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NESTING HABITAT USE BY BURROWING OWLS IN COLORADO

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ABSTRACT.—Habitats used by nesting Burrowing Owls (*Speotyto cunicularia*), and the fidelity shown to traditionally used nesting areas were studied in 1990 and 1991. Nesting Burrowing Owls ($N = 47$ pairs) occupied burrows with a shorter distance to the nearest road, and shorter grass and forb height ($P < 0.005$) than generally available, while using black-tailed prairie dog (*Cynomys ludovicianus*) towns with greater burrow density, nearest perch distance, and percentage of bare ground ($P < 0.05$) than available. Of adults banded in 1990, 39% returned in 1991, while only 5% of chicks banded in 1990 returned. Of returning adults, 66% reused the same prairie dog town used the prior year. From 1990 to 1991, 90% of prairie dog towns were reused ($N = 18$), and 20% of nesting burrows ($N = 4$) were reused. Burrowing Owls exhibited a strong fidelity to previously used nesting towns, and were moderately site-specific in nesting habitat requirements.

Uso del hábitat de nidificación de *Speotyto cunicularia* en Colorado

RESUMEN.—Tanto el hábitat reproductivo usado por *Speotyto cunicularia* y la fidelidad mostrada a tracicionales áreas de nidificación fueron estudiados en 1990 y 1991. *Speotyto cunicularia* ($N = 47$ parejas) ocupó galerías subterráneas a corta distancia de la carretera, con hierbas bajas y altas ($P < 0.005$) generalmente disponibles, mientras que usahan las densas galerías existentes en las colonias de *Cynomys ludovicianus,* con nerchas más cercanas y un porcentaje de suelo desnudo ($P < 0.05$) en forma cignifivamente mayor que las disponible. De los adultos marcados en 1990, el 39% retornó en 1991, mientras que sólo el 5% de los pollos marcados en 1990 retornó. De los adultos retornados, el 66% utilizó la misma galería del año anterior. De 1990 a 1991, el 90% de las galerías de *C. ludovicianus* fueron reutilizadas ($N = 18$), y el 20% de las galerías de nidificación ($N = 4$) fueron reutilizadas. *Speotyto cunicularia* exhibe una fuerte fidelidad a galerías de nidificación previamente usadas y fueron moderadamente sitio-específicos en los requerimientos de hábitat de nidificación.

[Traducción de Ivan Lazo]

Burrowing Owls (*Speotyto cunicularia*) use open areas with short vegetation (Coulombe 1971, MacCracken et al. 1985, Haug and Oliphant 1990). Largely unstudied are the vegetation and physical characteristics of Burrowing Owl nesting habitats and how they differ from available unused habitat. Green and Anthony (1989) documented this relationship in habitats lacking vegetation-controlling sciurids. They, as well as MacCracken et al. (1985), identified differences in vegetation at burrows used for nesting by owls by contrasting them with control burrows adjacent to the occupied burrow. However, as Burrowing Owl nestlings grew, they usually inhabited burrows nearby the natal burrow (Plumpton pers. obs.), indicating that nesting adults may be selecting qualities in adjacent burrows as well. We know of no study that has contrasted black-tailed prairie dog (*Cynomys ludovicianus*) towns occupied by Burrowing Owls for nesting against available, but unused towns.

The objective of this study was to measure the attributes of nesting burrows and habitats used by Burrowing Owls, and determine how they differed from apparently similar, active prairie dog towns unused by nesting Burrowing Owls. Additionally, we examined

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Table 1. Characteristics of burrows used by Burrowing Owls and unoccupied control burrows at the Rocky Mountain Arsenal, 1990.

	NEST BURROWS			CONTROL BURROWS		
VARIABLE	$\bar{x}$	SE	(*N*)	$\bar{x}$	SE	(*N*)
Burrow density[a]	28.7	2.5	(19)	21.0	1.4	(19)[b]
Distance to road (m)	105.3	28.8	(19)	209.7	39.6	(19)[c]
Town size (ha)	16.1	7.8	(19)	20.4	5.9	(16)
Forb cover (%)	25.8	2.5	(17)	21.6	2.2	(17)
Bare ground (%)	63.3	3.1	(17)	64.9	2.9	(17)
Forb height (cm)	6.7	0.5	(17)	6.9	0.3	(17)
Vertical density of vegetation at burrows						
0–10 cm	1.82	0.18	(17)	1.81	0.19	(17)
10–20 cm	0.35	0.09	(17)	0.37	0.09	(17)
20–30 cm	0.09	0.04	(17)	0.04	0.05	(17)
30–40 cm	0.04	0.02	(17)	0.00	0.00	(17)
40–50 cm	0.03	0.02	(17)	0.00	0.00	(17)
50–60 cm	0.01	0.01	(17)	0.00	0.00	(17)
60–70 cm	0.00	0.00	(17)	0.00	0.00	(17)
70–80 cm	0.00	0.00	(17)	0.00	0.00	(17)

[a] (#/0.2 ha).
[b] $P < 0.01$.
[c] $P < 0.005$.

successive-year fidelity to burrows and prairie dog towns by nesting Burrowing Owls.

STUDY AREA

The Rocky Mountain Arsenal (RMA) is located in south-central Adams County, Colorado, and covers 6900 ha. RMA is within the north temperate grassland biome, specifically the high plains district of the northern great plains province. The climate is semi-arid, with light rainfall, and moderate to high winds. Average annual precipitation is about 38 cm. Elevation ranges from 1564–1625 m. The climax community for RMA was a shortgrass prairie, but the vegetation is now dominated by five major communities: weedy forbs, cheatgrass (*Bromus* spp.)/weedy forbs, cheatgrass/perennial grassland, native perennial grassland, and crested wheatgrass (*Agropyron cristatum*).

METHODS

Physical and vegetation characteristics were measured at all burrows used by nesting owl pairs, and at an equal number of unoccupied control burrows during 1990 ($N = 19$) and 1991 ($N = 28$). Since all nesting occurred in active black-tailed prairie dog towns, control burrows were selected at random from active prairie dog towns (towns) unused by Burrowing Owls. Since Burrowing Owls were capable of evicting prairie dogs from desired burrows (Plumpton pers. obs.), occupancy by prairie dogs at the time of random selection was considered irrelevant.

Physical measurements included compass orientation of the burrow entrance, number of burrows (density) within a 25-m radius (0.2 ha circle), distance within the tunnel from the burrow opening to a vision-obscuring bend, distance from the burrow to the nearest road, distance to the nearest above ground perch (e.g., pole, woody plant) within 25 m, and town size. Nesting burrow orientations were characterized by calculating mean angle ($\bar{a}$), dispersion (r), and angular deviation (s) (Batschelet 1965). Orientation data from used burrows were tested for differences between years using a χ^2 test. A χ^2 goodness-of-fit test was used to determine uniformity of used and control burrow orientations. To determine whether owls selected burrows with orientations different from available, used burrows were tested against control burrows using χ^2 (Batschelet 1965) and Watson's U^2 tests (Zar 1974).

Vegetation measurements included percent occurrence of grass, forb, and bare ground, and were taken at burrows using 10-pin point-frame sampling (Levy and Madden 1933). Ten transects, each 25 m in length, radiated from the burrow entrance at random azimuths. Point frames were placed along transects at 5-m intervals, for a total of 50 sampling points/burrow. Grass and forb height were measured at the nearest occurrence within the point frame at each plot. Vertical density was measured at this same reference point, by inserting a rod vertically into the vegetation, and counting the number of plant contacts with the rod in 10-cm increments. Because of the minimal number of vegetation contacts above 10 cm, and to maintain minimum expected cell counts in the χ^2 test, levels 2–8 (10–80 cm) were lumped for 1990, and levels 3–8 (20–80 cm) were lumped for 1991. A 2×2 and 2×3 contingency table was used in the analysis of 1990 and 1991 data, respectively.

Table 2. Characteristics of burrows used by Burrowing Owls and unoccupied control burrows at the Rocky Mountain Arsenal, 1991.

	NEST BURROWS			CONTROL BURROWS		
VARIABLE	$\bar{x}$	SE	(*N*)	$\bar{x}$	SE	(*N*)
Burrow density[a]	21.3	1.5	(28)	22.3	2.0	(28)
Distance to road (m)	114.5	21.9	(28)	108.3	26.7	(28)
Town size (ha)	29.2	8.7	(21)	5.2	0.7	(21)
Forb cover (%)	34.7	3.2	(26)	42.9	3.3	(26)
Bare ground (%)	53.1	2.8	(26)	37.5	2.3	(26)[b]
Forb height (cm)	6.9	0.5	(26)	9.7	0.5	(26)[c]
Vertical density of vegetation at burrows						
0–10 cm	1.93	0.12	(26)	2.94	0.16	(26)
10–20 cm	0.40	0.08	(26)	0.91	0.09	(26)
20–30 cm	0.59	0.02	(26)	0.19	0.04	(26)
30–40 cm	0.01	0.00	(26)	0.03	0.01	(26)
40–50 cm	0.00	0.00	(26)	0.01	0.00	(26)
50–60 cm	0.00	0.00	(26)	0.00	0.00	(26)
60–70 cm	0.00	0.00	(26)	0.00	0.00	(26)
70–80 cm	0.00	0.00	(26)	0.00	0.00	(26)

[a] (#/0.2 ha).
[b] $P < 0.0001$.
[c] $P < 0.0005$.

Data for all variables except burrow orientation were tested for normality using the Shapiro/Wilk test (Shapiro and Wilk 1965). Data were tested within treatments for between-year differences. When no differences existed between years for either used or control burrows ($P > 0.05$), data were pooled for analysis. When data were normally distributed, *t*-tests were used. When non-normal data could not be normalized with log transformation, Wilcoxon 2-sample tests and Kruskal/Wallis approximations were used (SAS Institute Inc. 1988).

To examine inter-year fidelity to burrows, owls were captured and fitted with color-anodized leg bands engraved with unique alphanumeric codes (Acraft Sign and Nameplate Co., Ltd., Edmonton, Alberta, Canada). Owls were captured following techniques described by Plumpton and Lutz (1992). Fidelity to nesting burrows or towns by Burrowing Owls was determined by resighting in 1991 birds banded in 1990.

RESULTS

Nesting burrows were oriented with a mean angle ($\bar{a}$) = 95°, dispersion (r) = 0.061, and angular deviation (s) = 78.53. The orientations of neither nesting nor control burrows were different from expected in direction categories (nesting: $\chi^2 = 7.45$, $P > 0.05$, df = 7; control: $\chi^2 = 2.47$, $P > 0.05$, df = 7). No difference existed in orientation between used and available burrows ($\chi^2 = 10.06$, $P > 0.05$, df = 5; $U^2 = 0.069$, $P > 0.05$, df = 45).

In 1990, burrows used for nesting were in towns of greater burrow density than control towns (*t*-test, df = 18, $P = 0.009$; Table 1). In 1991, burrow density in towns used for nesting was not different from control towns ($P > 0.05$; Table 2). Used burrows were not different from controls in tunnel length (*t*-test, df = 91, $P = 0.13$; Table 3). In 1990, used burrows were closer to roads than controls (Wilcoxon $z = 2.9$, Kruskal/Wallis χ^2 approximation = 8.9, df = 1, $P = 0.003$; Table 1). In 1991, used burrows were not different from controls in distance to roads ($P > 0.05$; Table 2). Burrowing Owls used burrows farther from perches than control burrows ($z = 2.0$, $\chi^2 = 4.3$, df = 1, $P = 0.004$; Table 3). In both years, used towns were no different from control towns in size ($z = -1.4$, $\chi^2 = 1.9$, df = 1, $P = 0.16$; Table 1 and $z = 1.9$, $\chi^2 = 3.7$, df = 1, $P = 0.06$; Table 2).

Towns that Burrowing Owls used were no different from controls based on percent grass cover ($z = 1.5$, $\chi^2 = 2.5$, df = 1, $P = 0.11$; Table 3) nor was percent forb cover different between used and control towns ($z = -1.5$, $\chi^2 = 2.5$, df = 1, $P = 0.1$; Table 1 and $z = 1.5$, $\chi^2 = 2.3$, df = 1, $P = 0.12$; Table 2). In 1991, mean percent bare ground was greater at used than control burrows ($z = -3.7$, $\chi^2 = 14.2$, df = 1, $P =$

Table 3. Characteristics of burrows used by Burrowing Owls and unoccupied control burrows at the Rocky Mountain Arsenal, 1990–1991.

	NEST BURROWS			CONTROL BURROWS		
VARIABLE	$\bar{x}$	SE	(*N*)	$\bar{x}$	SE	(*N*)
Tunnel length (cm)	86.9	3.93	(46)	77.6	4.60	(47)
Perch distance (m)	11.0	1.35	(29)	6.8	0.64	(40)[a]
Grass cover (%)	11.7	2.4	(43)	17.1	2.9	(43)
Grass height (cm)	7.3	0.97	(43)	11.2	1.22	(43)[b]

[a] $P < 0.005$.
[b] $P < 0.05$.

0.0002; Table 2). For both years combined, Burrowing Owls used towns with shorter mean grass height than controls ($z = 2.3$, $\chi^2 = 5.5$, df = 1, $P = 0.02$; Table 3). In 1990, mean forb height was not different at used and control burrows ($z = 0.7$, $\chi^2 = 0.5$, df = 1, $P = 0.49$; Table 1). In 1991, mean forb height was shorter at used than control towns ($z = 3.5$, $\chi^2 = 12.3$, df = 1, $P = 0.0005$; Table 2). For each year separately, the vertical density of vegetation at burrows in nesting towns was not different from controls ($\chi^2 = 0.18$ and 1.61 for 1990 and 1991, respectively, $P > 0.05$; Tables 1 and 2).

