk)
near Canberra (calculated from data in Olsen and Olsen
1989).

Recently Fledged Young Near Canberra. The third
data set came from a survey by the Canberra Ornitholo-
gists Group. We compared months when ornithologists
saw fledged dependent young of the four main prey species
near the Canberra Peregrine Falcon study area to the
months when these peregrines had nearly fledged nestlings
as in the second data set. Where a number of sightings of
the same brood were reported in the Canberra Ornithol-
ogists Group data, only the earliest sighting is counted
This gives the earliest dates that young were available as
prey to peregrines.

Bird Counts Near Canberra. In a fourth data set, we
analyzed 42 monthly estimates of all bird species counted
near the Canberra Peregrine Falcon study area (Olsen et
al. 1991) to determine whether the 77 species in general,
and the four main prey species in particular, peaked in
abundance while peregrines near Canberra had nestlings
(Oct.–Dec.) or while their young were fledging and achiev-
ing independence (Jan.–Mar.).

The banding and Nest Record Scheme data indicated
when prey species were likely to be available to Peregrine
Falcons as fledglings, though the evidence was indirect.
The data on bird abundance from Olsen et al. (1991)
showed the total abundance of adult and fledgling prey
birds during the peregrines' nestling period (Oct.–Dec),
and while Peregrine Falcon chicks are achieving indepen-
dence (Jan.–Mar.). The data for recently fledged young
from the Canberra Ornithological Group provided the
most direct estimate of availability of recently fledged prey
during the late Peregrine Falcon nestling period imme-
diately before those peregrines fledge.

RESULTS

Banding Records. The banding data for young
Eastern Rosellas, Crimson Rosellas, Galahs and Eu-
ropean Starlings spanned 5 mo with most nestlings
banded in Oct.–Dec., the same months in which
peregrines were most frequently banded (Fig. 1).
With the possible exception of early Galah broods,
the majority of prey species appear to fledge either
at the same time (Nov.–Dec.) or after young pere-
grines fledge. When all prey were compared to all
prey except European Starlings in Fig. 1, the mean,
standard deviations and ranges were similar indi-
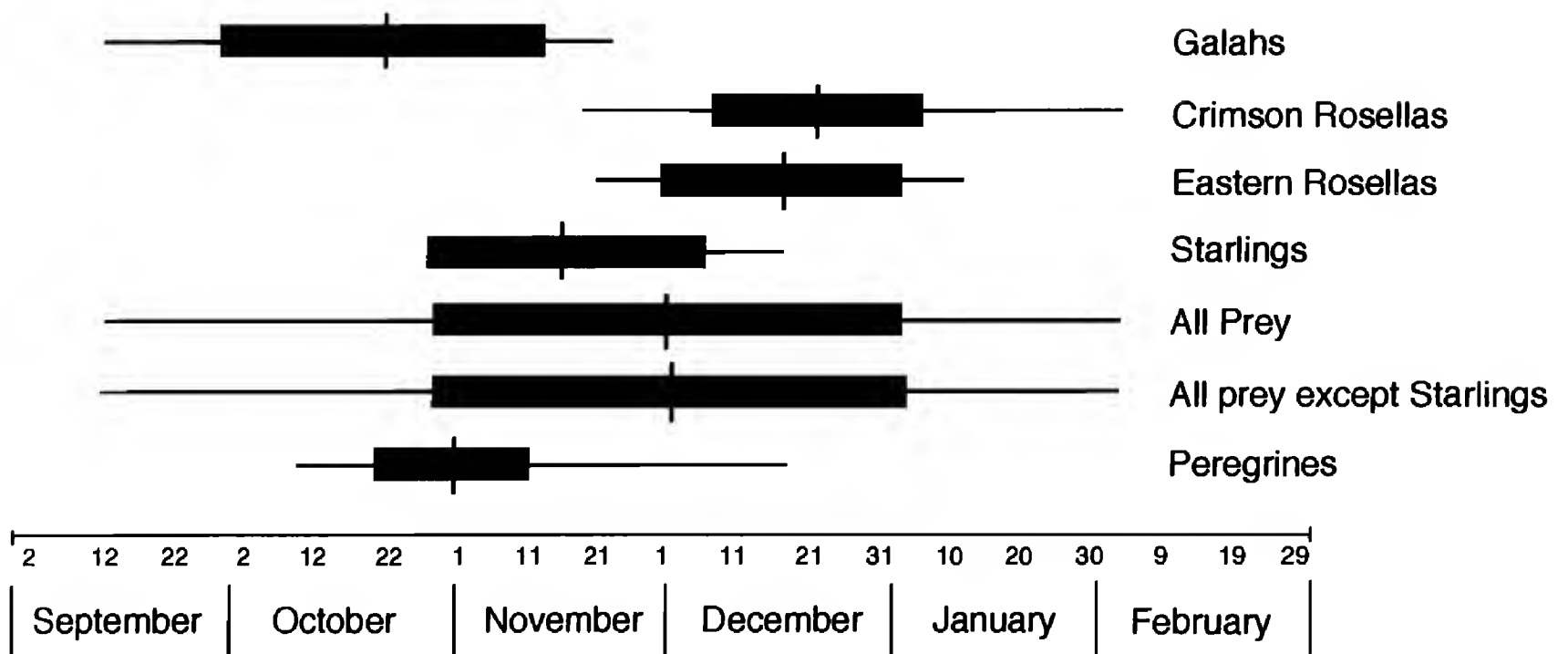cating that introduced European Starlings fledge

Figure 1.   Mean dates, standard deviations and ranges for dates when nestlings of the four main prey species and Peregrine Falcons were banded.

young at about the same time of year as native species. These results do not support the hypothesis that Peregrine Falcon hatching coincides with a peak in food. Because all of these prey species breed in tree cavities, the nestlings are unavailable as prey. Instead, peak abundance in prey species appears to occur after the peregrine offspring have fledged.

Nest Record Scheme. Nestling records for Eastern Rosella, Crimson Rosella, Galah and European Starling from the Nest Record Scheme, generally support the data from the banding scheme. Here

again the data clearly demonstrated a peak in nestling abundance coinciding with or following the peregrine nestling period (Table 1).

Recently Fledged Young Near Canberra. Counts of recently fledged young of the four main prey species generally supported the data from the banding and Nest Record Scheme. They showed a peak in abundance after Peregrine Falcon young had fledged though there appeared to be numbers of fledgling European Starlings available while peregrines had nestlings (Table 1).

Table 1.   Percent of young seen, in each month, of the four main prey species of Peregrine Falcons in southeast Australia (a = latest entries for each nest in the Nest Record Scheme, i.e., the last time young were seen in that particular nest. b = first records for just fledged dependent young from the Canberra Ornithological Group data, i.e., the first time fledged young were seen for each brood reported, and c = peregrine nestlings estimated from Olsen and Olsen (1989) to be 5 wk old).

		PERCENT OF YOUNG SEEN					
	(N)	SEPT.	OCT.	NOV.	DEC.	JAN.	FEB.
Eastern Rosella	a-75			44	39	15	1
	b-31	3	3	3	48	36	7
Crimson Rosella	a-63			16	75	10	
	b-55		6	9	29	38	18
Galah	a-43	19	16	56	9		
	b-78			30	36	19	15
European Starling	a-835	1	30	38	28	3	
	b-70		26	43	30	1	
Totals for main	a-958	5.0	11.5	38.5	37.75	7.0	0.25
prey species	b-234	0.75	8.75	21.25	35.75	23.5	10.0
Peregrine Falcon	c-234		3	91	6		

Table 2. Average number of birds seen per month of 77 potential prey bird species and of the four main prey species (Crimson Rosellas, Eastern Rosellas, Galah and European Starlings) counted near Canberra from Jun. 1982–Jan. 1986 (Olsen et al. 1991). Seasons are: spring (Oct.–Dec.) when peregrine chicks are being fed as nestlings and as fledglings; summer (Jan.–Mar.) when peregrine chicks are achieving independence; autumn (Apr.–Jun.) when there is no breeding activity; and winter (Jul.–Sept.) when peregrines initiate breeding and egg-laying.

SEASON	PEREGRINE FALCON BREEDING STAGE	NUMBERS OF ALL 77 BIRD SPECIES SEEN/ MONTH	NUMBERS OF FOUR MAIN PREY SPECIES SEEN/ MONTH
Spring	young fed by parents	322	60
Summer	independence of young	492	165
Autumn	non-breeding	459	110
Winter	laying eggs	380	124

Bird Counts Near Canberra. Bird numbers, for all species analyzed by Olsen et al. (1991) peaked during summer and autumn when nestling Peregrine Falcons had fledged and were gaining independence (Table 2). Bird numbers were at their lowest during spring when Peregrine Falcons were feeding young in the nest. This pattern was even more pronounced when only the four major prey species were considered (Table 2).

DISCUSSION

The young of cavity-nesting species, including the four major prey species were not available to Peregrine Falcons until the prey fledged. The peak of fledged prey did not occur when peregrines were feeding their nestlings, but during summer and autumn after peregrine young had fledged. Birds generally, and the four main prey species in particular, were most abundant after the peregrines fledged. Starlings may be one species that is more available to nestling peregrines than other prey species. We believe these measures of adult and fledgling bird prey abundance are also good measures of bird prey availability because adult and fledglings of the four main prey species are generally seen in open areas and do not leave the general region where they breed (Taylor and C.O.G. 1992).

Peregrine Falcons need about 4 mo to complete a breeding cycle. Breeding later in the year than they currently do could increase the quantity of food available to adults when feeding their young in the nest, but fledged peregrines would then encounter smaller populations of inexperienced prey fledglings. Experienced parrots, European Starlings, and other prey are much more difficult for recently fledged Peregrine Falcons to capture. British Falconers described how they caught young inexperienced bird prey with young inexperienced falcons, but this became more difficult as the season progressed and the quarry gained experience (Michell 1900). As the year progresses, young prey may flock together or learn to use cover and make hunting more difficult or dangerous for falcons (Olsen 1989). For raptors feeding primarily on birds, prey abundance at the time of rearing nestlings, and prey abundance *per se* at the time of fledging, may not be the most important considerations in the timing of the breeding season. Young Peregrine Falcons must learn to hunt inexperienced prey before this prey gains experience at evading capture. This strategy is likely to maximize survival and may be the ultimate factor in determining the timing of breeding.