In 1990, 34 adult Burrowing Owls were captured. Nineteen adult males and 15 adult females from 22 mated pairs received color leg bands. Prior to migration from the area, three adults were found dead. In 1991, 12 of the known remaining 31 (39%) returned to the RMA; eight (66%) used a burrow within the same town used in 1990. The mean inter-nest distance for those owls that occupied the same town in 1990 and 1991 was 100.9 m (range = 34.4–251.1 m). Of the 20 prairie dog towns used by all owls in 1990, 18 (90%) were reused in 1991. Of the 20 burrows used by all mated pairs in 1990, four (20%) were reused in 1991. Of the eight 1991 adults choosing burrows used in 1990, three (37%) were birds banded in 1990. At least two other burrows which were used for nesting in 1990 had unbanded pairs occupying them in 1991.

DISCUSSION

For cavity-nesting bird species, both nest site placement and orientation may influence the microclimate of the nest (Inouye et al. 1981). However, Burrowing Owls in this study used nesting burrows without regard to compass orientation, as was reported in previous studies without supporting statistics (Coulombe 1971, Butts 1973, Martin 1973, Butts and Lewis 1982).

In 1990, Burrowing Owls used burrows in areas with greater burrow density than available. Growing chicks often dispersed into burrows near the natal burrow while still largely dependent on the adults. Use of areas for nesting with greater burrow density may be explained by this habit. Chicks often foraged a short distance from the natal burrow while parent birds were hunting, and high burrow densities may provide needed escape burrows for these owlets. However, for unknown reasons, selection for high burrow density was not observed in 1991. Selection for either high burrow density in 1990 or nonselection in 1991 may therefore have been a chance occurrence.

Burrowing Owls are known to select areas with more bare ground and less grass cover than the surrounding area (MacCracken et al. 1985, Green and Anthony 1989). In our study, greater amounts of bare ground, and lower grass and forb height were selected for, but neither percent grass nor forb were selected for. Bare ground and short grass and forbs may afford Burrowing Owls visual security from predators and easier foraging (Green and Anthony 1989). Green and Anthony (1989) found Burrowing Owls used areas with less ($P < 0.05$) vertical density of vegetation from 0–10 cm than "potential" burrows, although their study was done in vegetation uncropped by sciurids. In our study, all burrows used by owls were in active prairie dog towns featuring short vegetation, and vertical density did not differ between used and control burrows.

Green and Anthony (1989) found that elevated perches were not used by Burrowing Owls where the surrounding vegetation was less than 5 cm in height. Similarly, in our study, Burrowing Owls used burrows with perches farther away than at control burrows; vegetation height at these burrows averaged less than 8 cm. Although Burrowing Owls often used elevated perches, they were apparently unnecessary in the short vegetation of active towns. Burrowing Owls at RMA appear to occupy habitats based on similar criteria to

those studied elsewhere; they occupied areas featuring short, sparse vegetation.

Burrowing Owls were moderately selective of the physical variables (3/6 significant) and vegetation variables (3/6 significant) we measured. Several variables we measured were different between used and control burrows for only a single year. These included burrow density and road distance in 1990, and bare ground and forb height in 1991. We believe that single-year differences were attributable to climate: in 1990, the area received little rainfall, and the differences between full-grown vegetation and that which was cropped by prairie dogs were small. Thus, selection of physical, rather than vegetative, characteristics was observed in only this year. Conversely, in 1991, with far greater rainfall and greater differences in cropped versus uncropped vegetation, selection was for shorter forb height and more bare ground. Based on these data, we suggest that habitat alterations that diminish burrow availability and that allow vegetation to grow uncropped (>8 cm) and beyond early successional stage will adversely affect nesting Burrowing Owls.

Burrowing Owls show a high degree of fidelity to traditionally used nesting towns at RMA. Towns that have been used in consecutive years probably represent the best nesting habitat present at RMA. Management for Burrowing Owls therefore should include protection of active, traditionally used towns. A form of active management, in the event of extirpation of prairie dogs, would include artificial maintenance of vegetation height and succession by mowing. Mowing would be most critical around mid-March, when birds first arrive from migration and select nesting burrows.

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LIVE PREY TO YOUNG RAPTORS—INCIDENTAL OR ADAPTIVE?

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ABSTRACT.—Raptors sometimes bring prey that is still alive to their nests, or potential prey may blunder into raptor nests or result from competition for a nest. Such delivery of live prey seems incidental or accidental and non-adaptive: the live prey sometimes escapes. When live prey is a nestling bird it may be "adopted" and even reared, thus providing insights into parental behavior and to similar behavior among captives. Raptors that catch flying prey often drop prey near their fledged young, which the latter catch or attempt to catch in midair. In one species, the Peregrine Falcon (*Falco peregrinus*), such dropped prey regularly includes some living birds.

Presas vivas para rapaces juveniles—accidental o adapativo?

RESUMEN.—Algunas veces las aves rapaces llevan presas aún vivas a sus nidos, estas pueden constituir un despropósito en los nidos de las rapaces o generar una competencia por el nido. Tal liberación de la presa viva parece accidental y no adaptativa: la presa algunas veces escapa. Cuando la presa viva es un polluelo, este puede ser adoptado y hasta criado, proveyendo conductas parentales entre los cautivos. Las rapaces que capturan presas voladoras a menudo dejan caer la presa cerca de sus juveniles, las que más tarde captura o intenta capturar en el aire. En *Falco peregrinus,* regularmente las presas incluyen algunas aves vivas.

[Traducción de Ivan Lazo]

Scattered observations exist of raptors bringing live prey to their nestlings. All classes of prey are represented except mammals, perhaps because the latter might bite and injure both adult and immature raptors. We have not found instances for owls but their nocturnal habits and frequent use of cavities for nesting make observations difficult.

Live prey may be in raptor nests for diverse reasons or under varying circumstances. Our objective was to enumerate these reasons, give examples of each, and discuss whether any of them are adaptive to raptors. Instances of live prey being "adopted" by raptors are also evaluated. Presentation of prey, alive or dead, to fledged raptors is also considered.

OBSERVATIONS

Adventitious Occurrences. Potential living prey—reptiles, birds, mammals—may occasionally blunder into a raptor's nest. Weaver finches (*Passer*) and grackles (*Quiscula*) sometimes breed in the base of large hawk nests; their young might flutter into the raptor's nest. Occasionally two raptor species compete for the same nest and brood mix-ups occur. Mikkola (1983:164) wrote: "Even if a female Ural Owl (*Strix uralensis*) has already laid her eggs in her chosen nest, she remains highly vulnerable to the attentions of a nest-hunting Goshawk (*Accipiter gentilis*)." One nest contained three eggs of the hawk and one of the owl. All four were incubated by the goshawk. "On 23 May the nest contained a newly hatched Ural Owl chick and three eggs of the (then) real owners . . . the owlet soon disappeared and on the 8th June the nest contained only three goshawk nestlings."

S.K. Sherrod (pers. comm.) was told by Russian naturalist, R. Pfeffer, of finding a young Northern Raven (*Corvus corax*) in the nest of a Golden Eagle (*Aquila chrysaetos*). Both species had shown interest in the nest and Pfeffer assumed that the ravens had laid eggs before being evicted, one of which was hatched by the eagle. Or perhaps one of the eagles had brought the raven to the nest (see below).

Instances Involving Insects and Lower Vertebrates. After intensive study of Mauritius Kestrels

(*Falco punctatus*) in the field and captivity, C.G. Jones (pers. comm.) wrote: "We now have about 10 records of kestrels delivering live or twitching prey to the nest. All that I can recall were when the kestrels were rearing well-grown young. I have seen many hundreds of prey items delivered to the nest during the incubating phase and if my memory serves me correctly, none of these (geckos, *Phelsuma*) were alive. Large insects, such as locusts and dragonflies, are not usually delivered to the nestlings until their last week or so in the nest. Some of these insects are very much alive when they are brought to the nest."

At a nest of the Chanting Goshawk (*Melierax canorus*) the male brought a live agama lizard " . . . which he deposited on the nest where it lay feigning death. When the female leant forward to pick it up a while later, the agama came to life and dived over the nest edge, pursued by the female, but it escaped" (Steyn and Myburgh 1992).

Tenneson (1992) stated that living snakes are not infrequently brought to the "nest" of the ophiophagous Laughing Falcon (*Herpetotheres cachinnans*) but also found that surplus snakes are draped over boughs at the nest site. Obviously these snakes could not be alive. This falcon promptly dispatches venomous snakes, which comprise a substantial portion of its food. It is possible, therefore, that the living snakes observed were "more dead than alive." Poikilothermic vertebrates may flap or writhe for some time after "death," so a precise distinction is sometimes impossible. Fish sometimes flop over the side of a Bald Eagle's (*Haliaeetus leucocephalus*) nest, or turtles walk over its rim (Palmer 1988:215). In such cases, failure to kill the prey results in its loss.

Live Birds Brought to Raptor Nests without Receiving Parental Care. A Cooper's Hawk (*Accipiter cooperii*) brought two living, nestling Scarlet Tanagers (*Piranga olivacea*) to its nest (Meng 1959). One of three quelea finches (*Quelea*) brought to a brood of Taita Falcons (*Falco fasciinucha*) was alive (Hartley et al. 1993).

At several nests of the Australian Square-tailed Kite (*Lophoictinia isura*), food brought to the kite nestlings consisted entirely of nestling birds. A friarbird (*Philemon* sp.) was alive when delivered by the male; the female kite seized it at once and began to feed it to her chicks (Cupper and Cupper 1981). In the related but larger Black-breasted Kite, (*Hamirostra melanosternon*), the food includes large lizards and some nestling birds, both living and dead. Two living prey were chicks of other species of raptors: a Black Kite (*Milvus migrans*) and an Australian Kestrel (*Falco cenchroides*). Both were pinned down by the Black-breasted Kite and fed to her chicks but not until after the young kestrel had repulsed a kite nestling by raking it with its talons (but see below).

Gossett and Smith (1993) found a living, uninjured passerine chick in a nest of the Ferruginous Hawk (*Buteo regalis*), which contained two young Ferruginous Hawks more than a week old. The hawks' nest was on a metal tower and the observers thought that the passerine must have been brought there by one of the hawks. The next day they found only a wing quill of the foreign nestling.

Living Birds Brought as Prey but Receiving Parental Care. On 3 June 1960, one of us (WRS) watched a female Golden Eagle incubating her single egg at a nest in Maine. The following day she was moving restlessly and often peered into the nest. Probably the chick was cheeping within the egg. At 0515 H the next morning the female eagle was attempting to feed a nestling, a partly feathered American Crow (*Corvus brachyrhynchos*), which she later moved back under her when it tottered across the nest. The eaglet was hatching. A week later the eaglet was there along with a few black feathers, presumably from the hapless crow. The nearest site for American Crows was a valley about 7 km away.

The following remarkable events were observed and photographed at nests of the Black-breasted Kite (Cupper 1977, Cupper and Cupper 1981). On 8 October one attended nest was empty, two others held eggs. On 7 November the previously empty nest held two chicks. Although the time interval seemed too short to lay and hatch a clutch of eggs (and the chicks were very small), it was assumed the young must have been kites. Food remains in the nest proved to be legs of Australian Kestrels. On the next visit 20 days later, a young kestrel with some down on its head fluttered about the base of the nest tree; a second fledgling flew down from the tree and gave a distraction display. The next day, along with the female kite, there were four young kestrels of varying ages in the nest; later three more flew in. An adult kite, presumably the male, arrived with another young kestrel, this one dead. The chicks fed on it. The next day the kites were brooding and feeding their adopted kestrels of various ages. Evidently the male Black-breasted Kite had formed a search image on kestrels. He brought in many young ones, some dead, some alive. The female kite began to feed and rear the

young kestrels, and there was no indication that she ever laid eggs.

Over a period of years, Watson et al. (1993) examined more than 600 nests of Bald Eagles in the Puget Sound area. Three of them (two at the same nest in alternate years) each contained a living nestling Red-tailed Hawk (*Buteo jamaicensis*) and in two of these the young hawks fledged; it was not determined how the young hawks fared after fledging. The observations were from a helicopter, but photographs were taken. The hawks were always younger than the eaglets in the same nest, and the observers concluded that the hawks must have been brought to the nest by one of the eagles. A nest of the Bald Eagle in Michigan also contained a healthy, recently fed Red-tailed Hawk chick about a month younger than two eaglets in the nest. A photograph shows the hawk at one side of the nest; the eaglets at the other. No further observations were possible and the outcome was not known (Stefanek et al. 1992).

In one astounding incident, a pair of American Kestrels (*Falco sparverius*) lost their brood in a nest box, apparently to a mammalian predator (Tlusty and Hamerstrom 1992). The kestrels then transferred their attention to a box 1.1 km away which contained a brood of young European Starlings (*Sturnus vulgaris*). The kestrels repulsed the parent starlings and adopted and fed the young starlings on mice and other items, entering the nest box to tear the prey to pieces.

Living Birds Brought to Raptor Fledglings. In several species adults fly near young which have fledged or are about to, carrying prey conspicuously presented. The fledglings often fly out and seize such prey or attempt to catch it in midair if the adult drops it. The next step would be the similar presentation of living, perhaps incapacitated, prey. Sherrod (1983) who spent days observing recently fledged Peregrine Falcons (*Falco peregrinus*) found that living birds, as well as dead ones, are indeed dropped for the young to pursue. If a flying prey escapes the sallies of the fledglings, an adult may recapture it, carry it aloft again, and release it still alive. Living birds thus presented are mostly small species but range up to the size of the Rock Dove (*Columba livia*).

Pursuit of living prey must accelerate the acquisition of foraging techniques in these young falcons. Probably similar behavior will be found in other species of the genus *Falco* that catch birds in midair pursuit. Dropping of live prey has been observed at least twice in the New Zealand Falcon (*Falco novaeseelandiae*; Lawrence and Gay 1991). After its young have fledged the Eurasian Sparrowhawk (*Accipiter nisus*) drops birds for them to catch, but very rarely does one of these prey items show signs of life (Newton 1986:208). In the related Cooper's Hawk, H. McElroy (pers. comm.) saw an adult carrying a bird fly in among the branches of a tree where its brood were perched. It dropped a live bird which fluttered down at an angle and was caught by one of the immatures. More observations are needed to be sure that such use of living birds is established behavior in accipiters or other species of somewhat similar habits.

Bent (1937:155) quotes a correspondent who reported a Red-tailed Hawk dropping live mice to its young; they attempted to catch them in midair "with fair success." This requires confirmation.

DISCUSSION

As indicated, the delivery of living prey to raptor nestlings is so rare as to suggest that it is incidental and non-adaptive. Living prey sometimes escapes. Nestling raptors have never been seen to manipulate living prey as do the young of a few kinds of mammals, such as cats (Felidae). To do so in an elevated nest might result in some of the young raptors falling to their death. The Mauritius Kestrel may be an exception. It brings living insects to its young only when they are well grown. The species is a cavity nester so the danger of the young falling from the nest would be less than in an open nest.

All the records of living birds brought as prey to raptor nests were nestlings. This might suggest that if adults were brought, they would escape or be quickly killed. Nestling birds are incompletely feathered. They need not be deplumed before taking them to the nest and in the process killed and often decapitated as are adult prey. I. Newton (pers. comm.) concluded that not infrequently birds captured by the Eurasian Sparrowhawk are still alive at the time the hawk arrives with them at its plucking post. Nestlings, on the other hand, may be taken directly to the nest.

When large, vigorous and sometimes potentially dangerous prey is caught, "Cooper's Hawk—like other accipiters (and hawks in general)—will respond to movement of the prey by strongly grasping it, then relaxing their grip, then clamping down again" (Palmer 1988:350). Nestlings will be less apt

to trigger such killing reactions. Still, it does seem remarkable that Bald Eagles on four known occasions have brought small, nestling Red-tailed Hawks to their nest alive.

S.K. Sherrod (pers. comm.) makes the further interesting suggestion that if nestling raptors perceive an approaching winged predator as a parent and begin to vocalize, it might set up conflicting stimuli causing the predator to carry off one of the young without killing it. All of the young hawks in Bald Eagle nests were Red-tailed Hawks but this is a large conspicuous species which often nests in somewhat exposed sites. Red-tailed Hawk chicks (and adults?) do occasionally appear as prey items in Bald Eagle nests (W.S. Clark pers. comm.).

After fledging, young raptors are no longer in danger of falling. Yet the regular presentation of living prey, even at that stage, has been established as yet only in the Peregrine Falcon. Many raptors secure most of their food, such as rodents, on the ground. Nevertheless, none of them are known to provide living prey to their fledglings on the ground as do a few mammals. Probably this is because inexperienced hawks conspicuously engaged with living prey might attract larger predators. When a trained falcon brings its quarry to the ground and struggles with it, falconers dash to save their bird as they know it may be killed by other predators. The presentation of living prey to raptor fledglings on the ground could thus be maladaptive.

Although the delivery of living birds as prey to raptor nestlings is probably incidental, it assumes some interest when the prey is a young bird which begs for food and is "adopted," fed, and even reared to fledging. Hawks do not always recognize their own young. Recently fledged Ospreys (*Pandion haliaetus*), for example, sometimes visit neighboring Osprey nests and successfully beg for food, sometimes intimidating younger Ospreys in doing so (Poole 1989:111). The same apparently occurs in the Eurasian Sparrowhawk (Newton 1986:210). That Bald Eagles have reared both their own young and young Red-tailed Hawks, a third or a quarter of the size of the eaglets, indicates how indiscriminate the instinct to feed a begging chick may be. Extensive studies on captive breeding of many raptors has shown that when physiologically prepared for breeding, they often readily adopt alien chicks, sometimes even halting incubation and perhaps inhibiting egg-laying to do so.

Research on parental care is presently an active field (Winkler 1992). Raptors are a group in which observations and experiments can be carried out both in captivity and in the field, and in which there is a wide range of behavior.

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REQUEST FOR INFORMATION

Dieter Schmidl is preparing a book on the Red-naped Shahin (*Falco pelegrinoides babylonicus*) also called the Russett-headed Falcon (*F. pelegrinus babylonicus*) or Desert Peregrine Falcon (*F. peregrinus babylonicus*). Schmidl requests the following information on the species: literature mentioning this falcon, e.g., from handbooks, checklists, expedition reports, etc.; published or unpublished manuscripts with observations of, for example, breeding records and sightings; addresses of institutions or persons engaged in the study of this falcon; and information on museum specimens. All contributions will be acknowledged and contributors will be informed about publication date of the book.—**Dieter Schmidl, Max-Planck-Institut, D-82319 Seewiesen, Germany. FAX (8157)-29209.**

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THE POST-FLEDGING DEPENDENCE PERIOD OF THE BLACK-SHOULDERED KITE (*Elanus caeruleus*)

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ABSTRACT.—The post-fledging dependence period was studied in four broods (10 fledglings) of Black-shouldered Kites (*Elanus caeruleus*) in central Spain, and lasted around 34 d. In the two pairs most closely studied, the adult female abandoned the family group in the first two wk after fledging and the male continued alone caring for the offspring. Initial prey transfers from adult to fledglings were on perches but changed gradually to aerial transfers. Fledglings of one family group moved with the male to a hunting area 2 km from the nesting area. Fledglings gradually improved their flying skills, increasing the time spent flying and the use of gliding and hovering flights relative to exclusively flapping flights. They showed behaviors that were considered as play and gradually developed their hunting skills, catching small mammals before becoming independent. As the fledglings started hunting by themselves, the male decreased the time spent hunting and the number of prey given to them. No aggressive actions by the male toward its offspring were observed at the end of the post-fledging dependence period.

El periodo de emancipación en el Elanio Azul (*Elanus caeruleus*)

RESUMEN.—Se estudió el periodo de emancipación en cuatro polladas (10 jóvenes) de Elanio Azul (*Elanus caeruleus*) en España central, y éste duró alrededor de 34 días. En las dos parejas estudiadas con más detalle, la hembra adulta abandonó el grupo familiar en las dos primeras semanas del periodo de emancipación, y el macho continuó solo cuidando de la descendencia. Inicialmente las transferencias de presas entre adultos y jóvenes tenían lugar en un posadero, cambiando gradualmente hacia transferencias en vuelo. Los jóvenes de uno de los grupos familiares se desplazaron junto con el macho a un cazadero a 2 km de distancia, abandonando la zona del nido. Los jóvenes mejoraron gradualmente su capacidad de vuelo, incrementando el tiempo pasado volando y el empleo de vuelos planeados y cernidos en detrimento de vuelos exclusivamente aleteados. Los jóvenes mostraron pautas de comportamiento que fueron consideradas como juegos y maduraron gradualmente las técnicas de caza, capturando micromamíferos por sí solos antes de independizarse. A medida que los jóvenes pasaban más tiempo cazando disminuyó el tiempo que el macho dedicaba a esta actividad y se redujeron las transferencias de presas del macho a los jóvenes. No se observaron agresiones por parte del macho hacia su descendencia al final del periodo de emancipación.

[Traducción Autor]

There is very little published information on the post-fledging dependence period of the Black-shouldered Kite (*Elanus caeruleus*). Neither Brown and Amadon (1968) nor Cramp and Simmons (1980) give any information on this period. However, Mendelsohn (1981) observed the post-fledging of 10 Black-shouldered Kite fledglings in South Africa, provided some behavioral observations, and found a mean duration of post-fledging dependency of 82 d (cited also by Newton 1979).

This study describes the post-fledging dependence period, flight progression and maturation of hunting behavior in four broods of Black-shouldered Kites in central Spain.

STUDY AREA AND METHODS

In the spring of 1989, four family groups (pairs 1–4, brood-size four, three, one and two chicks, respectively) were studied near Madrigalejo in the Guadiana River Basin (39°4′N, 5°40′W), central Spain. This is an area of flat to gently undulating topography with irrigated and cereal crops. Black-shouldered Kites nested on evergreen oaks (*Quercus rotundifolia*) that were scattered in the cereal fields.

Observations started on 21 May, when the first chicks fledged—defined here as the age when the first flight was observed—and ended on 12 July, when most fledglings seemed to have disappeared from the area and the three remaining (pair 2) were no longer being fed by the adults. All four family groups were checked regularly, with short

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visits at sunrise or sunset, to determine if fledglings and adults were still present at the nesting area (every 1–5 d from 21 May to 10 June, and at least once every 10 d from 10 June to 12 July, totaling 10–17 visits on different days per family group).

Two dawn-to-dusk (0500–1930 GMT) observations of pair 1 and one observation from 1300–2000 GMT of pair 2 showed that 80% of the activity of fledglings took place before 0830 GMT in the mornings and after 1600 GMT in the evening, and that hunting and feeding by adults were even more concentrated at dawn and dusk. Accordingly, I decided to continue with behavioral observations of the family groups only from 0430–0830 and from 1600–2000 GMT. A total of 146 hr of behavioral observations were made (66, 64, 8 and 8 hr in pairs 1–4, respectively). Pairs 1 and 2 were more intensively observed because the topography and tree density facilitated the observation of individuals.

All chicks were individually marked 10–15 d before fledging by feather dying (Young and Kochert 1987). Five fledglings (one in pairs 1, 3 and 4 and two in pair 2) were also equipped with radiotransmitters attached with a backpack harness (Beske 1978; weight with harness 9 g = 3% of body mass). In the two family groups observed more intensively, two adults were marked by feather dying before observations began, the female of pair 1 and the male of pair 2.

Observations were initially performed from inside a vehicle parked 300 m from the nest by one observer with 10× binoculars and a 60–80× field scope. Once fledglings started wandering they were followed by the observer from a distance of 100–1500 m.

Numerous behaviors related to the learning of hunting skills were observed in the fledglings during the post-fledging period. Following Fagen (1976) and Ficken (1977), some behaviors were considered as play because they were different from the habitual adult hunting behavior. They were behavioral sequences that were used by fledglings out of context, or involved repetition of incomplete behavioral sequences. Other hunting behaviors without the previous characteristics were considered as gradual maturation of hunting skills.

RESULTS AND DISCUSSION

Fledging Age and Duration of the Post-Fledging Dependence Period. Chicks fledged 34–41 d after hatching, a similar age to that reported by others for the Black-shouldered Kite (e.g., Cramp and Simmons 1980). On pair 2, where I saw the first flight of all chicks, there was an 8-d difference in fledging date between the first and the last chick in the brood.

At the two broods less intensively watched, the fledglings were last seen 25 d (pair 3) and 16 d (pair 4) after fledging. One fledgling in each brood was equipped with a radiotransmitter, but the signals could not be located thereafter in the vicinity of the nesting area. Nonetheless, I cannot disregard the possibility that the fledglings had moved with one or both adults to a different hunting area far from the nest because, due to interference, the signal of the radiotransmitters was usually not received from more than 1–2 km. At the two broods more intensively observed, the male stopped feeding his offspring 30–39 d (pair 1) and 22–42 d after fledging (pair 2). Fledglings of both family groups were observed at the male hunting territory hunting independently before they dispersed. Based on the two more intensively observed broods, I estimated an average post-fledging duration of 34 d for the population in central Spain (39°N). This is less than half the dependence period observed by Mendelsohn (1981) at 25°S in South Africa (82 d), but follows the general tendency of shorter post-fledging periods at higher latitudes (Bustamante 1990).

One fledgling from brood 1 disappeared 9 d after fledging, and probably died before independence. Its siblings were fed by the male for at least 21 d more.

Feeding by Adults and Prey Transfers. In the two pairs with marked adults (pairs 1 and 2), both parents hunted (mainly rodents and small birds) and brought the prey to the young. The female usually brought the prey to the nest, both those caught by her and those caught by the male partner. In pair 2, the female hunted close to the nest and caught 19% of the prey she delivered to the nest while 35% were given to her by the male (N = 26 prey). The females of pairs 1 and 2 abandoned the family group long before the fledglings were independent (6 and 11 d after fledging, respectively) and the male continued alone feeding the fledglings (Fig. 1). Since adults were not marked in the other two family groups and observations were more difficult, it was not clear if one or both adults cared for the young before they all disappeared. Early female abandonment after fledging was also observed by Mendelsohn (1981) in the Black-shouldered Kite. Otherwise, it has only been recorded in the Snail Kite (*Rostrhamus sociabilis*), although males may also desert early in this species (Beissinger and Snyder 1987, Beissinger 1990).

Feeding frequency by pairs 1 and 2 increased slightly during the first two weeks after fledging and decreased thereafter (Fig. 1) as the fledglings were starting to hunt by themselves.

Initially, prey were brought by the parents to the nest. The nest was used as a feeding platform and as a roost by the fledglings, but soon it was replaced by other alternative perches (trees and fences). At one family group (pair 1) the fledglings followed the

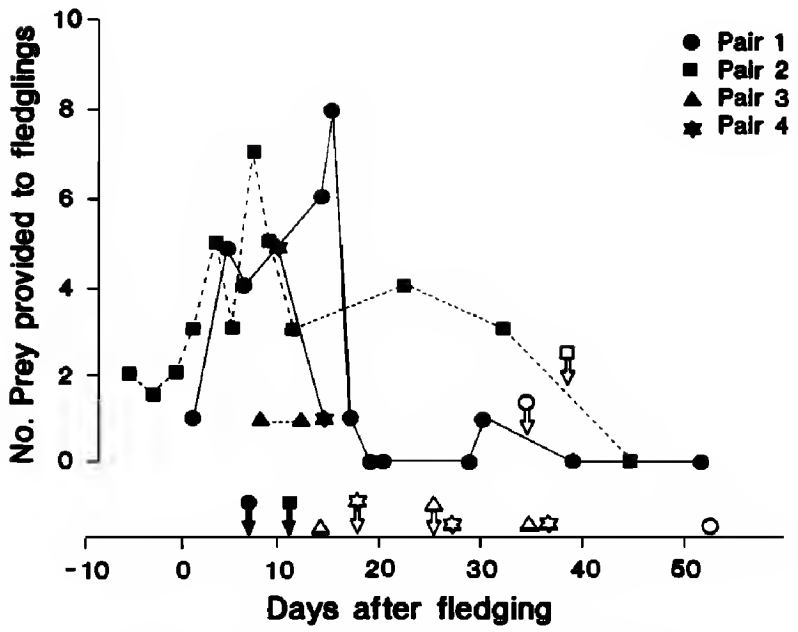

Figure 1. Number of prey brought to the fledglings in a 4-hr period at sunrise or sunset, or average when both were observed the same day. Male and female combined when both present. Solid arrows indicate the last day females of pair 1 and 2 were seen. Open arrows indicate the estimated time of independence (pairs 1 and 2) or the day fledglings were last seen (pairs 3 and 4). Open symbols indicate timing of other short visits to each nest site to check if birds were present.