Cade (1960), Harris (1981), and Falk and Moller (1988) have indicated that prey was abundant when arctic peregrines hatched their young, but Sherrod (1983) believed that arctic Peregrine Falcons hastened their departure southward because prey species migrate out of the north. These peregrines may find prey particularly abundant on their southern wintering grounds (Enderson et al. 1991), so fledged peregrines could gain hunting experience on juvenile prey that has migrated from the Arctic or is resident on these migration routes and wintering grounds.

We believe that recently fledged and recently independent Peregrine Falcons in Australia need young, inexperienced prey to learn to hunt and the data presented here indicate that the timing of breeding allows this to happen. Further studies are needed to determine whether fledged and recently independent young of different peregrine subspecies, or other raptor species need inexperienced prey in order to learn to hunt and whether they experience peaks in prey availability during the nestling, fledging or post-fledging stage of their breeding cycles.

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PRESENCE AND DISTRIBUTION OF MEXICAN OWLS: A REVIEW

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ABSTRACT.—Mexico has a rich owl assemblage, represented by 27 species. Eighteen of these species occur in the Nearctic and Neotropical regions, and nine species occur only in the Neotropical region. Their biology, ecology and distribution, however, are poorly known. We recorded 3683 specimens collected between 1840 and 1991 from 11 national and 37 foreign museums, and reviewed the literature concerning these owls. From these data we present a more unified distribution of Mexican owls. Four species, Barn Owl (*Tyto alba*), Great Horned Owl (*Bubo virginianus*), Ferruginous Pygmy-Owl (*Glaucidium brasilianum*) and Burrowing Owl (*Speotyto cunicularia*), have a wide distribution. The Balsas Screech Owl (*Otus seductus*) is endemic to the central Pacific region. Oaxaca and Michoacan had the highest owl species richness with 21 and 19 species, respectively. Aguascalientes, Campeche and Tlaxcala had the lowest owl species richness, four, five, and five respectively. The Ferruginous Pygmy-Owl was the most collected owl, representing 30.7% of the specimens, and the Unspotted Saw-whet Owl (*Aegolius ridgwayi*) the least with 0.19%. Of the Neotropical species, the Unspotted Saw-whet Owl, Striped Owl (*Asio clamator*), and Stygian Owl (*A. stygius*) are considered endangered by the Mexican government. The screech-owl group (*Otus*) and the Barred Owl (*Strix varia*)/Fulvous Owl (*S. fulvescens = S. v. fulvescens*) have uncertain distributions due to taxonomic uncertainties.

Presencia y distribución de los búhos Mexicanas: una revisión

RESUMEN.—México tiene una alta riqueza de especies de búhos, representada por 27 especies. Dieciocho de estas especies se encuentran tanto en la región neártica como en la neotropical, y nueve de las especies se localizan solo en la región neotropical. Su biología, ecología así como su distribución es poco conocida. Nosotros compilamos 3683 datos de especímenes de búhos colectados en México; con registros desde 1840 hasta 1991, de 11 museos nacionales y de 37 extranjeros, adicionalmente revisamos intensamente la literatura disponible. Combinando estos datos, damos una distribución unificada de los búhos de México. Cuatro especies, la Lechuza de Campanario (*Tyto alba*), el Búho Cornado Americano (*Bubo virginianus*), el Tecolotito Bajeño (*Glaucidium brasilianum*) y el Tecolote Zancón (*Speotyto cunicularia*) tienen una amplia distribución en el continente Americano. El Tecolote Ojioscuro del Balsas (*Otus seductus*) es endémico para la región del Pacífico Central de México. Los estados de mayor riqueza de especies fueron Oaxaca y Michoacán con 21 y 19 especies respectivamente, por el contrario los estados con menor riqueza fueron Aguascalientes, Campeche y Tlaxcala con 4, 5 y 5 respectivamente. El Tecolotito Bajeño ha sido la especie de búho más colectada, representando el 30.7% de los especímenes, y el que registro con menos colectas fué el Tecolote Abetero Sureño (*Aegolius ridgwayi*) representando tan solo el 0.19%. De las especies neotropicales, el Tecolote Abetero Sureño, el Búho Cornado Cariblanco (*Asio clamator*) y el Búho Cornado Oscuro (*A. stygius*) son consideradas como amenazadas por el gobierno Mexicano. El grupo Otus así como el Búho Serrano Vientrirrayado (*Strix varia*)/Búho Serrano Sureño (*S. fulvescens = S. v. fulvescens*) tienen distribuciones controversiales debidas a su clasificación incierta.

[Traducción Autores]

Currently, there are 178 species of owls recognized in the world (Sibley and Alhquist 1990), of which 27 (15%) species occur in Mexico. This exceeds the owl species diversity (*N* = 22) of northern forests, north of 35° (Norberg 1987). Although, there is some overlap.

Owls in Mexico have been little studied and most literature is old (Ridgway 1895, Kelso and Kelso

Figure 1. Map of the Mexican Republic showing locations of 32 states.

1936, Moore 1937a, 1937b, 1941, 1947a, Moore, and Peters 1939, Alvarez del Toro 1949, Briggs 1954, Moore and Marshall 1959, Buchanan 1964, Northern 1965). Generally, most Mexican owl species have limited morphological descriptions and only approximated distributions (Friedman et al. 1950, Blake 1972, Davis 1972, Peterson and Chalif 1973, 1989, Edwards 1989). Unfortunately, these distributions are often controversial. Here, we present a review of the distribution and relative status of Mexican owls based on museum specimen data and available literature.

STUDY AREA AND METHODS

Mexico (2 million km²) has 32 states (Fig. 1) with >50% of the land mass above 1000 m elevation (Ramos 1985). Its 32 vegetation types (Rzedowski 1986), geographic location, and topography contribute to a rich diversity of fauna and flora.

To obtain information on Mexican owl specimens we wrote letters to or visited 11 national museums (Colección Ornitológica del Instituto de Biología, Colección Ornitológica de San Nicolás de Hidalgo, Universidad de Mi-

choacán, Escuela Nacional de Ciencias Biológicas, Instituto de Historia Natural de Chiapas, Instituto Nacional de Investigaciones Forestales y Agropecuarias-Bacalar, Instituto Nacional de Investigaciones sobre Recursos Bióticos, Laboratorio Natural de Las Joyas, Universidad de Guadalajara, Museo de Zoología de la Facultad de Ciencias, Museo de Zoología Iztacala, Salón de las Aves de Saltillo Coahuila, Universidad Autónoma de Baja California Sur and 37 foreign museums (Australian Museum, Anniston Museum of Natural History, Academy of Natural Sciences of Philadelphia, Bell Museum of Natural History, British Museum, Carnegie Museum of Natural History, Cornell University Collection, Collection Zoology Museum Amsterdam-Nederland, Denver Museum of Natural History, Delaware Museum of Natural History, Fort Hays Museum, Florida Museum of Natural History, Forschungsinstitut und Naturmuseum Senckenberg, Harvard Museum of Comparative Zoology, Illinois State Museum Collection, Kansas University Collection, Los Angeles California Museum-Natural History, Louisiana State University Museum Zoology, Moore Laboratory of Zoology-Occidental College, Museo Nacional de Ciencias Naturales-España, Museum of Natural History-Chicago, Museum of Vertebrate Zoology-University of California Berkeley, Oklahoma Museum of Natural History, Provincial Museum of Alberta, Peabody Museum Col-

lection–Yale University, Royal Ontario Museum, Rijksmuseum Van Naturvlijke Historie–Leiden, Santa Barbara Museum of Natural History, Southwestern College Collection, San Diego Museum of Natural History, Staatliches Museum für Naturkunde in Stuttgart, Texas Cooperative Wildlife Collection, National Museum of Natural History–Smithsonian Institute, University of Washington, Thomas Burke Memorial State Museum, University of Wisconsin Zoological Museum, Western Foundation Vertebrate Zoology Collection, Zoological Institute of the Academy of Sciences–URSS). Additionally, we reviewed the existing literature for information concerning Mexican owls. For vegetation types, we followed Rzedowski (1986).

State boundaries were the unit used to delineate distributions of the owls. We applied the taxonomy used by Amadon and Bull (1988) for most of the owl species which occur in Mexico. We followed Marshall et al. (1991) for recent changes of Vermiculated Screech-Owl (*Otus guatemalae*) to Variable Screech-Owl (*O. atricapillus*), and A.O.U. (1991) for generic change of the Burrowing Owl from *Athene* to *Speotyto*. We included the Fulvous Owl (*Strix fulvescens*) as a subspecies of the Barred Owl (*Strix varia*) = *S. v. fulvescens* (Edwards 1989, J. Marshall pers. comm.).

RESULTS

We compiled and analyzed data on 3683 specimens of Mexican owls. Twenty-seven Mexican owl species from both the Nearctic and Neotropical zoogeographic regions are represented. Eighteen species occur in the Nearctic and Neotropical regions, while nine species occur only in the Neotropical region. The Balsas Screech-Owl (*Otus seductus*) is endemic to Mexico's Pacific slope region. The Bearded Screech-Owl (*Otus barbarus*) and Unspotted Saw-whet Owl (*Aegolius ridgwayi*) are found only in Chiapas.

The greatest number of museum specimens were of the Ferruginous Pygmy-Owl (*Glaucidium brasilianum*) and least number of the Unspotted Saw-whet Owl. The richest owl assemblage came from Oaxaca and Michoacan with 21 and 19 species, respectively.