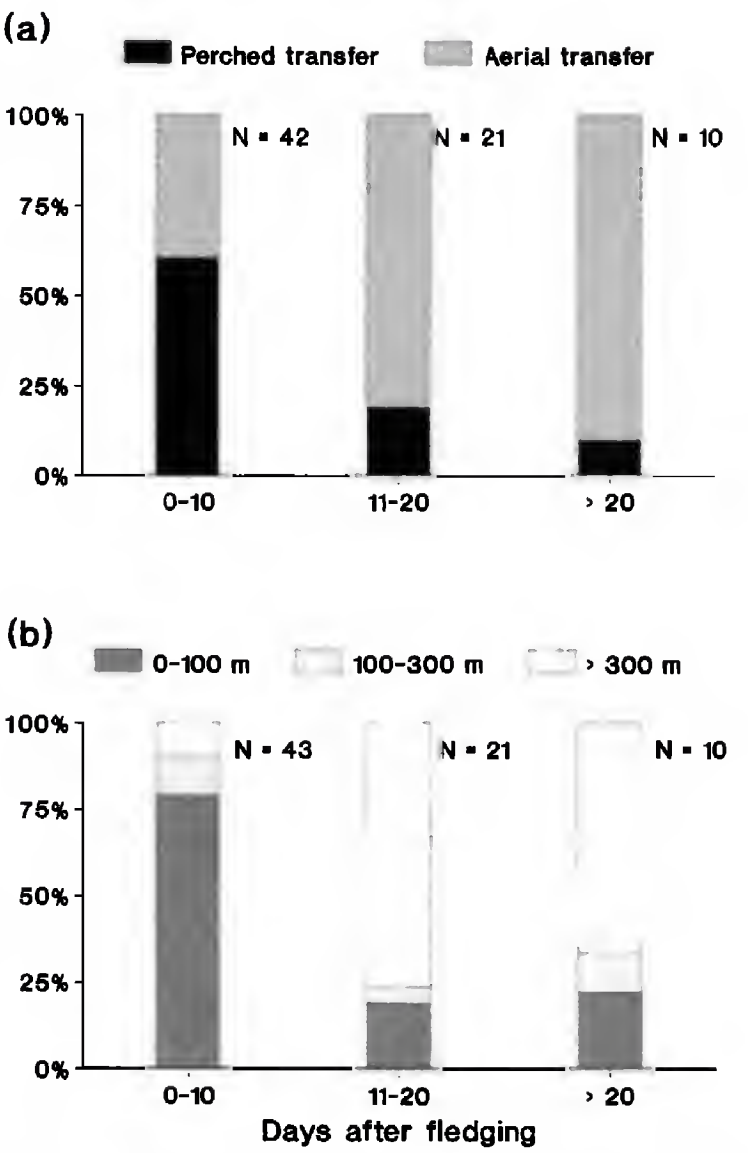

Figure 2. Change in prey transfers with days after fledging: (a) Percentage of perched and aerial transfers in relation to days after fledging. (b) Percentage of prey transfers at different distances from the nest in relation to days after fledging.

male to a hunting area 2 km away, and the nest was rarely used after that. A few days after first flights, fledglings tended to fly toward the adult coming with prey. During the first attempts, adults avoided approaching fledglings and brought the prey to the nest, especially if any of the chicks in the brood had not fledged yet. Once all siblings were on the wing, adults hovered and waited for the approach of fledglings. The first fledgling to reach the adult turned upside-down and removed the prey from the adult's talons in the air. As the fledglings improved their flight skills, this type of prey transfer almost replaced transfers on a perch (Fig. 2a). Prey transfers tended to take place farther from the nest as fledglings got older (Fig. 2b). Sometimes the prey fell to the ground during the transfer, and in most instances was retrieved by one of the fledglings.

Aerial prey transfers may be a way to practice the skills necessary for the capture of agile prey and have been recorded mainly in species feeding on birds and small mammals (e.g., *Accipiter* spp., Simmons 1984, Newton 1986, Palmer 1988; *Circus* spp., Snyder 1931, Benson 1958, Palmer 1988; *Falco* spp., Schuyl et al. 1936, Tinbergen 1940, Sherrod 1983). Also, it has been suggested that aerial prey transfers can be used by parents to test the flying proficiency of the fledglings and decide when to stop feeding them (Simmons 1984, Ferrer 1990).

Nest Defense by Adults. Adults behaved aggressively toward some species of raptors coming close to the nest or the fledglings. In those instances, one or both adults chased away the intruder, diving repeatedly until it left the area. Montagu's Harrier (*Circus pygargus*) was the most frequent intruder in the nesting areas ($N = 82$), but was never chased away by the adults even when coming very close to the nest or fledglings. The Common Buzzard (*Buteo buteo*) was a frequent intruder and was chased on 77% of the occasions it was observed close to a breeding territory ($N = 22$). Black Kites (*Milvus migrans*) and other Black-shouldered Kites, relatively infrequent intruders, were also chased away (one of two intrusions and two of six intrusions, respectively). The Common Buzzard was probably the only spe-

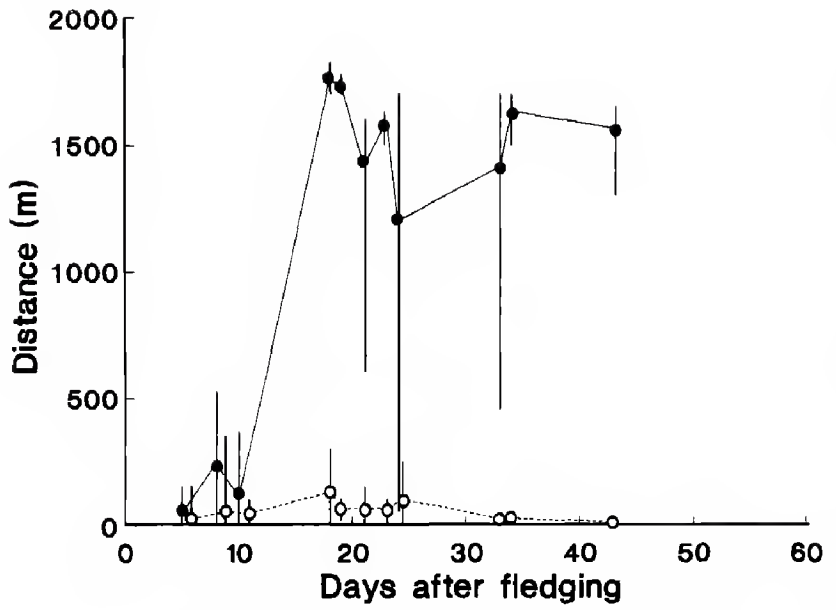

Figure 3. Distance from the nest, mean (solid circle) and range, and distance among fledglings, mean (open circle) and range, in pair 1 in relation to days after fledging. The average distance from the nest and the average distance among fledglings were calculated for each day at ½ hr intervals.

cies of raptor observed in the area that posed a certain risk of predation on inexperienced Black-shouldered Kite fledglings. Although there are no records of the Black-shouldered Kite as prey of the Common Buzzard, birds larger than kites have been frequently recorded in the diet of Common Buzzards (Cramp and Simmons 1980). Thus, it was not strange that adult kites behaved aggressively toward the buzzards. The Black-shouldered Kite excludes other conspecifics from its hunting territory (Mendelsohn 1981), so aggression toward other Black-shouldered Kites could be expected.

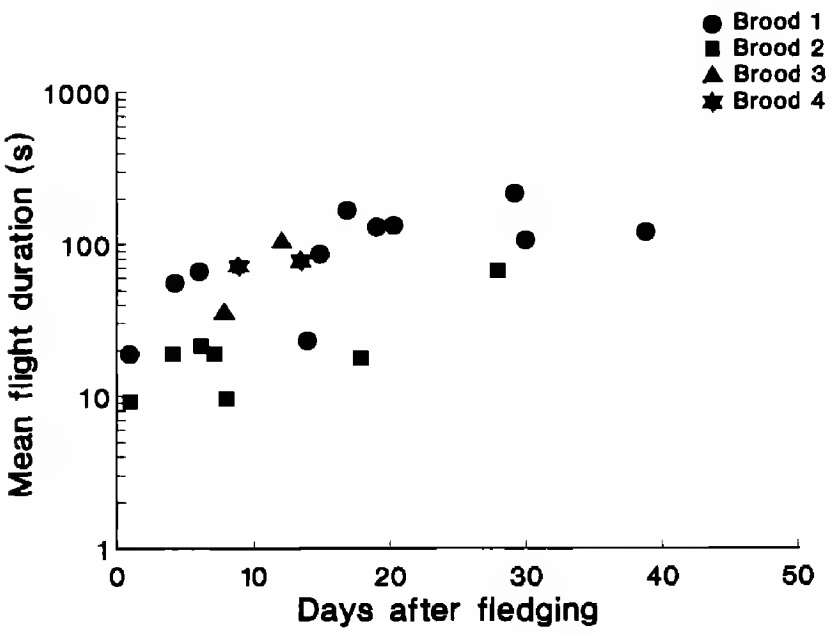

Figure 4. Change in mean flight duration (on a log scale) with days after fledging. The mean value for all siblings in multiple broods is represented. For pair 2, days after fledging is the mean value for the chicks that had already fledged on that date.

Social Interactions. Family groups, with the exception of the adult female, maintained a strong cohesion during the post-fledging dependence period. Fledglings in most instances could see the male hunting from their perch. In the only pair in which the male used to hunt far from the nest (pair 1), the fledglings followed the male to the hunting area and perched there. However, the fledglings still remained close to each other (Fig. 3). Mendelsohn (1981) also noted that Black-shouldered Kite fledglings followed the male when hunting, but in most species of raptors fledglings do not follow the adults far from the nest (e.g., Matray 1974, Bustamante and Hiraldo 1989, Bustamante in press, but see Johnson 1986).

Although siblings were sometimes observed chasing each other (eight different instances), they never disputed prey among themselves and frequently chose to perch close to each other without any aggression. Fledglings also chased Montagu's Harriers (three different kite fledglings in three different instances), the most common raptor in the area. In contrast, harriers were never chased by the adult kites. No aggressive actions from the male toward its offspring were observed at the end of the post-fledging period.

Development of Flight Skills. The first flights of fledglings were short flapping flights between perches. Daily number of flights increased with age, although not significantly, during the post-fledging ($r_S = 0.28$, $N = 22$, $P = 0.2$). Other flight variables like total time spent flying ($r_S = 0.63$, $N = 22$, $P = 0.004$) or mean flight duration ($r_S = 0.71$, $N = 22$, $P = 0.001$) (Fig. 4) had a significant increase with age. The first hovering flight was observed a mean of 8.9 d (SD = 2.9, $N = 8$) after fledging. Fledglings gradually increased the use of gliding and hovering compared to exclusively flapping flights (Fig. 5), but no soaring flights were observed.

Development of Hunting Behavior. Two play behaviors were frequently observed: (1) *Mock pouncing.* Fledglings jumped repeatedly from a low perch (e.g., a fence) to the ground with extended talons. The behavior was comparable to perch hunting but the fledglings never captured prey or any other object, and the behavior was repeated on the same spot several times in a row. This behavior was recorded for the first time 3 d after fledging. It was seen in 11 different instances and at least in three out of the

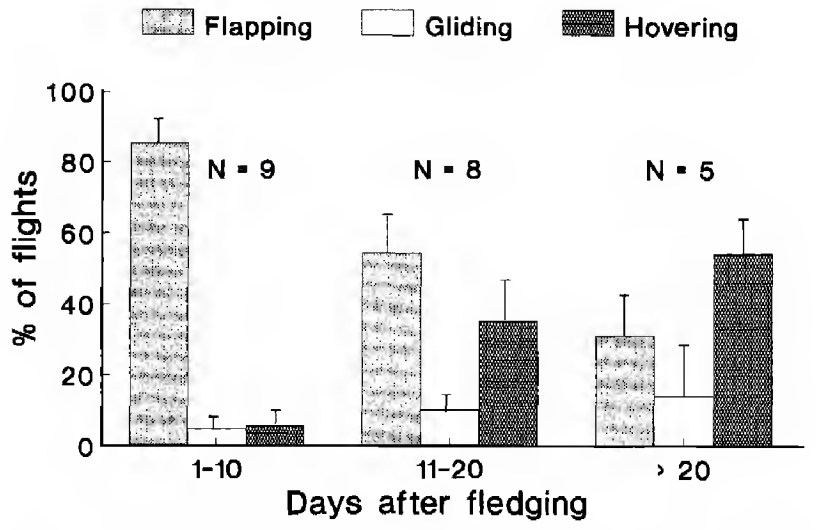

Figure 5. Percentage of different flight types in relation to days after fledging. Mean and SE of daily percentage of flights in each category. N = number of days.