Species Accounts

Barn Owl (TALB)   *Tyto alba*

The most widely distributed owl in Mexico, it inhabitats forest, open areas, villages and cities, and islands from sea level to 3500 m in elevation. One hundred forty-one specimens from 31 states were recorded (Fig. 2). Friedman et al. (1950) also reported Barn Owls from Hidalgo and Quintana Roo, as have we (Enríquez-Rocha and Rangel-Salazar pers. obs.). Paynter (1955) and Hartig (1979) did not report the Barn Owl from the Yucatan Penin-

STATES	TALB	OFLA	OASI	OKEN	OSED	OCOO	OTRI	OBAR	OGUA	LCRI	PPER	BVIR	CVIR	CNIG	SVAR	SOCC	GGNO	GMIN	GBRA	MWHI	SCUN	AACA	ARID	ACLA	ASTY	AOTU	AFLA
AGS	O		O	O													O									O	
BC	O		O										O			X	O		O	O						O	O
BCS	O		O	O									O			X	O		O	O						O	O
CAM	O								X		O						O	O									
CHIH	O	O	O	O		O				O	O		O	O			O	O	O					X	O	O	O
CHIS	O							O	O	O	O	O	O	O	O	O	O	O	O		O		O	O			X
COA	O	O	O	O									O			O	O			X	O	O	O			O	O
COL	O		O				O	O	O		O		O	O	O	X	X	O	O	O							
DGO	O		O	O			O		O				O		O	X	O				X	O				O	X
DF	O	O	O	O			O						O			X	O	O	O							O	O
GRO	O	O	O		X	O	O			O			O	O			O	O	O	O	O				X	O	O
GTO	O										O			O			O	O	O							O	O
HGO	X	O	O	O		X										O	O		O							O	O
JAL	O	O	O	O		O				O	O		O	O			O	O	O	O			O	X		O	O
MEX	O	O		O		O	O					O	O			X	O			O	X	O	O			X	O
MICH	O	O	O	O		O	O	O		O			O	O			O	O	O	X	O	O	O			O	O
MOR	O	O					O					O	O				O	O	O	O	O	O				O	
NAY	O						O		O			O	O				O	O	O	O	O						
NL	O	X	O	O				O					O	O			O	O			O	O	X			O	
OAX	O	O	O			O	O	O	O	O	O	O	O	O			O	O	O			O	O	X	O		X
PUE	O	O				X					O	O			X	O	O		O	O	O	O					X
QRO	O		O	X		O		O					O				O			O	O				X		
QROO	O					O				O	O	O					O		X		O				O		X
SIN	O	O	O	O		O		O			O	O				O	O	O	O	O			O				
SLP	O	O				O		O			O	O	O	O	X	O	O	O		O						O	O
SON	O	O	O	O		O		O			O	O			O	O	O	O	O	O			O				
TAB	O							X	O		X	O					O	O								O	
TAM	O		O	O			O		O				O	O			O	O	O	X	O				O		O
TLAX	O	O	O															O					O				
VER	O	O				O		O	O	O	O	O	O	O			O	O	O		O	X			O	O	X
YUC	O								O			O	O				O		O			X		X			
ZAC	O		O					O					O			O	O	O									

Figure 2. Presence of owl species by state in Mexico. Codes are described in the text. (O = museum records and X = literature records.)

sula. Blake (1972) and Grossman and Hamlet (1988) considered them widely distributed throughout Mexico.

Flammulated Owl (OFLA)   *Otus flammeolus*

Flammulated Owl inhabits highlands and pine forest from 2100–3000 m elevation. It is migratory in southern Sinaloa, central Mexico and south through the highlands of Chiapas. Eighty-one specimens from 16 states were recorded (Fig. 2). Additionally, it has been reported for Distrito Federal (Ridgway 1914, Friedman et al. 1950, Blake 1972) and Nuevo León (A.O.U. 1983, Contreras-Balderas 1992).

Eastern Screech-Owl (OASI)   *Otus asio*

Eastern Screech-Owl inhabits pine forest, pine-oak forest and riparian habitats from sea level to 1500 m elevation. One hundred and seven specimens from 19 states were recorded (Fig. 2). Its distribution is restricted to northeastern and southern Mexico, which agrees with Marshall (1967) and Rowley (1984).

Western Screech-Owl (OKEN)   *Otus kennicottii*

Western Screech-Owl inhabits dense pine and pine-oak forests, open habitats, and semi-desert vegetation from 0–2400 m elevation. One hundred and forty-eight specimens from 15 states were recorded (Fig. 2). There is confusion regarding species and subspecies distributions due to taxonomic changes (Marshall 1967). Our data conflict with Blake (1972) who reported this species in Queretaro and Hidalgo. Its distribution is northcentral, southwestern, and Baja California.

Balsas Screech-Owl (OSED)   *Otus seductus*

Balsas Screech-Owl inhabits tropical deciduous forest and arid tropical scrub, and the edges of cropland. It ranges from sea level to 1200 m elevation. Twenty-five specimens from two states were recorded (Fig. 2). It has also been recorded in Guerrero (Marshall 1967, Peterson and Chalif 1973, A.O.U. 1983). This, the only endemic Mexican owl, is currently found only in Michoacan and Colima.

Pacific Screech-Owl (OCOO)   *Otus cooperi*

Pacific Screech-Owl inhabits tropical lowlands, mangroves, open forests, palm groves, and swamps. It occurs from sea level to 90 m elevation. Twenty-three specimens from six states were recorded (Fig. 2). It appears to exist only along the Pacific slope in southwestern Mexico.

Whiskered Screech-Owl (OTRI)   *Otus trichopsis*

Whiskered Screech-Owl inhabits highlands, in pine-oak forest, pine forest and dry oak. It ranges from 1200–3000 m elevation. One hundred and ninety-three specimens from 20 states were recorded (Fig. 2). Additionally, it has been reported from Hidalgo and Puebla (Davis 1972, A.O.U. 1983). It has a wide distribution but is absent in the Yucatan and Baja California peninsulas.

Bearded Screech-Owl (OBAR)   *Otus barbarus*

Bearded Screech-Owl inhabits pine and pine-oak forest from 1400–1800 m elevation. Only nine specimens, all from Chiapas, were recorded (Fig. 2), but Ridgway (1914) reported it south of Chiapas in the highlands of Guatemala. It has the most restricted distribution of any Mexican owl.

Vermiculated Screech-Owl (OGUA)

Otus guatemalae

Vermiculated Screech-Owl inhabits riparian areas, tropical semi-deciduous and deciduous forests, and forest edges. It ranges from sea level to 1500 m

elevation. One hundred and six specimens from 16 states were recorded (Fig. 2). Although reported from Campeche and Tabasco (Friedman et al. 1950, Paynter 1955, Storer 1961, Davis 1972), no specimens were located. This is the only species from the *Otus* genus found in the Yucatan Peninsula.

Crested Owl (LCRI)   *Lophostrix cristata*

Crested Owl occurs in southern Mexico and inhabits tropical evergreen and semi-deciduous forest, riparian areas, partial clearings, and foothills. It ranges from sea level to 1000 m elevation. Twenty-two specimens from four states were recorded (Fig. 2). Grossman and Hamlet (1988) reported it from the Yucatan Peninsula, but we could not confirm this.

Spectacled Owl (PPER)   *Pulsatrix perspicillata*

Spectacled Owl inhabits tropical evergreen and semi-deciduous forests, riparian areas, partial clearings, and forest edges. It ranges from sea level to 900 m. Thirty-one specimens from three states were recorded (Fig. 2). It appears restricted to southern Mexico, but Grossman and Hamlet (1988) report it for the Yucatan Peninsula. We are uncertain of this.

Great Horned Owl (BVIR)   *Bubo virginianus*

Great Horned Owl inhabits a wide diversity of habitats from forest land to open areas. It ranges from sea level to 2700 m elevation. Two hundred thirty-six specimens from 26 states were recorded (Fig. 2). Brodkorb (1943) reported it for Tabasco, but no specimens exist. The present distribution encompasses almost the entire country and its presence in Tabasco seems likely.

Mottled Owl (CVIR)   *Ciccaba virgata*

Mottled Owl inhabits tropical lowland forest, open tropical forest, and foothills. It ranges from sea level to 2100 m elevation. Four hundred and one specimens from 22 states were recorded (Fig. 2). It has a wide distribution, but is not yet reported from Baja Peninsula and northcentral Mexico.

Black and White Owl (CNIG)

Ciccaba nigrolineata

Black and White Owl appears to have discontinuous distribution within Mexico. It inhabits tropical evergreen and semi-deciduous forests, forest edge, or partial clearings. It ranges from sea level to 1200 m elevation. Forty-six specimens from five states were recorded (Fig. 2). Our museum data agree with the

literature (Ridgway 1914, Friedman et al. 1950, Blake 1972, Davis 1972, Peterson and Chalif 1973, A.O.U. 1983, Edwards 1989). Paynter (1955) reported one specimen from Quintana Roo, and we have additional specimens from there.

Barred Owl (SVAR)   *Strix varia*

Found in pine and pine-oak forests, and ranges from 1500–3000 m elevation. Thirty-nine specimens from 10 states were recorded (Fig. 2). Some authors (Ridgway 1914, Peters 1940, Friedman et al. 1950, Davis 1972, A.O.U. 1983) reported it for Puebla, but we located no museum specimens. Alvarez del Toro (1980) reported the Fulvous Owl (*Strix ful- vescens*) from the Cloud Forest of Chiapas, but we identified only one museum specimen from the Cloud Forest as *Strix varia fulvescens*. Six specimens in three museums identified as *Strix varia* were reclassified as *S. v. fulvescens* by J.T. Marshall (pers. comm.). Also, two other specimens from Oaxaca were identified as *S. fulvescens,* but they should be reclassified as *S. v. fulvescens.*

Spotted Owl (SOCC)   *Strix occidentalis*

Spotted Owl has a discontinuous distribution, inhabiting pine and pine-oak forests from 1200–2500 m elevation. Twenty-seven specimens from eight states were recorded (Fig. 2). It has been reported in Baja California (Ridgway 1914, A.O.U. 1983, Edwards 1989, Peterson and Chalif 1989), but no specimens exist from there. A specimen from San Luis Potosi and one sight record from Durango do exist (R. Clark pers. comm.), but we were not able to confirm this.

Northern Pygmy-Owl (GGNO)

                                  Glaucidium gnoma

Northern Pygmy-Owl inhabits pine-oak forest and scrub vegetation, from 1800–3700 m elevation. One hundred eighty-eight specimens from 25 states were recorded (Fig. 2). It has also been reported from Colima (Ridgway 1914, Friedman et al. 1950), but no museum specimens are known.

Least Pygmy-Owl (GMIN)

                             Glaucidium minutissimum

Least Pygmy-Owl inhabits tropical forest, forest edge, plantations, and barrancas from sea level to 1800 m elevation. One hundred thirty-nine specimens from 14 states were recorded (Fig. 2). The specimen data agree with the distributions given by Davis (1972) and Peterson and Chalif (1989). It has

not been reported from Mexico's peninsulas or the northcentral and central plateaus.

Ferruginous Pygmy-Owl (GBRA)

                              Glaucidium brasilianum

Ferruginous Pygmy-Owl inhabits lowland riparian forest, forest edge, second growth, and thickets from sea level to 1500 m elevation. One thousand one hundred thirty-one specimens from 23 states were recorded (Fig. 2). It has not been reported in the Baja California Peninsula. Friedman et al. (1950), and A.O.U. (1983) report it for Distrito Federal and Coahuila but no museum specimens exist.

Elf Owl (MWHI)   *Micrathene whitneyi*

Elf Owl inhabits saguaro deserts and arid tropical scrub from sea level to 1800 m elevation. One hundred sixty-seven specimens from 16 states were recorded (Fig. 2). This includes the Revillagigedo Islands in the Pacific Ocean. It has also been reported for the state of Mexico (Peters 1940, Blake 1972), and Tamaulipas (Grossman and Hamlet 1988), but no specimens exist. It does not occur in southern Mexico.