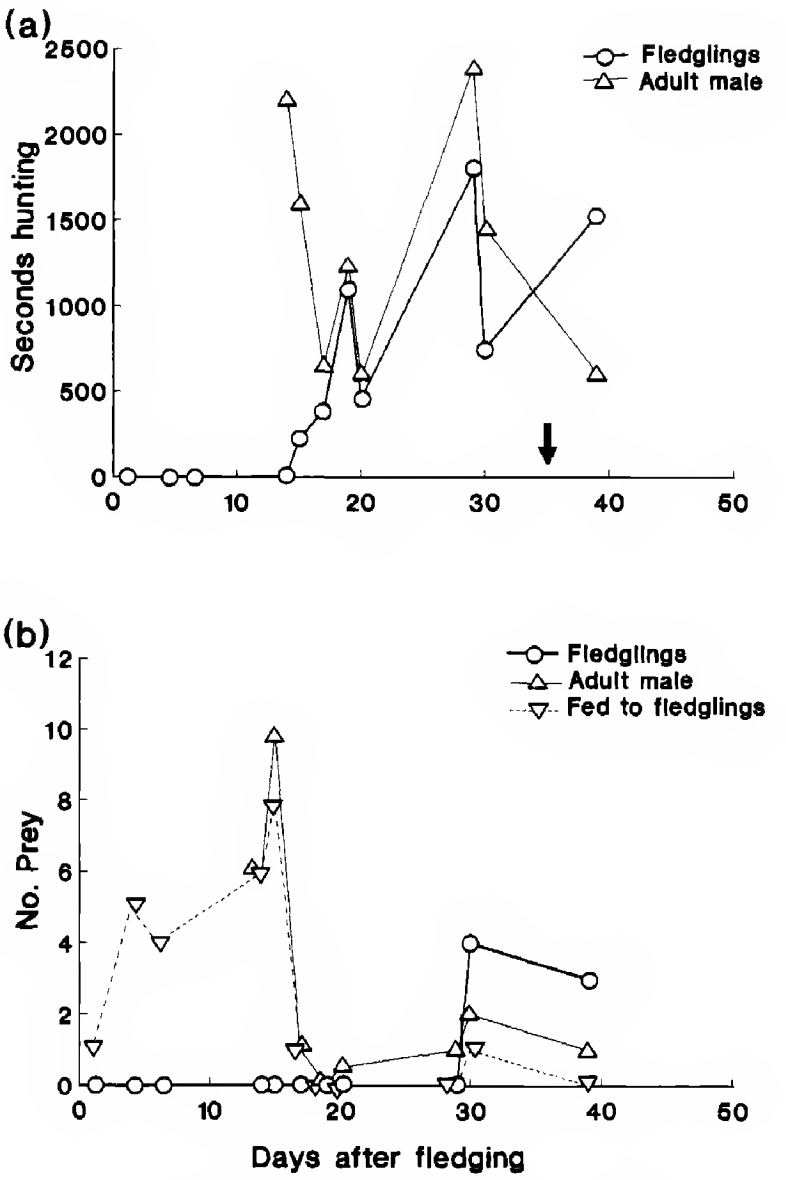

Figure 6. (a) Mean time devoted to hunting (seconds hunting in a 4-hr period), by the fledglings and the adult male of pair 1, in relation to days after fledging. All three fledglings pooled. (b) Number of prey caught by the fledglings, number caught by the adult male, and number delivered by the male to the fledglings in relation to days after fledging, in pair 1 (average number when both sunrise and sunset 4-hr periods were observed on the same day). The arrow indicates estimated age of independence of the fledglings.

10 fledglings. (2) *Void hunting attempts.* These were flight behaviors that included movements related to prey capture, but in a different context. They were also observed in fledglings that had already been seen successfully hunting, so they were not just immature hunting attempts. Void hunting included oblique dives toward the ground that were aborted before touching the surface, in contrast to the vertical dives used in hunting. On other occasions fledglings 'parachuted' toward the ground by dropping gently with wings held high above their backs and varying the angle of wings and tail to control speed. This behavior was also observed in hunting adults when they were approaching prey, but fledglings performed it very high in the air (so they could not be hunting) or when approaching a perch (something never observed in adults). Void hunting was recorded for the first time 3 d after fledging. Void hunting attempts were observed in 13 different instances in five of the 10 fledglings.

Behaviors here considered to be development of hunting behavior included: (1) *Searching from a perch.* Fledglings were observed watching attentively the ground or the horizon, frequently making characteristic head movements that easily distinguished it from resting behavior. This behavior probably combined both paying attention to prey movements on the ground and to other family members hunting nearby. It was recorded for the first time 3 d after fledging. It was observed in 17 different instances and in all the 10 fledglings. (2) *Hunting on the wing.* I considered as such any behavior performed on the wing related to prey searching or prey capture similar to those performed by hunting adults (e.g., hovering flights while watching the ground followed by vertical dives). Hunting attempts were recorded for the first time 14 d after fledging and in a total of 74 different instances. They were observed in six of the 10 fledglings. Eight captures of small mammals by fledglings were observed before fledglings had achieved independence. The first prey capture was observed 29 d after fledging. Also, one fledgling was observed unsuccessfully trying to capture a Little Bustard (*Tetrax tetrax*), which is too big a prey for the kite.

Mendelsohn (1981) also observed that Black-shouldered Kite fledglings hunted before indepen-

dence. He recorded the first prey capture 12 d after fledging, but he did not record any play behaviors.

The time fledglings spent hunting in pair 1 increased gradually during the post-fledging, at the same time that the male decreased the time he spent hunting and reduced the number of prey given to the young (Fig. 6).

Many fledgling behaviors suggest the importance of perfecting flying and hunting skills before independence in the Black-shouldered Kite. Even chases between siblings and chases of other raptors could be interpreted in this way, rather than as competition between siblings (siblings never disputed prey) or incipient nest defense behavior (the raptors chased were not the species chased by the adults). Fledglings were able to hunt the habitual prey of the adults (small mammals) before independence, but never hunted insects which are usually the first prey of many species of raptors after fledging (Newton 1979, Bustamante 1990).

In conclusion, the observations of the post-fledging of the Black-shouldered Kite agree with the hypothesis that gradual development of hunting skills before independence is important in species hunting prey difficult to catch, while it is uncommon in species with generalized feeding habits (e.g., *Milvus* kites; Bustamante and Hiraldo 1989, Bustamante in press).

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IDENTIFICATION OF PEREGRINE FALCONS USING A COMPUTERIZED CLASSIFICATION SYSTEM OF TOE-SCALE PATTERN ANALYSIS

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ABSTRACT.—Individual Peregrine Falcons (*Falco peregrinus*) may be identified by visually comparing their toe-scale patterns. However, these comparisons are tedious when dealing with large numbers of birds. We developed a computerized classification system to facilitate the identification process. The classification system was based on the analysis of photographs of the dorsal surface of the third toes of both feet, and on the formulation of an alphanumeric code that distinguished right from left feet, and single from double scales of 90 Peregrine Falcons (*F. p. anatum*). Each code was entered into a computerized filing program, and toe-scale patterns were classified by similarities, dividing them into groups. The system was tested by randomly selecting photographs on file, generating a code by established criteria and matching the code with the computerized file code. The system allowed quick differentiation of individual Peregrine Falcons from a large number of catalogued Peregrine Falcons.

Identificación de *Falco peregrinus* usando un sistema de clasificación computarizado de análisis de patrones de medida de dedos

RESUMEN.—Individuos de *Falco peregrinus* pueden ser identificados visualmente comparando sus patrones de medidas de dedos. Sin embargo, estas comparaciones son tediosas cuando se trata de un gran número de aves. Desarrollamos un sistema de clasificación computarizada para facilitar el proceso de identificación. El sistema está basado en el análisis de fotografías de la superficie dorsal del tercer dedo de ambos pies y sobre la formulación de un código alfanumérico que distingue el pie derecho del izquierdo, y escalas sencillas de dobles de 90 *F. p. anatum*. Cada código fue ingresado a un programa computacional y el patrón de medidas del dedo fue clasificado por similaridades, dividiendolos en grupos. El sistema fue probado seleccionando azarosamente fotografías de un archivo, generando un código con criterio establecido y asociando éste con el código del archivo computacional. El sistema determina rápidamente la diferenciación de individuos de *F. peregrinus* de un gran número de ejemplares catalogados.

[Traducción de Ivan Lazo]

Identification of individual raptors is important to document ownership, and could be valuable to trace movements or study population dynamics. Methods to mark birds include leg banding, attachment of wing-markers, and tattooing (Beyerbach 1980, Havelka 1983). These methods and their shortcomings have been described in detail elsewhere.

The potential to develop an unalterable, safe means of permanent identification for raptors as suggested by others deserves further investigation. The presence of unique, unchanging scale patterns on the feet of various bird species that cannot be altered or removed without the risk of severe foot damage has been documented and discussed (Clark 1972, 1973, 1974, Beyerbach 1980, Havelka 1983, Stauber 1984, 1985, Grier 1986). These patterns may be easily differentiated, and therefore, may be used for individual identification.

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Figure 1. Photograph of the middle toe (#3) of a Peregrine Falcon showing the toe-scale pattern.

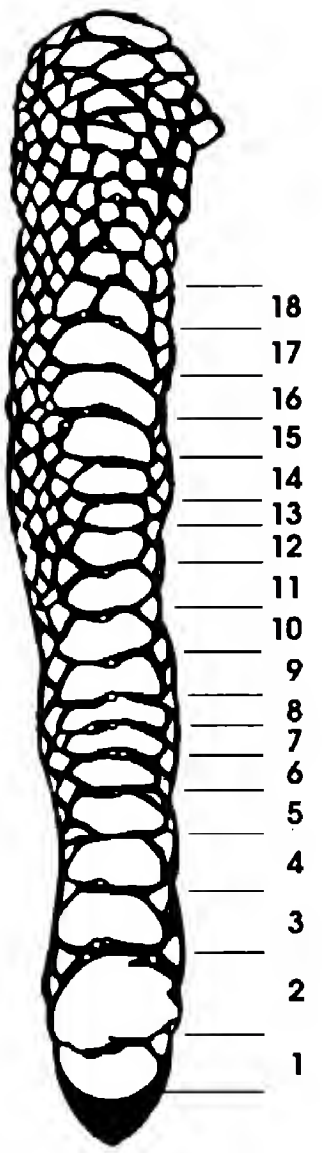

Figure 2. Hand tracing of the middle toe (#3) in the photograph shown in Fig. 1. Rows of scales are numbered sequentially counting proximally from the talon.

METHODS

Birds used for this study were Peregrine Falcons (*F. p. anatum*) housed at the Peregrine Fund, Inc., Boise, ID, U.S.A. Photographs were taken using a 35 mm single lens reflex camera, a standard 50 mm lens, and a 2× teleconverter. Because the birds were photographed indoors in incandescent and natural light, a strobe was used to ensure adequate exposure. Black-and-white film (ASA 125) was exposed at f5.6 and 1/1000 second. The dorsal surfaces of the middle digits (#3) of both feet were stained with a non-toxic iodine solution (Betadine Solution, Purdue Frederick, Norwalk, CT) to enhance the scale perimeters, making the grooves between scales more pronounced. The feet were positioned so that photographs could be taken perpendicular to the dorsal surface. The lens was focused as close (ca. 40 cm) to the foot as possible. The middle digit was extended to reduce errors in perception of angle due to curling of the toe. During photography the toe was placed on an identification grid marked in 2.54 × 2.54 mm squares, and showing the bird's U.S. Fish and Wildlife Service band number. The grid pattern enabled determination of photographic angle and absolute size. Both feet were photographed.

Black-and-white glossy prints (12.70 × 17.78 cm) were prepared from the negatives (Fig. 1). Prints were labeled with the band number, right or left foot, species, date, sex and age of the bird.

Each scale was labeled in sequence counting proximally from the talon (Fig. 2). The identification grid was used to determine right or left foot, and scales were labeled as single or double. A scale was characterized as "double" when it met one or more of the following criteria: (a) clear division of the scale into 2 parts (Fig. 3A); (b) both scales being at least partly within boundaries determined by imaginary lines drawn from the widest aspects of the scale above to the scale below (Fig. 3B); (c) the smaller scale of the "double" not having a "matching" scale on the opposite side of the larger scale (Fig. 3C); or (d) the double scale separating the scale above from the scale below by a distance greater than the usual distance between scales (with "point" contact of the above and below scales being acceptable) (Fig. 3D).

A sequence of single-digit numbers corresponding to the series of scales was constructed. Single scales were assigned the number 4, while double scales were given the number 8. These numbers were chosen because of ease in code sequences. Code sequences ended with the last identifiable scale (a single or an unambiguous double).

Each code sequence was based on the scale pattern of one middle toe. Using patterns from both feet doubled the

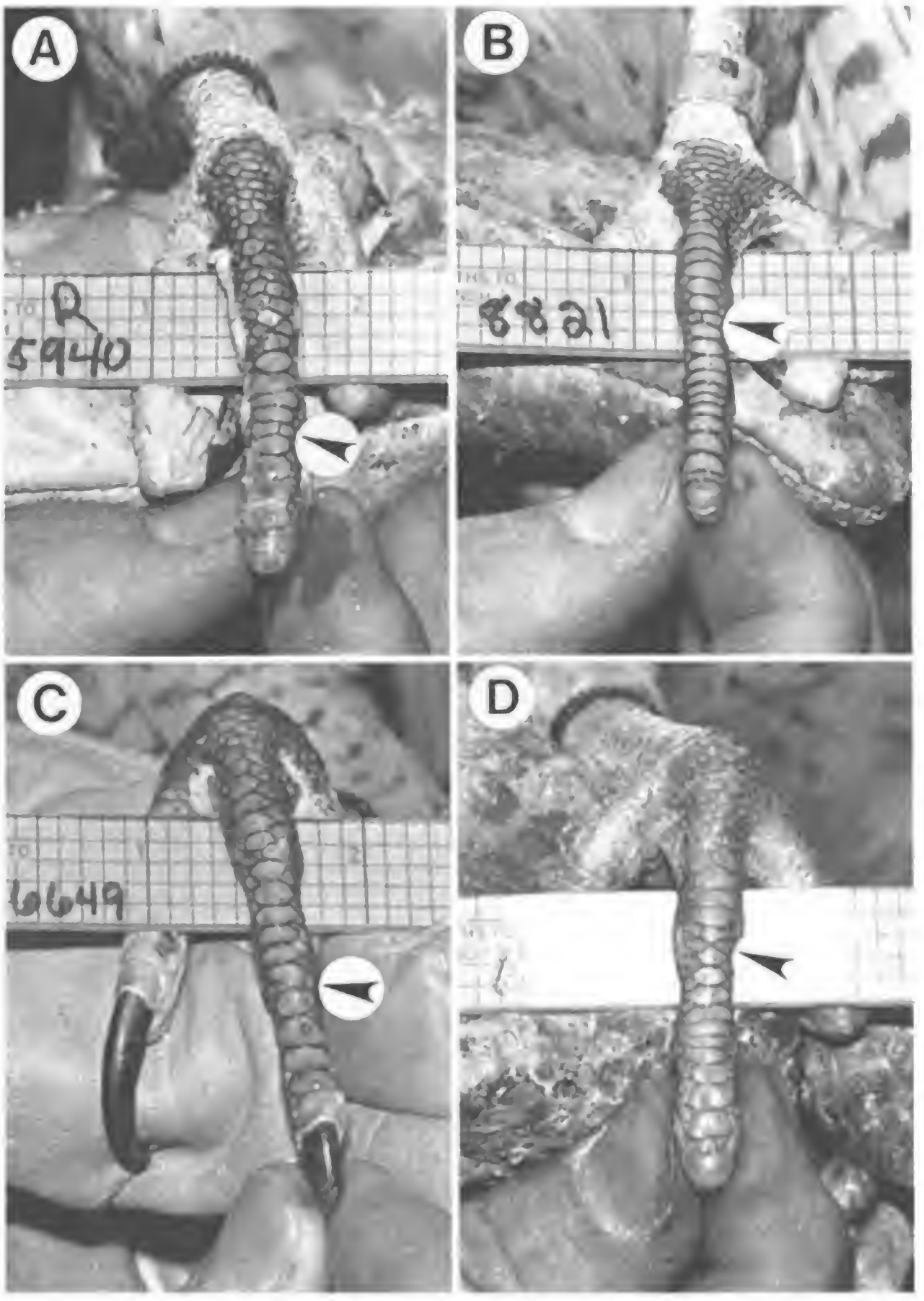

Figure 3. Criteria used to distinguish double from single scales: 3A. Clear division of the scale into 2 parts (arrow). 3B. Both scales (arrow) being at least partly within boundaries determined by imaginary lines drawn from the widest aspects of the scale above to the scale below. 3C. The smaller scale of the "double" not having a "matching" scale on the opposite side of the larger scale (arrow). 3D. The double scale (arrow) separating the scale above from the scale below by a distance greater than the usual distance between scales (with "point" contact of the above and below scales being acceptable).

available information for identification of falcons. For the filing program to use information from both feet simultaneously, right and left pattern codes were combined to create a single identification code for each falcon. Pattern codes for each toe were printed with the code from the right toe above the code for the left:

R .4.4.4.4.4.8.4.4.4.4.8.8.4.8.4.4.
L .4.4.4.4.8.4.4.4.4.4.8.4.8.4.4.4.4.4.

A code sequence combining right and left, and corresponding to each row of scales was constructed. When a "4" was over a "4," a "4" was entered. When a "4" was over an "8," a "5" was entered. When an "8" was over a "4," a "7" was entered. When an "8" was over an "8," an "8" was entered. The new code sequence ended with the last row to be characterized for both feet. The code sequence corresponding to the two patterns shown previously would be:

.4.4.4.4.5.7.4.4.4.4.8.7.5.7.4.4.

Codes were recorded in a database program (Q&A, Symantec, Cupertino, CA), and compared in order to group patterns based on the presence and location of double scales. Categorization into groups of identical codes reduced the number of prints to be used in the final matching process. In the final matching process the "suspect" print was visually compared with other prints in the same pattern group to find the "true" match.

RESULTS

Prints had from 15–20 discernible scales on the dorsal surface of each middle toe. Of 90 falcons, 75 had codes that were unique. The remaining codes had either one duplication (six groups of two identical codes), or two (one group of three identical codes). When this system was used by evaluators with no prior experience in toe-scale pattern analysis, the evaluators were successful in encoding and classifying patterns. They then easily differentiated "suspect" prints from others with identical codes by visual comparisons.

DISCUSSION

The uniqueness of toe-scale patterns in individual birds of various species has been well documented (Clark 1972, 1973, 1974, Beyerbach 1980, Havelka 1983, Stauber 1984, 1985, Grier 1986), and the potential to use this information to develop an identification system for Peregrine Falcons (or other birds) has been discussed. A major obstacle in adopting the toe-scale identification system has been the lack of a "user friendly" method allowing rapid screening of the scale pattern of one bird against numerous patterns of other birds.

There are distinct advantages in computerizing an analysis system. Large numbers of digitized prints including information about many birds can be stored in an organized, systematic manner. Time and labor spent matching a "suspect" bird's code with a print code on file can be reduced. Files or print codes can be transmitted to distant locations in a short time. Pattern characteristics can be sorted and compared to look for trends among species, subspecies or close relatives.

The primary objective of this study was to develop a computerized classification system of toe-scale patterns that could be used for rapid (initial) screening of any Peregrine Falcon's "footprint" against any number of catalogued "footprints" from other Peregrine Falcons coded by the system. The availability of 90 Peregrine Falcons from the Peregrine Fund, Inc., Boise, ID, U.S.A. was particularly welcome, since they represented a large sample size of one subspecies. Assuming there would be less variation within a subspecies than between different subspecies, a code system based on footprint variation from these birds would be a good test to validate the reliability of the system. Analysis of the toe-scale pattern of the third toe (left and right foot) from each bird resulted in generating a code where code duplication was minimal. It is felt that the results of this study provide baseline information of great utility in developing reliable identification systems for birds with unique toe-scale patterns. If this system is used with other available data (i.e., juvenile/adult, sex, weight) about individual birds, a reliable method of permanent, non-invasive, and unalterable identification of individual Peregrine Falcons could become available.

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CHROMOSOMES OF FIVE NORTH AMERICAN BUTEONINE HAWKS

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ABSTRACT.—Five species of buteonine hawks were karyotyped for the first time, including the Swainson's Hawk (*Buteo swainsoni*), Gray Hawk (*B. nitidus*), Ferruginous Hawk (*B. regalis*), Harris' Hawk (*Parabuteo unicinctus*), and Broad-winged Hawk (*B. platypterus*). All five species have 68 chromosomes. The karyotypes of the first four species appear to be very similar to each other and to other buteos reported previously in the literature, differing in the shape of only one chromosome. The Broad-winged Hawk karyotype differs in the morphology of several chromosomes.

Cromosomas de cinco especies norteamericanas de halcones del género *Buteo*

RESUMEN.—Por primera vez han sido examinados y caracterizados los cariotipos de cinco halcones del género *Buteo* (Aguililla Migratoria Mayor *Buteo swainsoni,* Aguililla Gris *B. nitidus,* Aguililla Real *B. regalis,* Aguililla Rojinegra *Parabuteo unicinctus,* y Aguililla Migratoria Menor *B. platypterus*). Todas las cinco especies tienen 68 cromosomas. Parece ser que los cariotipos de halcones de las cuatro primeras especies (*B. swainsoni, B. nitidus, B. regalis,* y *Parabuteo unicinctus*) son muy similares entre ellos, así como lo son con los de otros halcones de este género ya referidos en literatura anterior. Éstos se diferencian sólo por la forma de sólo un cromosoma, mientras que el Aguililla Migratoria Menor difiere por la morfología de varios cromosomas.

[Traducción de Eudoxio Paredes-Ruiz]

Chromosome analysis has been used to study phylogenetic relationships in several species, such as falcons (Schmutz and Oliphant 1987) and owls (Schmutz and Moker 1991). In our view, cytogenetics is well suited to cladistic analysis because the phylogenies are based on centric fusions (Robertsonian translocations) and inversions (White 1973, Hsu 1979), both of which also impair fertility (Therman 1980, Diedrich et al. 1983, Lippman-Hand and Vekemans 1983), part of the classical definition of species separation.

In an ongoing attempt to collect cytogenetic data on raptors for this purpose, we have karyotyped five species of buteonine hawks not previously reported. The five species of hawks are the Swainson's Hawk (*Buteo swainsoni*), Gray Hawk (*B. nitidus*), Ferruginous Hawk (*B. regalis*), Harris' Hawk (*Parabuteo unicinctus*), and Broad-winged Hawk (*B. platypterus*).

Prior to our study, five other species of buteos had been karyotyped. These were the Common Buzzard (*B. buteo*; Renzoni and Vegni-Talluri 1966, De Boer 1976), the Red-tailed Hawk (*B. jamaicensis*; Shoffner 1974, Pape and Ogasawara 1978, Stock and Worthen 1980), the Rough-legged Hawk (*B. lagopus*; Bulatova 1977), the Roadside Hawk (*B. magnirostris*; de Lucca 1983), and the White-tailed Hawk (*B. albicaudatus*; de Lucca 1985).

MATERIALS AND METHODS

The blood sample from the Ferruginous Hawk was collected in Alberta, Canada. Blood samples from the Harris' and four Gray Hawks were collected in Arizona. The blood samples from the Swainson's Hawk and the Broad-winged Hawk were collected from birds in captivity for rehabilitation at the Western College of Veterinary Medicine after injury near Saskatoon, Saskatchewan, Canada.

Lymphocyte cultures were established from 0.5 ml of whole blood and chromosomes prepared as described by Schmutz and Oliphant (1987). Karyotypes were based on the best metaphase(s) obtained on complete cells. Several cells were photographed and the chromosomes arranged Comparative studies of karyotypes not done in our own lab are based upon figures in the original published papers when available or photocopies through interlibrary loan.

RESULTS

Although most bird species have a large number of microchromosomes and few macrochromosomes, the hawks and eagles are atypical in that few of their chromosomes could be called microchromosomes. The Swainson's Hawk (Fig. 1), Gray Hawk (Fig. 2),

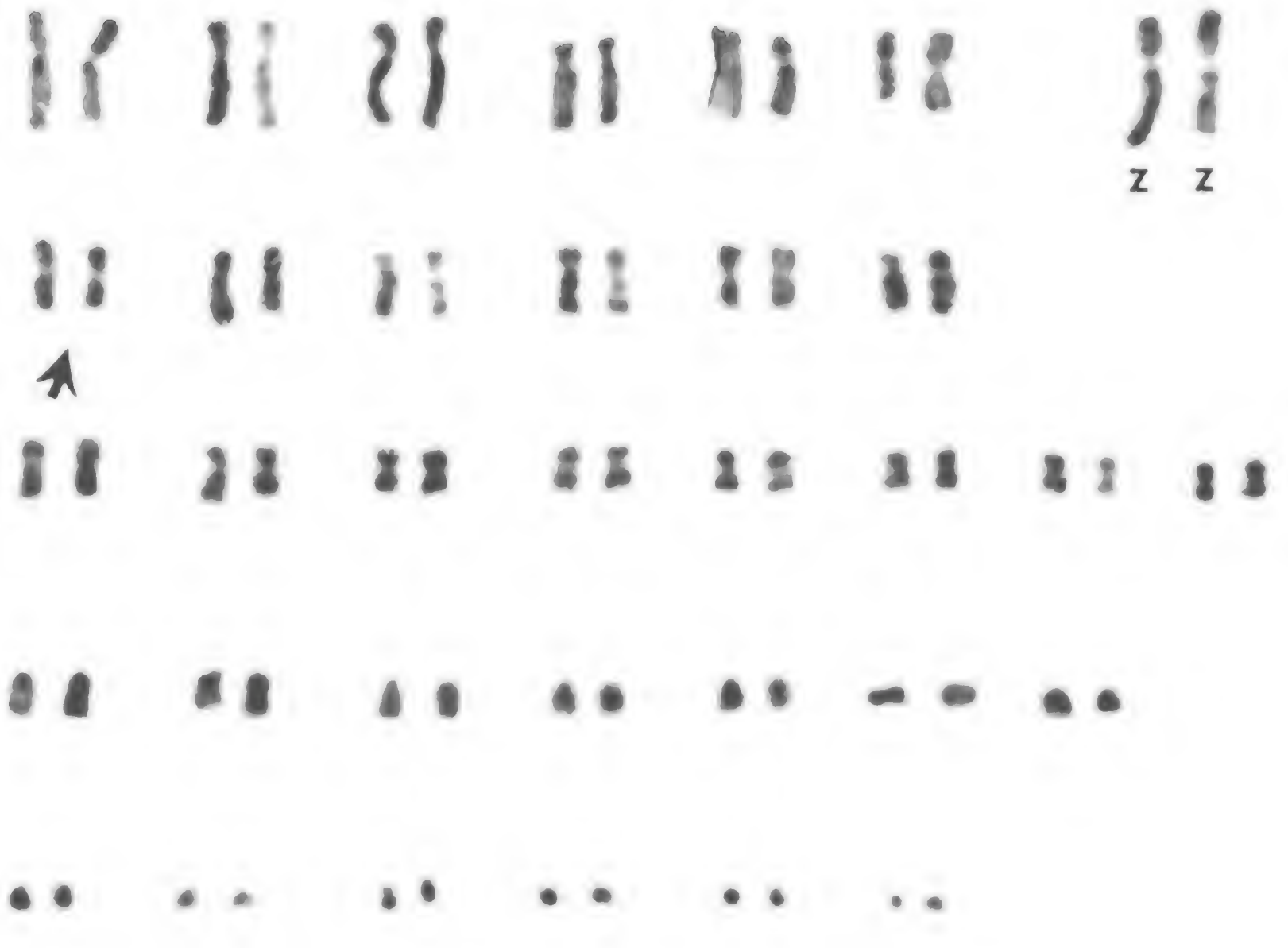

Figure 1. The karyotype of a male Swainson's Hawk (*Buteo swainsoni*) with an arrow marking chromosome 7, the variable chromosome which is metacentric in this species.