Burrowing Owl (SCUN)   *Speotyto cunicularia*

Burrowing Owl inhabits open lands, grasslands, prairies, and tropical scrub from sea level to 1800 m elevation. Two hundred seventy-seven specimens from 27 states were recorded (Fig. 2). It has a wide distribution and occurs throughout the country in suitable habitat (Grossman and Hamlet 1988).

Northern Saw-whet Owl (AACA)

                                  Aegolius acadicus

Northern Saw-whet Owl inhabits foothills with pine and pine-oak forests from 1800–2800 m elevation. Twenty-six specimens from 11 states were recorded (Fig. 2). It occurs in northcentral and central Mexico, and has been reported from Chihuahua, Jalisco, and Veracruz (Ridgway 1914, Friedman et al. 1950, Blake 1972, Davis 1972).

Unspotted Saw-whet Owl (ARID)

                                  Aegolius ridgwayi

Unspotted Saw-whet Owl inhabits cloud forest, pine, and pine-oak forest from 2100–3000 m elevation. Only seven specimens, all from Chiapas were recorded (Fig. 2). It has been reported previously from Chiapas (Moore 1947b, Alvarez del Toro 1980, Davis 1972, Peterson and Chalif 1973, A.O.U. 1983, Enríquez and Rangel-Salazar (pers. obs.). The

A.O.U. (1983) reported a questionable specimen record from Oaxaca.

Striped Owl (ACLA) *Asio clamator*

Striped Owl inhabits dense tropical evergreen forest, forest gaps, and forest edge from sea level to 900 m elevation. Twenty-six specimens from 3 states were recorded (Fig. 2). It occurs primarily in southeastern Mexico, but also in Veracruz, Chiapas (Blake 1972, Davis 1972, Peterson and Chalif 1973), and Oaxaca (Binford 1989).

Stygian Owl (ASTY) *Asio stygius*

Stygian Owl inhabits dense cloud forest in the mountains and ranges from 1500–3000 m elevation. Seventeen specimens from nine states were recorded (Fig. 2). It has also been reported in Chiapas (Friedman et al. 1950, Davis 1972, Alvarez del Toro 1980, A.O.U. 1983) and the Yucatan Peninsula (A.O.U. 1983, Edwards 1989), but, this does not agree with our data or that of Paynter (1955) and Hartig (1979).

Long-eared Owl (AOTU) *Asio otus*

Long-eared Owl inhabits pine and pine-oak forest and riparian forest from sea level to 1800 m elevation. Forty-one specimens from 13 states were recorded (Fig. 2). Museum data and the literature are in close agreement (Ridgway 1914, Friedman et al. 1950, Blake 1972, A.O.U. 1983). There are band recoveries of long distance migrants to Mexico from Saskatchewan, Canada (Houston 1966), Montana, U.S.A. (D. Holt pers. obs.), and Minnesota, U.S.A. (D. Evans pers. comm.).

Short-eared Owl (AFLA) *Asio flammeus*

Short-eared Owl inhabits grasslands, open tropical forests, prairies, and marshes from sea level to 1500 m elevation. Twenty-nine specimens from 14 states were recorded (Fig. 2). It has also been reported from Jalisco, Oaxaca, Puebla, Veracruz, Quintana Roo and Yucatan (Friedman et al. 1950, Hartig 1979, A.O.U. 1983, Binford 1989, Mac-Kinnon 1992).

DISCUSSION

The taxonomy and distribution of most Mexican owls is still incomplete. For example, subspecies of the screech owls (*Otus*) group discussed by Marshall (1967) were reported only from eastern Mexico. Our museum data, however, indicate that some of these subspecies occur in western Mexico. The Fulvous Owl has been considered a subspecies of the Barred Owl (Edwards 1989, J. Marshall pers. comm.); however, field work is still needed to verify this.

The Unspotted Saw-whet Owl, Striped Owl, and Stygian Owl are listed as endangered by the Mexican government (SEDUE 1991). The Balsas Screech-Owl, Bearded Screech-Owl, Crested Owl, Spectacled Owl, Black and White Owl, Barred Owl and Spotted Owl are being considered for endangered status because of their low numbers, restricted distribution, and habitat loss.

Museum collection data can help delineate geographic distribution and estimate relative abundance. Lack of museum collections may indicate a rare, uncommon, or easily overlooked species. Museum data can be important also for comparing present and historical distributions. Threatened and endangered species data in collections are also important for historic location sites. On the other hand, for some museum specimens the accompanying data are incomplete or completely wrong. Often date of collection and other important information were not included.

This is the first attempt in Mexico to draw information together about this taxonomic group. We hope this paper acts as a catalyst to spur further investigations into Mexican owl distribution, status, biology, ecology, and conservation.

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SHORT COMMUNICATIONS

NOTES ON THE DIET OF THE APLOMADO FALCON
(*FALCO FEMORALIS*) IN NORTHCENTRAL CHILE

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The Aplomado Falcon (*Falco femoralis*) is distributed from the southwestern United States south throughout South America to Tierra del Fuego (Cade 1982). Aplomado Falcons inhabit open savannas and desert grasslands, from coastal plains at sea level to elevations up to 4000 m in the Andes (Johnson 1965, Hector 1985). In Chile the Aplomado Falcon was considered uncommon throughout its range (Goodall et al. 1951), but more recently, Jaksić and Jiménez (1986) reevaluated its status as frequent in northern Chile, rare and increasing in the center of the country, and scarce in the south.

Despite the Aplomado Falcon's wide distribution in the Americas, its biology is still little known. Most accounts of the species deal with anecdotal descriptions of its feeding habits (see Hector 1981 and references therein). An exception is the detailed study of the diet and hunting behavior of *F. f. septentrionalis* in northern Mexico (Hector 1985, 1986) whose quantitative analysis of the falcon's diet revealed its mainly ornithofagous feeding habits, supplemented with large insects.

Here, I describe the diet of Aplomado Falcons in a locality of northcentral Chile, the first such investigation in South America. I then compare the findings with those of Hector (1985, 1986) in Mexico.

STUDY AREA AND METHODS

The study area encompassed the 4570 ha Chinchilla National Reserve (31°31'S 71°06'W) at Aucó and its surroundings. The reserve lies close to the town of Illapel, 300 km north of Santiago in northcentral Chile. The climate is semi-arid and the topography of the site is rugged with deep gorges and steep slopes (>15°) interspersed with flatlands and broad, open ravines with gentle slopes (<15°). The latter habitat types made up 23.2% of the Aucó surface (corrected by slope). The semi-desert vegetation is dominated by thorny deciduous shrubs with sparse cacti and bromeliads on the more rocky north-facing slopes. Grasses, herbs, small shrubs, and bare soil dominate the flatter areas (see Jiménez et al. 1992).

Aplomado Falcons are uncommon at Aucó; however, they can be seen at least once a month all year round, either alone or in pairs, mostly using flatlands and rolling hills. During 1991, two pairs nested close to the Reserve (B. Peña pers. comm.).

Between 26 January and 8 February 1992, I collected prey remains and pellets under perches and plucking sites used by Aplomado Falcons. The data collection period was after the breeding season (Jiménez pers. obs., Johnson 1965).

I identified the collected material by comparing it with voucher specimens from the Chilean Museum of Natural History. I used Hector's (1985: 337) method to determine the number of individuals taken. Prey weights were derived from Jiménez and Jaksić (1989a, 1989b) supplemented with personal field records. I assumed all insects weighed 1 g; a conservative estimate for the large insects typically captured. Geometric mean prey weights were calculated (Hector 1986, Jiménez and Jaksić 1989a).

RESULTS AND DISCUSSION

I found three pellets and abundant feathers, representing 40 individual prey items. Because of the small sample size conclusions should be drawn with caution.

Aplomado Falcons at Aucó hunted primarily birds (55.5% of total prey by number), followed by insects (42.5%; Table 1). Only one reptile, a lizard, was identified from prey remains. When considering prey weight, the rank order of the prey taken by the falcons did not change, but the relative importance of birds in the diet increased dramatically from 55.5–96.7%. Insects made up an insignificant amount of the prey biomass (1.7%).

In general, my results are consistent with previous qualitative (Housse 1945, Johnson 1965) and quantitative (Hector 1985, 1986) reports on the diet of Aplomado Falcons. In contrast to Cade (1982), Chilean Aplomado Falcons did not hunt small mammals, although two diurnal rodent species (*Akodon olivaceus* and *Octodon degus*) occur at the site and are taken by eight other local raptors and by two foxes (Jaksić et al. 1992). Thus, this falcon is the only vertebrate predator at Aucó which apparently does not hunt mammals.

At Aucó, Aplomado Falcons captured at least 11 bird species belonging to four orders and seven families (Table 1). The frequency of the birds captured was relatively

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Table 1. Prey taken by Aplomado Falcons in Aucó, northcentral Chile. Numbers in parentheses are for prey classes. The bird nomenclature follows Araya and Millie (1989). The geometric mean weight for birds and for total prey were computed (mean ± SD).

	PREY WEIGHT (g)[a]	NUMBER OF INDI- VIDUALS	% OF DIET	
			NUMBER	BIOMASS
Birds	(34.29 ± 1.77)	(22)	(55.5)	(96.7)
Black-winged Ground-Dove, *Metriopelia melanoptera*	125[b]	1	2.5	13.4
Band-winged Nightjar, *Caprimulgus longirostris*	45[c]	1	2.5	4.8
Giant Hummingbird, *Patagona gigas*	16[c]	1	2.5	1.7
White-throated Tapaculo, *Scelorchilus albicollis*	60[d]	1	2.5	6.4
Fire-eyed Diucon, *Pyrope pyrope*	38[d]	1	2.5	4.1
Chilean Mockingbird, *Mimus thenca*	66[d]	2	5.0	14.2
Long-tailed Meadowlark, *Sturnella loyca*	113[d]	1	2.5	12.1
Mourning Sierra-finch, *Phrygilus fruticeti*, male	32[d]	1	2.5	3.4
female	26[c]	4	10.0	11.1
Band-tailed Sierra-finch, *Phrygilus alaudinus*	18[d]	2	5.0	3.9
Diuca-finch, *Diuca diuca*	25[c]	4	10.0	10.7
Rufous-collared Sparrow, *Zonotrichia capensis*	19[d]	1	2.5	2.1
Passeriformes, unidentified	41[e]	2	5.0	8.8
Reptiles		(1)	(2.5)	(1.6)
Rough-scaled lizard, *Liolaemus nitidus*	15[d]	1	2.5	1.6
Insects		(17)	(42.5)	(1.7)
Scarabaeidae, unidentified	1	1	2.5	0.1
Bostrichidae, unidentified	1	1	2.5	0.1
Tenebrionidae, unidentified	1	3	7.5	0.3
Carabidae, unidentified	1	2	5.0	0.2
Chagual moth, *Castnia psittacus*	1	5	12.5	0.5
Sphecidae, unidentified	1	1	2.5	0.1
Cicadidae, unidentified	1	3	7.5	0.3
Gryllidae, unidentified	1	1	2.5	0.1
Total prey	(7.48 ± 6.08)	(40)	(100)	(100)

[a] Weight sources: [b] = after Jiménez and Jaksić (1989b); [c] = Jiménez (unpubl.); [d] = after Jiménez and Jaksić (1989a); [e] = weight estimated as the geometric mean weight of known avian prey. Insects were assumed to weigh 1 g.

evenly distributed among species, although only 30% of the 37 potential avian prey species in Aucó were hunted by Aplomado Falcons (Jiménez and Jaksić 1989a). It is surprising that no tinamu (*Nothoprocta perdicaria*) was captured because the species is very abundant at the site (pers. obs.), and has been described elsewhere as the preferred prey of Aplomado Falcons (Housse 1945, Johnson 1965). In northcentral Chile, Aplomado Falcons take fewer insectivorous birds (one species out of 10) and relatively more seed-eating species. Conversely, in Mexico, most prey of Aplomado Falcons are insectivorous birds (Hector 1985). The fact that Chilean Aplomados take fewer insectivorous birds, as well as fewer insects, may have important conservation-related implications. Aplomado Falcons in Chile may be relatively less affected by the organochlorine pesticides still in use than are Mexican falcons (Kiff et al. 1980).

The importance of insects in the diet of Aplomado Falcons is underestimated when biomass is considered. However, the 1 g weight assumption for insect prey may be too low; insects taken were quite large, especially the chagual moths (*Castnia psittacus*). As reported by Hector (1985) for Mexican Aplomado Falcons, the most common insect prey for the Chilean birds were moths and cicadas.

The geometric mean weight of prey taken at Aucó is much smaller than that for Mexican Aplomado Falcons (Hector 1981; 7.48 vs. 23.8 g, respectively; Table 1). However, the figure for bird prey is remarkably close to the one found for male Mexican Aplomado Falcons (Hector 1986): 34.29 vs. 34.98 g, respectively.

Although the sample size is small, this study shows that Aplomado Falcons rely mostly on avian prey, apparently paying no attention to potential mammalian prey. Insects made a minute amount of these falcons' diet. The results

of this study agree well with another quantitative study conducted in the northern end of the Aplomado Falcon distribution.

RESUMEN.—A base de restos de presas y contenidos de egagrópilas se estudia la dieta del halcón perdiguero (*Falco femoralis*) en la localidad de Aucó (31°31'S 71°06'W), en Chile centronorte. Tanto en número como en biomasa, las presas más abundantes son las aves (55,5 y 96,7%, respectivamente). Los insectos sólo son importantes desde el punto de vista numérico (42,5%), pero su contribución en biomasa en casi nula (1,7%). La presencia de reptiles en la dieta es escasa y los mamíferos no son consumidos por estos halcones. Comparados con halcones perdigueros mexicanos, los estudiados en Chile tienen una dieta muy similar en los tipos y tamaños de las presas consumidas. Sin embargo, los perdigueros chilenos consumen menos aves insectívoras y más granívoras que los mexicanos.

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BALD EAGLES PREY ON SANDHILL CRANES IN FLORIDA

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We collected the remains of at least four Sandhill Cranes (*Grus canadensis*) from two Bald Eagle (*Haliaeetus leucocephalus*) nests in Florida. We are not aware of other reported cases in the literature of successful predation by Bald Eagles on cranes (Stalmaster 1988), although Brill (1987) reported a Bald Eagle striking a Sandhill Crane in Nebraska. R. Johnson (pers. comm.) observed two subadult Bald Eagles feeding on a fresh adult Sandhill Crane carcass at Lake Almanor, Plumas County, California in winter 1986–87. He was not able to determine how or if the eagles captured the Sandhill Crane. Windingstad et al. (1981) reported a Golden Eagle (*Aquila chrysaetos*) striking and killing a healthy immature Whooping Crane (*G. americana*), while Johns (1977) reported a Golden Eagle attempting to kill a Sandhill Crane. R.E. Gill, Jr. (pers. comm.) has found remains of Lesser Sandhill Cranes (*G. c. canadensis*) in Golden Eagle nests in Alaska and has observed attacks by Golden Eagles on cranes migrating across the Seward Peninsula.

On 9 March 1991, we collected four crane legs in fairly fresh condition from a Bald Eagle nest near Kanapaha Prairie, Alachua County, Florida. They had been woven into the rim of the nest. We concluded that the legs represented three different individuals based on their length. One leg was marked with a numbered U.S. Fish and Wildlife Service (USFWS) band and color leg bands. This bird was identified as a 6-yr-old Greater Sandhill Crane (*G. c. tabida*) banded in 1986 (hatch year 1985) on the Florida wintering grounds. A shorter leg also was marked with a color leg band, but no USFWS band was found. On 3 April 1992, we found an unbanded Sandhill Crane leg in an eagle nest near Orange Lake, Marion County, Florida.

Both eagle nests were located near areas frequented by large flocks of Sandhill Cranes, primarily wintering Greater Sandhill Cranes. In 1991, between 200 and 300 cranes used Kanapaha Prairie for roosting, loafing, and, to a lesser extent, feeding. Between 500 and 700 cranes used the area near the Orange Lake eagle nest for feeding in 1992. Six to eight pairs of Florida Sandhill Cranes (*G. c. pratensis*) nest on each of these areas.

Bald Eagles have been reported to kill prey heavier than themselves, although this generally involved sick or injured individuals (Stalmaster 1987, Gerrard and Bortollotti 1988). The crane remains found in these two eagle nests probably were sick, injured, or dead individuals. Healthy adult cranes likely are too large and aggressive to be preyed on by Bald Eagles. An average weight for an adult crane of the *tabida* subspecies is 4.4 kg for females and 5.1 kg for males (Nesbitt et al. 1992). Adult southern Bald Eagles weigh approximately 3–4.5 kg.

Each winter since 1986, 30–50 Sandhill Cranes at the Kanapaha site have suffered from mycotoxicosis after feeding on waste peanuts from nearby fields. Cranes affected by this toxin are unable to raise their head and neck (Windingstad et al. 1989). They soon became debilitated to the point of being unable to fly or defend themselves

Several crane carcasses were found near traditional crane winter roost sites with evidence of raptor predation, i.e., talon marks and extensive plucking. Since eagles frequently scavenge, it is likely that some crane carcasses were retrieved after death. There is evidence, however, that Bald Eagles killed live Sandhill Cranes. The size and spacing of talon marks found on some crane carcasses were likely those of a Bald Eagle and their location in the head and neck and associated hemorrhage suggest that predation was the final cause of death (M. Spalding pers. comm.). The eagle pair nesting at the Kanapaha site routinely flew over the Sandhill Crane flock morning and evening and attempted to capture cranes that were debilitated by mycotoxin poisoning. Prior to the appearance of mycotoxicosis in the Kanapaha flock in 1985, the cranes took little notice of eagles in their vicinity. Since 1985, they have become noticeably wary and will flush at the approach of an eagle. This eagle pair also preyed on Cattle Egrets

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(*Bubulcus ibis*), particularly after the Sandhill Cranes departed the area in the spring (Folk 1992).

Wintering cranes are most abundant in Florida from November through March, which closely corresponds with the Florida Bald Eagle nesting season (November through May; Wood and Collopy 1993). Florida eagles feed young January through May. As opportunistic predators, these Bald Eagles have learned to capitalize on the large food source provided by debilitated Sandhill Cranes.

RESUMEN.—Colectamos los remanentes de la menos cuatro *Grus canadensis*, desde dos nidos de *Haliaeetus leucocephalus*, en Florida. Una pierna estaba marcada con un anillo seriado del Servicio de Pesca y Vida Silvestre de Los Estados Unidos. Esta ave fue identificada como un *G. c. tabida* de seis años, marcado en 1986 en los hábitat invernales de Florida. Los dos nidos de *H. leucocephalus* cerca de áreas frecuentadas por grandes bandadas de *G. canadensis* invernantes. Sospechamos que los individuos de *G canadensis* capturados estaban debilitados por micotoxicosis, una enfermedad que afecta entre 30 a 50 de los 200 a 300 *G. canadensis* que invernan cerca de uno de los nidos de *H. leucocephalus*.

[Traducción de Ivan Lazo]

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FEMALE PARTICIPATION IN COURTSHIP DISPLAYS OF WESTERN MARSH HARRIERS (*CIRCUS AERUGINOSUS*) IN CENTRAL SPAIN

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As part of territorial advertisement, courtship behavior or both, harriers (*Circus* spp.) perform complex aerial displays on their breeding grounds. The intensity and form of aerial displays vary among the species and between sexes of the same species. Since aerial displays of harriers are presumed to be stable species specific characters which function in mate recognition (Clouet 1978, Cramp and Simmons 1980, Simmons 1988, 1991), they have been useful in assessing the taxonomy of the marsh harrier complex (Simmons 1991).

The aerial dances performed by male Western Marsh Harriers (*C. aeruginosus*) have been described as including a basic undulating display in the horizontal plane, also seen in other species (so-called "sky-dancing"), and several other aerobatics such as plunges, somersaults and rolls (for details see Glutz et al. 1971, Cramp and Simmons 1980). However, these elaborate aerial maneuvers are unrecorded in female *C. aeruginosus*. Here we describe the prebreeding aerial evolutions of male and female Western Marsh Harriers in central Spain.

STUDY AREA AND METHODS

Behavioral observations of Western Marsh Harriers were made during 1990–1993 at the Almoguera Reservoir (40°17′N 2°56′W; Tajo River; central Spain), where 12 pairs bred in medium-sized *Phragmites* and *Typha* marshes bordering the reservoir margins. Almost half of the adult population overwintered in the area, and had during winter a female-biased sex-ratio (10:4 individuals in December 1992). Observations were carried out from vantage hills located between the maximum heights reached by soaring harriers and their nesting grounds. We monitored the activity of harriers ($N = 170$) in 86 hr of continuous focal observation throughout daylight period, and recorded 65 display sequences for birds of known sex.