Ferruginous Hawk (Fig. 3), and Harris' Hawk (Fig. 4) each had 68 chromosomes including one large metacentric pair (the sex chromosomes), five large submetacentric pairs, six medium-sized metacentric pairs, eight small metacentric pairs, and 13 small acrocentric pairs, and one pair which was variable in morphology. This variable chromosome was either a large submetacentric or large acrocentric. It was the seventh largest by size and therefore we refer to it as chromosome 7. Traditionally chromosomes are grouped by centromere position and then secondarily by size. We have decided to arrange the chromosomes for ease of comparison among the species, in the traditional order for the Swainson's Hawk and Common Buzzard but with chromosome 7 out of its traditional place for the other species. Other authors, such as Stock and Worthen (1980) who have published only a single species karyotype, place this chromosome with the other acrocentrics so it would be number 21 in their karyotype.

The Broad-winged hawk differed from the other four hawks we studied although the total number remained 68 (Fig. 5). The largest pair was again metacentric and we presume it to be the sex chromosome pair. However, there were only 16 submetacentric or metacentric pairs in total as opposed to 20–21 pairs.

We subdivided the buteonine hawks into two major groups based on the different morphologies of chromosome 7 (Fig. 6) and placed *B. platypterus* in a third separate group since chromosomes 16–20 differed. Although the karyotype of the Gray Hawk (Fig. 2) does not have an obvious acrocentric chromosome 7, it is the clearest karyotype overall and therefore we chose to publish it. Other karyotypes we studied clearly indicate that chromosome 7 is acrocentric in this species. Less clear, is the morphology of chromosome 20 which also appears acrocentric in this photograph (Fig. 2).

We attempted to include the other buteo species

Figure 2. The karyotype of a male Gray Hawk (*Buteo nitidus*) with an arrow marking chromosome 7, the variable chromosome which is acrocentric in this species.

Figure 3. The karyotype of a female Ferruginous Hawk (*Buteo regalis*) with an arrow marking chromosome 7, the variable chromosome which is acrocentric in this species.

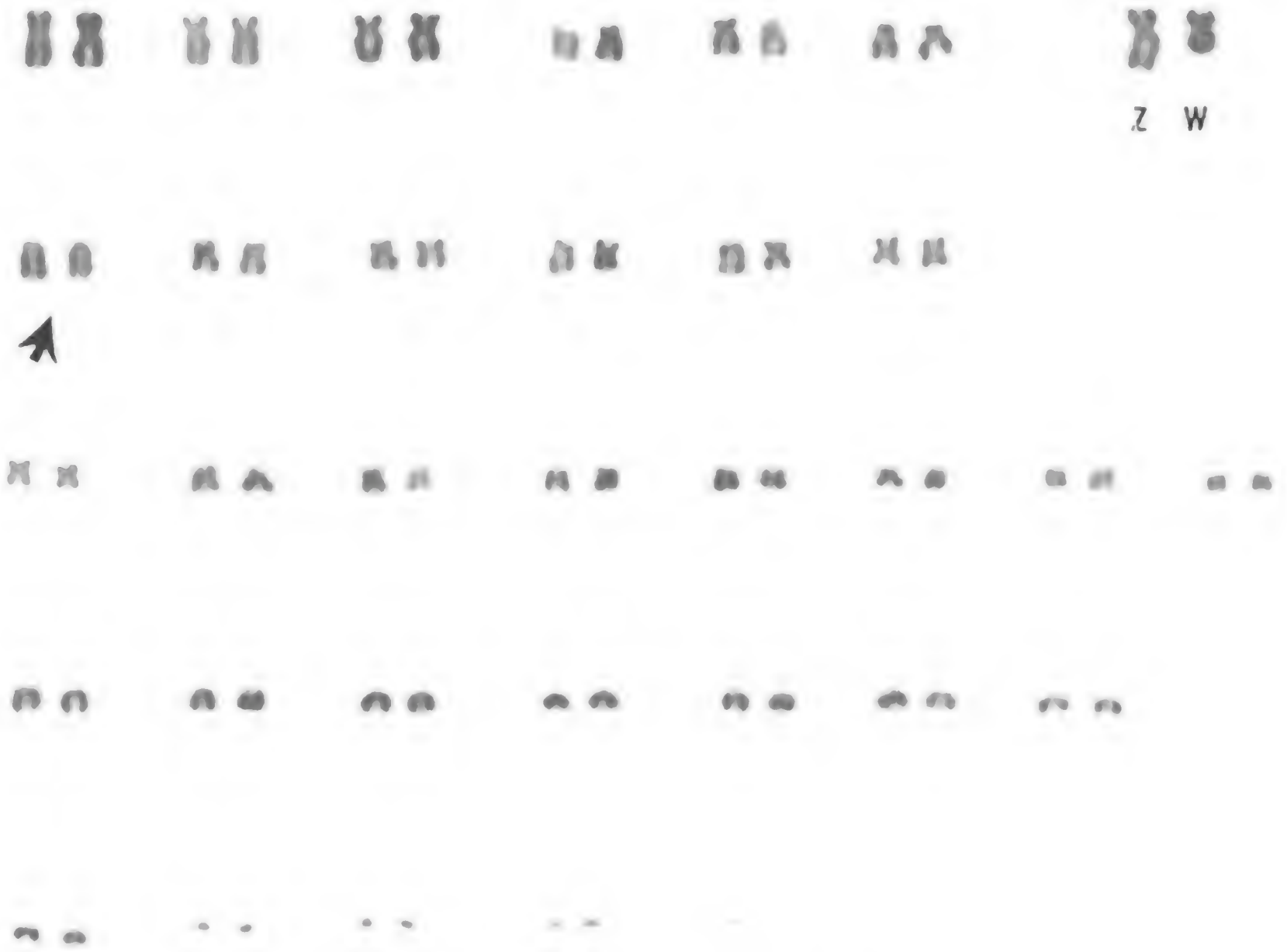

Figure 4. The karyotype of a female Harris' Hawk (*Parabuteo unicinctus*) with an arrow marking chromosome 7, the variable chromosome which is acrocentric in this species.

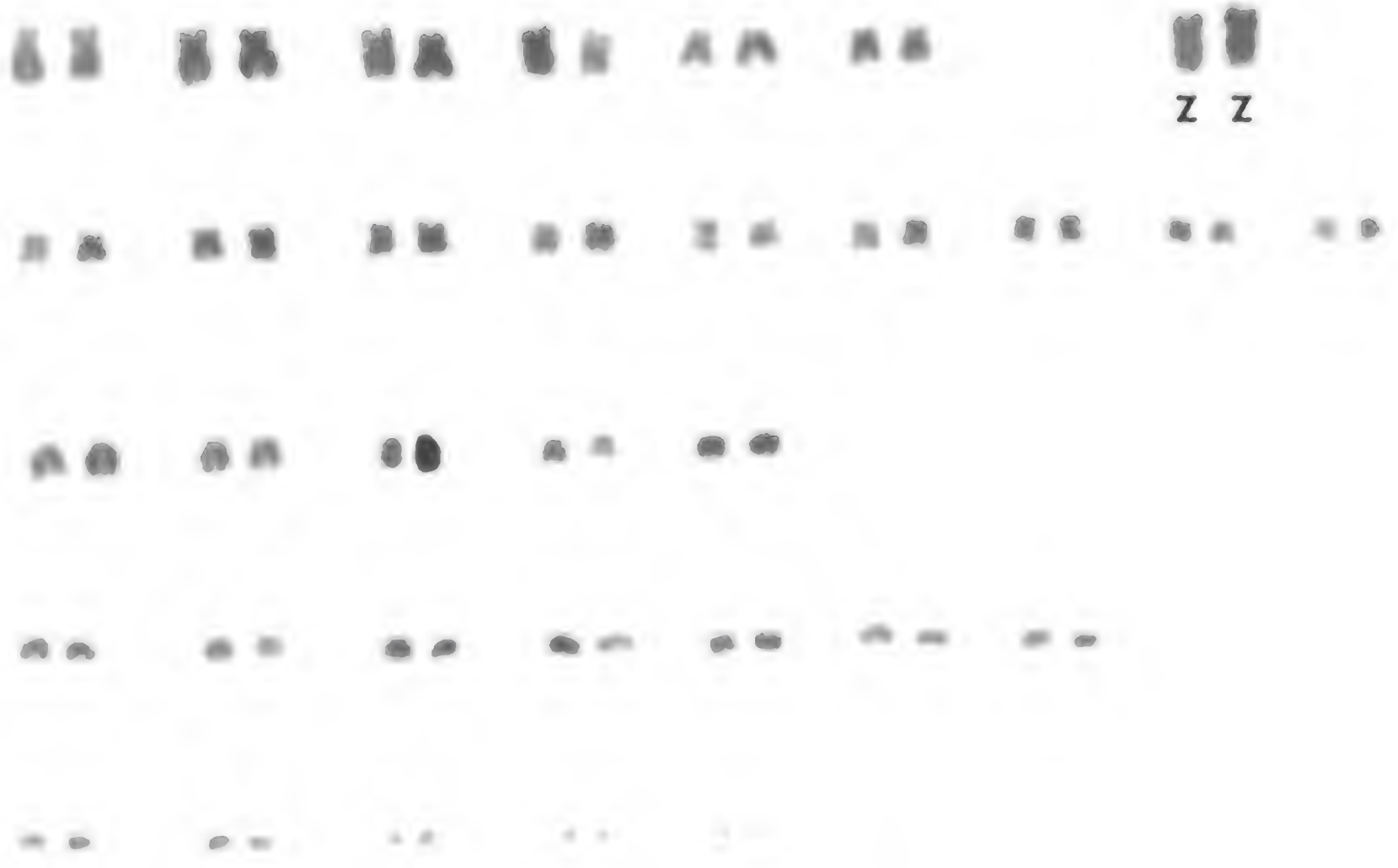

Figure 5. The karyotype of a female Broad-winged Hawk (*B. platypterus*). The karyotype is arranged to emphasize that chromosomes 16–20 in the middle row are acrocentric in this species as opposed to metacentric in the other buteos.

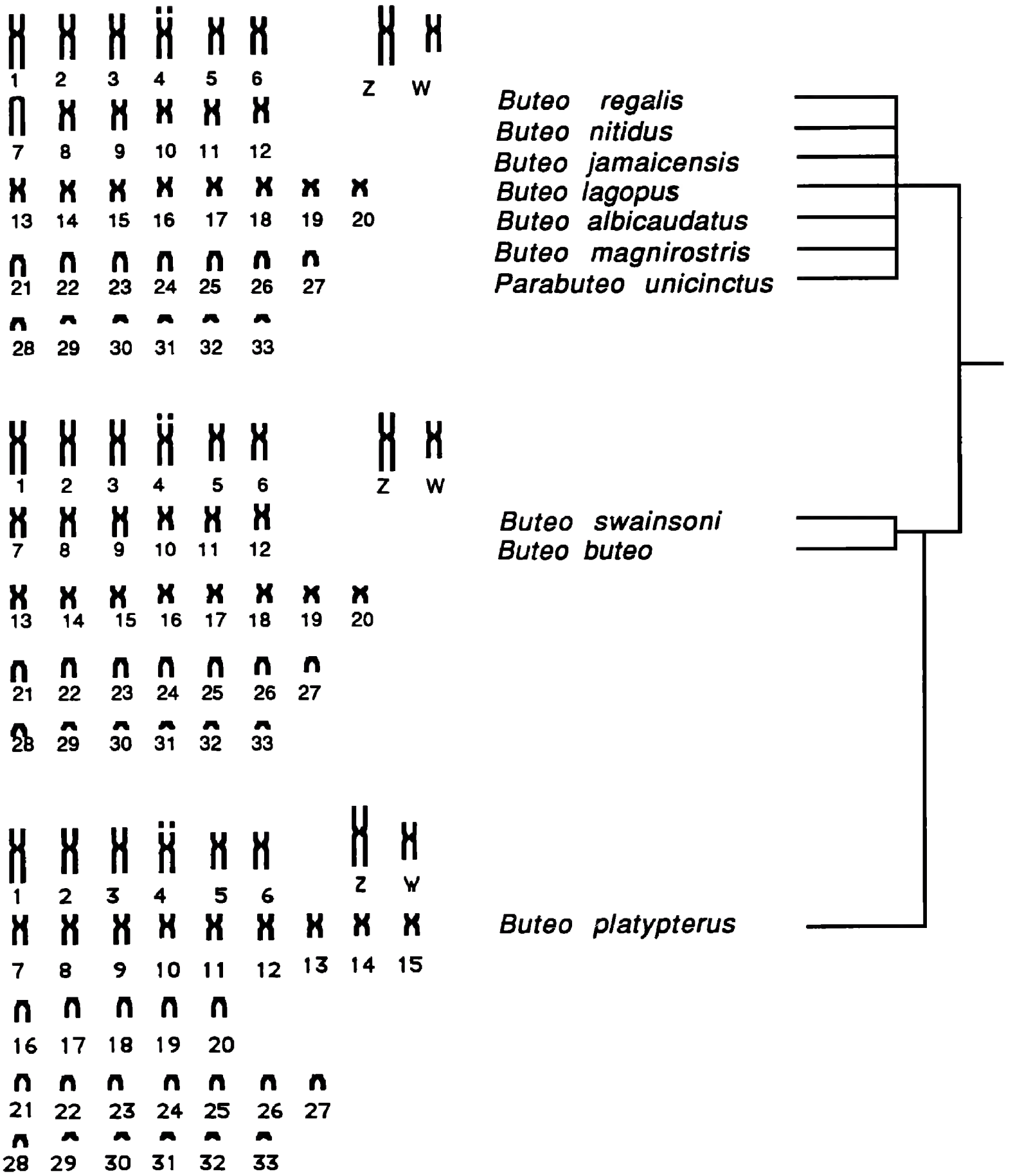

Figure 6. A cladogram illustrating the relationships among the buteonine hawks studied to date and computer drawn idiograms of the three karyotypes observed, upon which the phylogeny is based.

studied previously, although the copies of the karyotypes that we used make our interpretation tentative. The karyotypes of the Common Buzzard (*B. buteo*; De Boer 1976), the Red-tailed Hawk (*B. jamaicensis*; Stock and Worthen 1980), and the White-tailed Hawk (*B. albicaudatus*; de Lucca 1985) match the buteos we did very closely. However, a minute metacentric was described (De Boer 1976, Stock and Worthen 1980) which we cannot verify or dispute since the small chromosomes in our karyotypes are

not elongated enough to determine this. We worked with poor photocopies of karyotypes of the Rough-legged Hawk (*B. lagopus*; Bulatova 1977) and the Roadside Hawk (*B. magnirostris*; de Lucca 1983) and can only say that the top two rows (Fig. 6) agree in general with the karyotypes of the buteos we studied.