OBSERVATIONS AND DISCUSSION

Western Marsh Harriers displayed repeatedly (1.49 displays/hr) prior to laying (mean laying dates were mid-April; see González 1991), less frequently during hatching and fledging periods (0.75 displays per hour), and rarely in autumn-winter (1 display/30 hr). Females performed 58.46% of the recorded display sequences. Most displays took place during morning (75.38% before 1400 H). Aerial displays often were performed after lengthy sequences of high soaring and straight speed-gaining flights. Both male and female *C. aeruginosus* performed the horizontal sky-dancing display with all its variations, as described for males by Cramp and Simmons (1980). Furthermore, both sexes were observed displaying in a vertically oriented form with fast spiralling undulations seldom completed in a full loop calling at each peak. This behavior is very similar to the so-called "sky-spiralling" display described for the African Marsh Harrier (*Circus ranivorus*; Simmons 1991) and for the Swamp Harrier (*Circus approximans*; Baker-Gabb 1981) but so far has not been recorded as a stage in the display sequence of the Western Marsh Harrier. The general scheme of the aerial displays performed by Western Marsh Harriers in the study area closely coincided with that presented by Simmons (1991; Fig. 3) for *C. ranivorus*. However, as in this species, the sky-dancing display and the vertical drop sometimes proceeded separately after positioning and speed-increasing flights. The descent normally finished on the nest, swooping near another harrier or soaring close to the ground before the process was repeated.

Previous descriptions of the aerial displays of *C. aeruginosus* are based on observations from north and central Europe, where Marsh Harriers are migratory. In these zones, males return to their breeding sites earlier than females to establish territories and females do not display (Glutz et al. 1971, Cramp and Simmons 1980, Witkowski 1989). In our study area, female Marsh Harriers are sedentary with some movements (González 1991, pers. obs.), and frequently display like the males. Advertisement of territory occupancy by means of aerial displays can thus be carried out by both sexes as in other marsh harrier species (Baker-Gabb 1981, Simmons 1991). The mate attraction component of the aerial display is possibly more important for unmated birds, since polygyny is very rare

in Spanish *C. aeruginosus* (Fernández 1990, González 1991). The observations presented here give evidence that the structure of aerial displays and the sex of displayers show geographical variations in the Western Marsh Harrier

RESUMEN.—Tanto los machos como las hembras de Aguilucho lagunero *Circus aeruginosus* observados en una zona de cría del Centro de España, realizaron acrobacias aéreas antes y durante la época de reproducción. Las maniobras aéreas incluyeron un movimiento ondulante en el plano horizontal (sky-dancing), descrito anteriormente solo para los machos de la especie, y una caida vertical con ondulaciones laterales y gritos que no se había citado en esta especie aunque si en otras del género *Circus* que habitan también medios palustres.

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DIET OF THE RED-BACKED BUZZARD
(*BUTEO POLYOSOMA EXSUL*) AND THE SHORT-EARED OWL
(*ASIO FLAMMEUS SUINDA*) IN THE JUAN FERNÁNDEZ
ARCHIPELAGO OFF CHILE

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The Juan Fernández Islands (Robinson Crusoe, Santa Clara and Alejandro Selkirk) off the Chilean coast hold a unique biota featuring high levels of endemism in both plants and terrestrial animals (Castilla 1987, Stuessy et al. 1991). Four raptors inhabit the islands: Peregrine Falcon (*Falco peregrinus*), American Kestrel or Cernícalo de Juan Fernández (*F. sparverius*), Red-backed Buzzard or Blindado (*Buteo polyosoma*), and Short-eared Owl or Nuco (*Asio flammeus*). Of these, two are endemic subspecies: *F. sparverius fernandensis* and *B. polyosoma exsul* (Johnson 1965, Schlatter 1987). These species are threatened by illegal hunting and nest ravaging by introduced mammals (CONAF 1976). In general, Chilean raptors are decreasing due to illegal hunting, habitat alteration, and prey reduction (Jaksić and Jiménez 1986). Even the Short-eared Owl is categorized as inadequately known (Glade 1987). In fact, the biology is poorly if at all known (Schlatter 1987) for the raptors of Juan Fernández Islands and for all oceanic Chilean birds.

The diets of Juan Fernández' Red-backed Buzzard and Short-eared Owl are cases in point. Although there are some data available on their respective diets in continental Chile (Schlatter et al. 1980, Rau et al. 1992), no such quantitative information exists on their diet in Juan Fernández Islands. Anecdotal information suggests that Red-backed Buzzards prey on introduced rodents (*Mus* and *Rattus*), poultry, young goats, and native petrels (*Pterodroma*; Lonnberg 1921, Johnson 1965, Torres and Aguayo 1971). According to Sáiz (1982), Red-backed Buzzards do not consume European rabbits (*Oryctolagus cuniculus*). Short-eared Owls, on the other hand, reportedly prey on *Mus* and *Rattus* and rabbits (CONAF 1976, Sáiz 1982). Herein, we describe quantitatively the diets of island Red-backed Buzzards and Short-eared Owls.

From November 1988 to April 1991 and in January 1992, we collected 26 pellets regurgitated by Red-backed Buzzards (22 from Alejandro Selkirk Island and four from Robinson Crusoe Island), and 20 pellets cast by Short-

eared Owls (seven from Santa Clara Island and 13 from Robinson Crusoe Island, as well as prey remains found scattered around a nest). Prey remains were identified to the finest possible level of resolution. Identification of mammalian species was attained by comparison with a reference collection in the Sección Mamíferos, Museo Nacional de Historia Natural, Santiago.

Thirty-six vertebrate prey items were identified from pellets of Red-backed Buzzards, as well as seven invertebrates (three coleopterans, three arachnids, and one decapod). Given the proportion of biomass contributed by vertebrates, we focused our analysis on this prey category (Table 1). The most frequent prey were rodents (47.3%), particularly the introduced house mouse (*Mus musculus*), whereas birds, largely petrels, accounted for 39.8% of the vertebrate prey. Interestingly, it has been suggested that attacks by Red-backed Buzzards may have forced petrels to use burrows to reduce predation risks (Johnson 1965). While this behavior may decrease their vulnerability to buzzards, it is ineffective toward introduced terrestrial predators such as coatis (*Nasua nasua*) and cats (*Felis catus*, Torres and Aguayo 1971).

Red-backed Buzzards also preyed on European rabbits, which accounted for 5.6% of their vertebrate prey. Unidentified fishes made up 5.6% of the prey by number. Housse (1945) mentioned fish remains among the prey of *Buteo polyosoma polyosoma*, suggesting that they were occasional prey when the abundance of mammals and birds was low. Fish may have been consumed as carrion. In fact, *Buteo polyosoma exsul* was observed by one of us (MSS) scavenging on dead fur seal (*Arctocephalus philippii*) pups and eating placentae of Juan Fernández fur seals, a suspected but so far unconfirmed behavior of this raptor (Torres 1987). Three pellets contained some hair attributable to seals. Scavenging suggests that Red-backed Buzzard is an opportunistic raptor.

In central Chile, *B. polyosoma polyosoma* preys largely on native rodents, secondarily on introduced rabbits, and less frequently on native birds (Schlatter et al. 1980). Therefore, this hawk's diet in the Juan Fernández Islands is roughly similar to that in the continent, except for the consumption of fish and large mammal carrion.

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Table 1. Percent of prey in the diet of Red-backed Buzzard (*Buteo polyosoma exsul*) and Short-eared Owl (*Asio flammeus suinda*) in the Juan Fernández Archipelago.

PREY CATEGORIES	*BUTEO*	*ASIO*
Mammals		
House mouse (*Mus musculus*)	41.7	0.0
European rabbit (*Oryctolagus cuniculus*)	5.6	60.7
Rodentia: unidentified	5.6	10.7
Mammal: unidentified	2.6	10.7
Birds		
Pterodroma	27.8	17.9
Birds: unidentified	11.1	0.0
Fishes		
Fish: unidentified	5.6	0.0
Total prey	36	28

A total of 28 prey items, all vertebrates, were determined for Short-eared Owl (Table 1). The most frequent were European rabbits, both adults and juveniles (eight and nine individuals, respectively). Secondarily, Short-eared Owls preyed on birds, particularly both adults and eggs of petrels, as well as on unidentified rodents. In continental Chile, Short-eared Owls consume rodents almost exclusively, mostly native species, and a negligible number of invertebrates (Rau et al. 1992).

Despite our small sample, it is noteworthy that in the Juan Fernández Islands both Red-backed Buzzards and Short-eared Owls preyed largely on introduced mammals: 53% by number in the Red-backed Buzzard and 71% in the Short-eared Owl. The staple prey appeared to be rabbits and murid rodents, species which are threatening the survival of several native species on the islands. The European rabbit, for instance, precludes the recruitment of seedlings of endangered native shrubs, such as *Chenopodium crusoeanum*. Acevedo (1990) stated that an effective recovery plan for the flora of Juan Fernández ought to consider the eradication or a severe population reduction of rabbits. Rabbit eradication, however, will depress the prey base for the Short-eared Owl. On the other hand, murids affect the survival of several ground-nesting birds, including petrels regarded as vulnerable (Glade 1987, Rottman and López-Callejas 1992) by preying upon their eggs. As with rabbit control, controlling those exotic rodents in order to ensure the survival of some bird species may have the secondary effect of diminishing the resource base for raptors whose conservation is also of concern.

Chilean raptors tend to be opportunistic predators, concentrating on the most abundant and vulnerable prey available (see Jaksić and Simonetti 1987 for a review), exhibiting both functional and numerical responses to changes in their resource spectrum (see Crespo 1966, Dalby 1975). Therefore, if faced with a decline in the abundance of exotic species by their control or eradication, raptors may turn to native birds which already are threatened. Alternatively, raptors may respond numerically, with a population reduction coupled to the decline of their staple prey, which also represents a problem given the fragile conservation status of these raptors. This paradoxical situation should be considered when planning for the control of introduced rabbits and rats, a mandatory action if the survival of several unique species of the Juan Fernández Islands are to be saved from extinction.

RESUMEN.—En base al análisis de regurgitados, estudiamos la dieta del Aguilucho de Más Afuera (*Buteo polyosoma exsul*) y del Nuco (*Asio flammeus suinda*) en el Archipiélago de Juan Fernández. El aguilucho consume principalmente múridos (introducidos) y aves. En menor medida depreda sobre conejos, consumiendo además peces y mamíferos marinos como carroña. El nuco consume principalmente conejos, fardelas y múridos. En ambas rapaces destaca que la mitad de su dieta la componen especies exóticas.

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OBSERVATIONS OF WINTERING GYRFALCONS (*FALCO RUSTICOLUS*) HUNTING SAGE GROUSE (*CENTROCERCUS UROPHASIANUS*) IN WYOMING AND MONTANA U.S.A.

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Little has been written on the prey preferences of wintering Gyrfalcons (*Falco rusticolus*) outside of their breeding range (Palmer 1988, Dobler 1989, Sanchez 1993). Most summaries of Gyrfalcon prey selection are from data collected during the breeding season (Sherrod 1978). Although wintering Gyrfalcons occur within the range of Sage Grouse (*Centrocercus urophasianus*; Cade 1982, Johnsgard 1983), we found no reports of wild Gyrfalcons preying upon this species. However, captive Gyrfalcons flown in falconry are reported to be able to kill Sage Grouse (Christopher and Hardaswick 1988).

Between 8 November and 6 December 1992, CSG and SP observed an individual Gyrfalcon on 10 separate days (identification was based on comparisons of photographs) 14 km east of Lander, Wyoming. The Gyrfalcon appeared to be an adult female based on its plumage, yellow feet,

and large size (Cramp and Simmons 1980, Cade 1982). Habitat in the area is primarily shrub-steppe dominated by sagebrush (*Artemisia tridentata*) and mixed grasses. The area is a major wintering site for Sage Grouse; CSG and SP frequently observed several hundred Sage Grouse in an area which measures about 8 km². On 5 December 1992, we observed three hunting flights by this Gyrfalcon at Sage Grouse within a 0.5 hr period. All three flights originated from fenceposts in the same area. All flights were of the "direct pursuit" type typically used by Gyrfalcons (Cramp and Simmons 1980, Cade 1982, Palmer 1988).

On the first flight, the Gyrfalcon flew directly to a strip of sagebrush about 200 m distant, and then landed on the snow and walked in small circles amongst the sagebrush for about 1 min as if searching for prey. CSG then walked to the area and flushed the Gyrfalcon and a Sage Grouse which had been hiding in the immediate area. The Gyrfalcon flew directly back to its initial perch on the fencepost.

About 10 min later, the Gyrfalcon flew back to the same general area and flushed five Sage Grouse from a strip of short sagebrush by repeatedly making shallow dives at them. It then chased one of the Sage Grouse, and then a second, but ceased pursuit of both Grouse after minimal effort and returned to its perch. Ten min later, the Gyrfalcon flew back to the same area and flushed another Sage Grouse. It chased it vigorously for about 275 m until the Sage Grouse escaped by entering a strip of tall sagebrush. The Gyrfalcon again returned to its previous perch. At this point, we left the area and ended the observation.

During the winter of 1992, BDM observed two adult female Gyrfalcons (based on appearances) hunting and successfully capturing Sage Grouse in Montana. Again, habitat in these areas was predominantly sagebrush shrub-steppe.

The first Gyrfalcon BDM observed was perched on a fencepost 60 km southwest of Dillon, Montana, on 29 January 1992. When BDM flushed a large flock of Sage Grouse, the Gyrfalcon immediately pursued the flock for about 350 m until it killed one. BDM later observed the Gyrfalcon eating the grouse.

On 7 February 1992, BDM observed what was believed to be another individual Gyrfalcon 11 km west of Dillon, Montana. During this observation, BDM did not see the Gyrfalcon until it appeared in pursuit of a lone Sage Grouse which he had flushed. The Gyrfalcon quickly caught up to the Sage Grouse, and by approaching it from below and slightly ahead, cut it off from escape cover. The Gyrfalcon then quickly climbed about 5 m and caught the grouse. BDM later observed the Gyrfalcon eating the captured Sage Grouse.

Our repeated observations of Gyrfalcons residing in Sage Grouse wintering areas, the observation of several hunting flights of Gyrfalcons at Sage Grouse, and the absence of other suitable prey indicates that these Gyr-

falcons may have been using Sage Grouse as a primary prey. This should not be considered atypical since Gyrfalcons are well known for their dependence on gallinaceous birds as primary prey during the breeding season. For example, Rock Ptarmigan (*Lagopus mutus*) and Willow Ptarmigan (*Lagopus lagopus*) can sometimes represent over 90% of the diet by weight (Cramp and Simmons 1980).

Our observations help support the limited data which suggests that Gyrfalcons wintering outside of their breeding range establish hunting areas where large concentrations of avian prey are present, such as Rock Doves (*Columba livia*), ducks (Anatidae), Canada Geese (*Branta canadensis*), Sharp-tailed Grouse (*Tympanuchus phasianellus*), and Greater Prairie-Chickens (*Tympanuchus cupido*; Dobler 1989, Sanchez 1993, Garber pers. obs., and P.A.B. Widener Jr. pers. comm.), are present.

While a few larger prey have been recorded as being captured by Gyrfalcons (Cramp and Simmons 1980), the weight of an adult Sage Grouse is definitely at the upper weight limits of prey reported to have been captured. The weight of a Sage Grouse is substantial (2010–3266 g for males and 1142–1754 g for females; Patterson 1952, Johnsgard 1983) when compared to that of a Gyrfalcon (805–1300 g for males and 1400–2100 g for females; Cade 1982). We did not determine the sex of the Sage Grouse which were pursued or captured by Gyrfalcons during our observations.

RESUMEN.—Se registraron tres observaciones separadas de *Falco rusticolus* cazando *Centrocerus urophasianus*, en Wyoming y Montana, E.E.U.U. De cinco intentos de caza observados, dos resultaron exitosos. Todas las observaciones fueron realizadas en áreas usadas por grandes bandadas de *C. urophasianus*.

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TRAPPING TECHNIQUES FOR BREEDING COOPER'S HAWKS: TWO MODIFICATIONS

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Bloom et al. (1992) have shown that use of a Great Horned Owl (*Bubo virginianus*) as a live decoy provides an effective trapping technique for breeding raptors of many different species, including Cooper's Hawk (*Accipiter cooperii*). They did not, however, address the problem of retrapping the same Cooper's Hawks in later years with the same technique, i.e., the difficulty of recapturing "trap-shy" individuals (Bloom 1987). Indeed, mention by Bloom et al. (1992) of several Cooper's Hawks recaptured over a 4-yr period, apparently with the same type of trap, suggests no such difficulty with this species. As part of our long-term research using decoy owls in mark-recapture studies of breeding Cooper's Hawks (Rosenfield et al. 1992), we have encountered many trap-shy individuals. Here we present two trap modifications to overcome this problem.

Great Horned Owl Set. The typical trap consists of a lure owl tethered by a swivel and leash to a perch within 0.5 m of the ground near a nest with nestling hawks present; a mist net or *dho-gaza* is erected within 1–2 m of the owl. Hereafter this design is called the "typical set." Our modification of this technique places the decoy in an elevated set well above ground level. During 1980–86, at >30 active nests where we had captured one or both of the breeding birds, the typical set did not elicit stoops by the resident hawks in a subsequent year. Often the hawks would not even approach the decoy. We suspected that these trap-shy birds would be more likely to stoop at the owl if it were placed closer to the nest and thus appeared to be a greater threat to the nestling hawks. To test this speculation, we placed a live owl within 1 m of the ground near an active Cooper's Hawk nest where three previous visits using the typical set had failed to elicit stoops. We simultaneously placed a stuffed Great Horned Owl about 10 m from the ground on a pole erected within 2 m of the live owl. During the next 20 min (while the lower owl repeatedly moved about and jumped from perch to ground and back up to the perch), the adult female Cooper's Hawk stooped at and struck the stuffed owl five times, but did not stoop at the lower owl. We returned 2 d later and erected a mist net within 1 m of the stuffed owl, which was again placed 10 m high. We captured the adult female within 5 min following set-up. It was a bird caught with the typical set in the previous year.

This elevated set (from 10–13 m off the ground) has worked successfully at four other sites where previous visits in the same year with the typical set had failed to catch the hawks. In all instances we caught one or both adults within 10 min of trap set-up, and all were recaptures of birds originally caught with the typical set in a previous year. Lure birds at these four sites were a stuffed Barred Owl (*Strix varia*), a stuffed Rough-legged Hawk (*Buteo lagopus*), a stuffed Great Horned Owl, and a live Great Horned Owl, respectively. The live owl was tethered on a very short leash (about 3 cm) which would not allow it to leap from the perch.

This elevated set took 2 hr to set up in one instance and 0.5–1 hr in other cases depending on how many tree branches had to be cleared for a net lane. Suspending the net from tree trunks took at least two people—one climber and an assistant on the ground to hand up materials. The decoy was perched atop a horizontal pole braced on tree branches. We strongly recommend that at least one trapper remain hidden near the elevated set to ensure the safety

of the trapped bird and/or the safety of a live lure owl. When we trapped a hawk, the climber lowered one end of the net with a rope until the entangled bird could be reached by an assistant on the ground.

Pre-incubation Trapping. Our other modification in trapping technique for breeding hawks is a matter of timing: we have coupled the use of lure birds with early-season (pre-incubation) trapping. Although many of our colleagues contend that trapping of adults should not be attempted until nestlings are present in order to minimize disturbance and the chance of desertion by adults (e.g., Fyfe and Olendorff 1976), pre-incubation trapping has worked well for us.

The pre-incubation period for Cooper's Hawks in Wisconsin lasts about one month, beginning in mid-March (Rosenfield et al. 1991). During that period both members of a mated pair predictably begin daily courtship activities (e.g., copulations and nest building) at dawn, usually within about 100 m of a partially constructed nest (Rosenfield 1990). At dawn we made 41 captures of 38 different Cooper's Hawks (25 males, 13 females) at 41 nesting areas during 1987 through 1992 (three birds were recaptured once each in two different years). Twelve (seven males) of these hawks were recaptures of birds who were trap-shy of the typical set. Hawks were trapped in mist nets, bow nets, and/or bal-chatris baited with European Starlings (*Sturnus vulgaris*) or Ring Doves (*Streptopelia risoria*).

Trapping at this time was expeditious because we could place bait birds precisely where we expected the hawks to appear. We set out traps in pre-dawn darkness. Disturbance was minimal because Cooper's Hawks typically do not roost near partially constructed nests. Moreover, by attaching a line to the lure bird, we were able to tug the bait at a moment that allowed us to "select" which member of the mated pair we wanted to catch. At dawn, we usually wanted to capture males because later in the day during the pre-incubation period, and throughout the incubation and nestling periods, hunting males were often absent from the nesting area. At these latter times of the day and season, we often waited 2–3 hr for an opportunity to trap males (with an owl set) upon their return to the nest. At dawn, in contrast, Cooper's Hawks detect bait birds quickly and respond to them almost immediately. One and occasionally both adults can usually be caught (or missed) within 0.5 hr.

Pre-incubation trapping has had no discernable effect on subsequent behavior and productivity of trapped birds in our study. At the 41 nests where we captured hawks during pre-incubation, there were no desertions by adults and 98% of the 41 pairs had complete clutches. Among 127 other pairs that we discovered at the pre-incubation stage during 1987–92, but did *not* attempt to trap at this stage, 93% laid eggs.

Repeated trials of pre-incubation trapping in subsequent years on the same nesting areas have convinced us that this technique also can result in trap-shyness. Re-

searchers involved in long-term mark-recapture studies of raptors may often need to apply a variety of trapping techniques.

RESUMEN.—Reportamos dos modificaciones de trampas que fueron exitosas en la recaptura de adultos de *Accipiter cooperii*, pero que han desarrollado aversión a la técnica de trampeo (un señuelo vivo sobre el suelo cerca de una red de niebla durante el estadio de polluelo de *A. cooperii*) usada tempranamente. Una modificación de la trampa incluye la elevación del señuelo y la red de niebla de 10 a 13 m del suelo. La otra implica el uso de aves atractivas durante el período de pre-incubación.

[Traducción de Ivan Lazo]

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LETTER

PEREGRINE FALCONS INCUBATE CLUTCH OF EGGS FOR MINIMUM OF 73 DAYS

The normal length of the incubation period for viable Peregrine Falcon (*Falco peregrinus*) eggs is 33–34 d in both captive (W.A. Burnham 1983, *J. Wildl. Manage.* 47:158–168) and wild (J.A. Hagar *in* A.C. Bent 1938, *U.S. Natl. Mus. Bull.* 170; R.A. Herbert and K.G.S. Herbert 1965, *Auk* 82:62–94) breeding situations. Duration of incubation behavior in instances where eggs fail to hatch after the normal interval is not well-addressed in the literature. Here we report our observations of extreme incubation fidelity in a pair of wild Peregrine Falcons.

Our observations occurred between 27 February and 30 June 1992 at Frankenstein Cliff, a 60-m rock face located at an elevation of 450 m in Crawford Notch State Park in Harts Location, New Hampshire. We watched an average of three times per week from a distance of 0.3 km from the cliff using 15–60× spotting scopes and an 80–130× telescope. Even when an adult falcon was lying in a horizontal incubating posture, we could routinely see when it was present on the nest ledge from our location 130 m below the cliff.

We first observed an unambiguous incubation exchange between adults on 15 April and that date was designated as onset of incubation. On 18 d over the following 38-d period (15 April–22 May), DJN conducted >37 hr of observation and confirmed the presence of an incubating adult on each visit. The longest unmonitored period after incubation began was 141 hr (<6 d). Since renesting Peregrine Falcons commonly select a new ledge and take about 3 wk to complete a replacement clutch (D.A. Ratcliffe 1980, The Peregrine Falcon, Buteo Books, Vermillion, SD U.S.A.), we are confident that this pair remained on their first clutch. Hatching failed to occur by the expected date, but we continued monitoring and documented regular incubation exchanges through 25 June and incubation by the adult female through 26 June. The pair finally abandoned the scrape before our 29 June visit yielding a ≥73-d incubation period (118% longer than normal). Climbers recovered two intact eggs from the abandoned scrape on 30 June; neither egg contained evidence of a developing embryo.

Breeding adults of many avian species are known to continue incubation of unhatchable eggs for intervals of 50%, occasionally 100%, longer than their normal incubation periods (A.F. Skutch 1976, Parent birds and their young, Univ. Texas Press, Austin, TX U.S.A.). Such persistence apparently is an appropriate response in view of the variability in incubation period observed (R.H. Drent *in* D.S. Farner and J.R. King 1975, Avian biology, Vol. 5, Academic Press, New York, NY U.S.A.) as extended incubation provides a "margin of safety" (A.F. Skutch 1962, *Wilson Bull.* 74: 115–152) against abandonment of potentially hatchable eggs. In species capable of clutch replacement, selective pressure against prolonging incubation beyond reasonable limits must be strong (L.C. Holcomb 1970, *Behaviour* 36:74–83). Peregrine Falcons are known to extend incubation beyond the normal length when eggs fail to hatch, but precise determinations of prolonged incubation attempts are rarely reported (T. Cade pers. comm.). An unsuccessful ≥46-d incubation attempt (37% longer than normal) documented by the Audubon Society of New Hampshire at another cliff in the state in 1990 is perhaps more typical.

The Audubon Society of New Hampshire coordinates Peregrine Falcon population monitoring in cooperation with the New Hampshire Fish and Game Department and several other state and federal agencies. We thank Paul Cormier, Ross Heald, Barbara Hoyt, Harrison Hoyt and Michael Pelchat for their field assistance and Michael Amaral and Carol Foss for suggesting improvements to the manuscript.—**Christian J. Martin and David J. North. Audubon Society of New Hampshire, 3 Silk Farm Road, Concord, NH 03301 U.S.A.**

News

1992 Leslie Brown Memorial Grant Recipient

Kevin I. McCann was born in Johannesburg, South Africa, and educated at the University of Witwatersrand where he received a B.S. in zoology and biology, an Honors Degree in Zoology, and is currently enrolled in a M.S. program specializing in Ornithology.

He has conducted field studies on a variety of raptors including Greater Kestrels, Bathawks, Rock Kestrels, and Lesser Kestrels. Currently he is studying the general ecology of the Lesser Kestrel in its non-breeding range in South Africa.

Future plans include undertaking a Ph.D. program and work in conservation of threatened raptors.

Kevin I. McCann

Erratum—In the introduction to "Diet changes in breeding Tawny Owls (*Strix aluco*)" by David A. Kirk (1992, *J. Raptor Res.* 26:239–242), (Talpidae) in line eight should read "(*Talpa europea*)," and (Lumbricina) in line 10 should read "(*Lumbricus terrestris* or *Allolobophora* spp.)." In Study Area and Methods the study area size should be 0.6 km² (line three). Finally, in the second paragraph of Results and Discussion, lines 25–27 should read, "although the total biomass intake of small and medium-sized birds was similar in the non-breeding season."

The Journal of Raptor Research is distributed quarterly to all current members. Original manuscripts dealing with the biology and conservation of diurnal and nocturnal birds of prey are welcomed from throughout the world, but must be written in English. Submissions can be in the form of research articles, letters to the editor, thesis abstracts and book reviews. Contributors should submit a typewritten original and three copies to the Editor. All submissions must be typewritten and double-spaced on one side of 215 by 280 mm (8½ × 11 in.) or standard international, white, bond paper, with 25 mm (1 in.) margins. The cover page should contain a title, the author's full name(s) and address(es). Name and address should be centered on the cover page. If the current address is different, indicate this via a footnote. Submit the current address on a separate page placed after the literature cited section. A short version of the title, not exceeding 35 characters, should be provided for a running head. An abstract of about 250 words should accompany all research articles on a separate page.

Tables, one to a page, should be double-spaced throughout and be assigned consecutive Arabic numerals. Collect all figure legends on a separate page. Each illustration should be centered on a single page and be no smaller than final size and no larger than twice final size. The name of the author(s) and figure number, assigned consecutively using Arabic numerals, should be pencilled on the back of each figure.

Names for birds should follow the A.O.U. Checklist of North American Birds (6th ed., 1983) or another authoritative source for other regions. Subspecific identification should be cited only when pertinent to the material presented. Metric units should be used for all measurements. Use the 24-hour clock (e.g., 0830 H and 2030 H) and "continental" dating (e.g., 1 January 1990).

Refer to a recent issue of the journal for details in format. Explicit instructions and publication policy are outlined in "Information for contributors," *J. Raptor Res.*, Vol. 24(1-2), which is available from the editor.

1993 ANNUAL MEETING

The Raptor Research Foundation, Inc. 1993 annual meeting will be held on 3–7 November at the Marriott City Center Hotel in Charlotte, North Carolina. Details about the meeting and a call for papers will be mailed to Foundation members in the summer, and can be obtained from Keith Bildstein or Laurie Goodrich, Scientific Program Chairpersons, Hawk Mountain Sanctuary, Rural Route 2, Box 191, Kempton, PA 19529-9449 U.S.A. Telephone (215) 756-6961, FAX (215) 756-4468. For futher information about the meeting or the associated art show, contact Robert Gefaell, Local Chairperson, P.O. Box 16443, Charlotte, NC 28297 U.S.A. Telephone (704) 334-8078 or (704) 875-6521 (Carolina Raptor Center). For information about the associated symposium "Raptors Adapting to Human Environment," contact David Bird, Raptor Research Centre, McGill University, 21,111 Lakeshore Road, Ste. Anne de Bellevue, Quebec, Canada H9X IC0. Telephone (514) 398-7760, FAX (514) 398-7983.

RAPTOR RESEARCH REPORTS

#1, R.R. Olendorff. 1971. *Falconiform Reproduction: A Review Part 1. The Pre-nesting Period.* $10.00 members, $12.50 non-members.

#2, F.N. Hamerstrom, B.E. Harrell and R.R. Olendorff [Editors]. 1974. *Management of Raptors. Proceedings of the Conference on Raptor Conservation Techniques, Fort Collins, CO, 22–24 March 1973.* $10.00 members, $12.50 non-members.

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#7, R.R. Olendorff [Editor]. 1989. *The Raptor Research Foundation, Inc. Bibliographic Index (1967–1986).* $2.50 members, $5.00 non-members.

#8, R.R. Olendorff, D.D. Bibles, M.T. Dean, J.R. Haugh and M.N. Kochert. 1989. *Raptor Habitat Management under the U.S. Bureau of Land Management Multiple-Use Mandate.* $5.00 members, $6.50 non-members.

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BOOKS

Biology and Management of Bald Eagles and Ospreys. Proceedings of the First International Symposium, Montreal, Canada.
D.M. Bird [Editor]. 1983.
$15.00 members, $18.00 non-members plus $5.00 shipping.

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Journal Back Issues are available. For details write: Jim Fitzpatrick, Treasurer, Raptor Research Foundation, Inc., Carpenter St. Croix Valley Nature Center, 12805 St. Croix Trail, Hastings, MN 55033.

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