DISCUSSION

Four species of buteonine hawks studied here for the first time have one of the same two karyotypes. This similarity supports the close taxonomic relationship Brown and Amadon (1968) suggested among these species. Further differentiation among subfamilies would need to be based on other types of data, such as DNA sequence data which is currently under investigation by Bob Sheehy (pers. comm.).

The difference in morphology of chromosome number 7 is likely due to an inversion, in this case a pericentric inversion, one of the two cytogenetic changes that typically occur during evolution (Hsu 1979). We are unable to say which is the "ancestral" shape of chromosome 7 and therefore our cladogram is "unrooted" and shows the two main branches as deriving at an equal point in time (Fig. 6).

The Harris' Hawk is placed in the genus *Parabuteo* as opposed to *Buteo*; however, its karyotype would not distinguish it from most of the other *Buteo* species studied to date. This suggests that the Harris' Hawk is indeed a close relative of the buteos.

In contrast the karyotype of the Broad-winged Hawk shows five chromosomes, numbers 16–20, that differ in morphology from the rest of the buteos (Fig. 5). This would suggest that it is the most divergent in the subfamily. It is more closely related to the Swainson's Hawk and Common Buzzard than the other buteos, based on the morphology of chromosome 7 (Fig. 6).

In contrast to the similarity found among the buteos, the nine species of falcons studied to date exhibit four different karyotypes in the genus (Schmutz and Oliphant 1987, Longmire et al. 1988). The primary cytogenetic differences among the falcons are centric fusions or translocations as opposed to inversions, with the Merlin (*Falco columbarius*) having the greatest number of chromosomes (Longmire et al. 1988) and therefore being the most diverged, followed by the Peregrine Falcon (*F. peregrinus*) and Prairie Falcon (*F. mexicanus*; Schmutz and Oliphant 1987).

Cytogeneticists frequently use banding of chromosomes to demonstrate specific translocations and inversions in mammals (Ward et al. 1991). Avian karyotypes are much more difficult to obtain than mammalian karyotypes, primarily due to the lower numbers of dividing cells stimulated by mitogens (Prus and Schmutz 1987). Low numbers of dividing cells therefore make chromosome banding difficult since most techniques work well on only a small proportion of these cells. Although chromosome banding is necessary to determine with precision which chromosomes are involved in translocations, banding is not necessary to identify the presence or absence of translocations, which is the key to phylogenetic comparisons.

In addition to a poor response to mitogens, cytogenetic studies of birds have been further hampered because fresh blood samples or growing feathers, capable of further cell division in culture, are required for analysis. Many rare and endangered birds exist in remote areas. Field collection of samples from wild caught birds is occasionally possible but the logistics of air transport to an appropriate lab within 24 hr is frequently impossible. Despite such difficulties, chromosome analysis can provide a useful tool in taxonomic studies and we encourage raptor biologists to collaborate in such studies.

ACKNOWLEDGMENTS

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RECENT DISTRIBUTION AND STATUS OF NESTING BALD EAGLES IN BAJA CALIFORNIA, MEXICO

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ABSTRACT.—We studied Bald Eagles (*Haliaeetus leucocephalus*) nesting in Baja California, Mexico, and vicinity from 1983–1993. The range of nesting Bald Eagles in Baja California has been reduced from a scattering of pairs along both the Pacific and Gulf sides to a remnant population in Magdalena Bay where no more than three pairs were found annually. Low numbers and a restricted distribution make this disjunct population especially vulnerable to human disturbance. Additional protection of present nesting localities and a reintroduction program on remote islands in the Gulf of California, where eagles historically nested, are proposed. Limited data on nesting success indicate that the Magdalena Bay population is reproducing successfully with young probably dispersing north following fledging. The Bald Eagles found wintering along the Colorado River Delta in January apparently nest farther north in the United States or Canada.

Distribución reciente y status de nidificación de *Haliaeetus leucocephalus,* en Baja California, México

RESUMEN.—Estudiamos la nidificación de *Haliaeetus leucocephalus* en Baja California, México y en sus veciandades, desde 1983 a 1993. El rango de nidificación de *H. leucocephalus* en Baja California se ha redicido tanto en la vertiente Pacifico como en lado del Golfo a una población remanente en Bahía Magdalena, donde no se encuentran más de tres pares anualmente. Bajos números y una restringida distribución, hacen que esta población disyunta sea vulnerable a la perturbación humana. Proponemos programas adicionales de protección de las actuales localidades de nidificación y un programa de reintroducción en islas remotas del Golfo de California, donde históricamente han anidada las águilas. Datos limitados sobre nidificación exitosa indican que la población de Bahía Magdalena se reproduce exitosamente con juveniles que probablemente se dispersan al norte. *Haliaeetus leucocephalus* se encuentra invernando a lo largo del delta del Río Colorado en enero, aparentemente nidifica más al norte, en los Estados Unidos o Canada.

[Traducción de Ivan Lazo]

Henny et al. (1978) confirmed recent Bald Eagle (*Haliaeetus leucocephalus*) nesting in the Magdalena Bay region of Baja California in 1977 (Fig. 1). On 26 March 1977, a pair with two large young in a nest was noted near San Jorge (25°34′N, 112°6′W); hereafter abbreviated as (2534-11206), north of Santo Domingo (nest F); on 27 March, a pair with one large young in a nest was seen on Isla Creciente near Almejas Bay (nest A). They also summarized unpublished sight records from 1962, 1971, and 1972 that indicated a continued presence in Magdalena Bay and suspected continued nesting prior to their 1977 rediscovery. In this paper we: (1) describe the historical nesting population of Bald Eagles in Baja California and vicinity (Gulf of California), (2) evaluate the present nesting population (new data for 1983–1993) in relation to the historical population, (3) present recent productivity information, and (4) describe a wintering population in the vicinity of the Colorado River Delta.

METHODS

Three aerial survey types are reported in this paper.

(1) A survey was flown by Henny and Anderson (1979) between 23 March and 1 April 1977 of all of coastal Baja

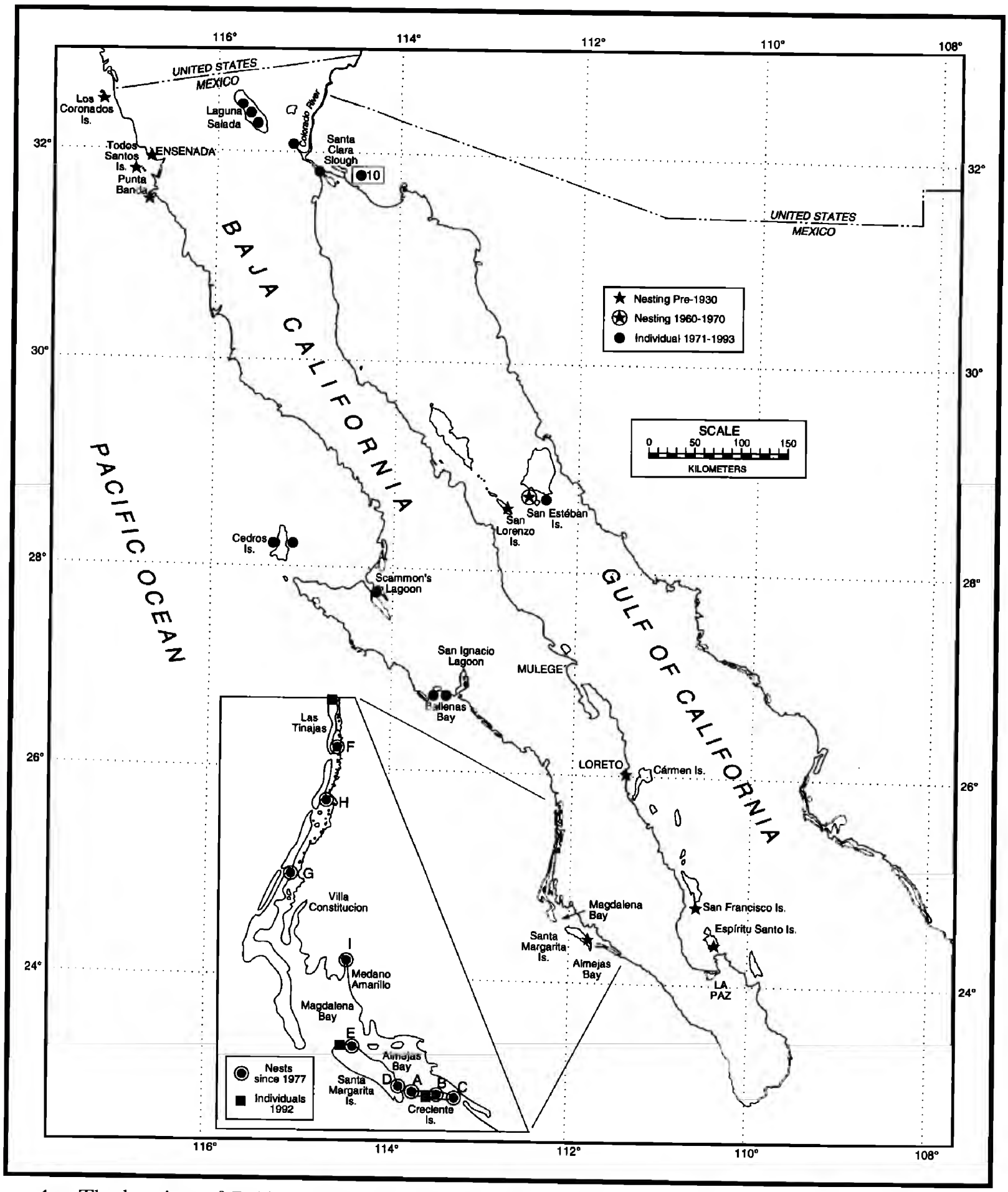

Figure 1. The locations of Bald Eagle nest sites since 1977 and individual observations in 1992 in the Magdalena Bay region (inset); and locations of all other nest records and observations of individuals in the remainder of Baja California and vicinity.

California plus the mainland coast of Mexico as far south as Mazatlan and adjacent islands. The survey was flown 60–100 m above the shorelines and inland up to 2 km. The survey was repeated in 1992–1993 with a twin engine Partenavia P68 and the same observers. Baja California was surveyed 24 March–2 April 1992 and coastal Sonora and Sinaloa 20–24 March 1993. Based on the 1977 observations (large young ready to fledge in late March), the

late March–early April surveys provided information on fledging rates at successful nests.

(2) Beginning in January 1983, the Magdalena Bay region (the only location where nesting Bald Eagles were found in 1977) was surveyed annually by air during the wintering waterfowl survey in coastal Mexico (Conant et al. 1984). This survey was not considered intensive for Bald Eagles, but included a detailed annual aerial check of the mangroves on Isla Creciente (1977 nest site). The mangroves to the north of Isla Creciente were checked opportunistically, and when a nest was located, the vicinity was checked annually thereafter. The mid-January survey occurred at the time when Bald Eagles were expected to be at nests with eggs or small young (active nests).

(3) Three special surveys included a 4.6 hr survey of the Magdalena Bay region by Knoder and Boeker (unpubl. data) on 12–13 March 1984 and our 6 hr survey of the entire Magdalena Bay Region on 29 March 1992. Also, the three active nests observed in mid-January 1993 were rechecked during a special flight on 24 March 1993 to determine the number of large young.

The annual nesting activity was scored on the basis of 1 (for an adult incubating or with eggs or young) and 0.5 (for each adult near a nest without eggs, young or an incubating bird). This approach was an attempt to reduce the nesting activity for each year to a single value for comparative purposes.

RESULTS

Nesting in Baja California before 1977. Published records of Bald Eagles nesting in Baja California from 1927–1977 were unknown to us in 1977 (Henny et al. 1978). Friedmann et al. (1950:61) described the distribution of nesting Bald Eagles in Baja California as "a scattering of pairs on both the Pacific and Gulf sides." Nesting Bald Eagles in Mexico were reported in the Magdalena Bay region by Bryant (1889) who found a pair on Isla Santa Margarita in that same year (2425-11150); he also saw a single adult north of Magdalena Bay (Fig .1). Wilbur (1987) reported an egg set collected by Ed N. Harrison from a nest in a large cardon cactus (*Pachycereus pringlei*) at Isla Santa Margarita on 28 January 1938. Nesting locations on the Pacific side summarized by Grinnell (1928) included Isla Todos Santos (1897, 1905, 1920), Isla Los Coronados, indirect report (1902), Guadalupe Canyon north of Ensenada (1926); localities on the Gulf side included Isla Espiritu Santo (1885?), the mainland opposite Isla Carmen (1887), and Isla San Francisco (1909).

Bancroft (1932:334) also reported "the only pair of Bald Eagles known still to exist on the Gulf" on Isla San Lorenzo (sometime between 1925 and 1930). He also mentioned nesting Bald Eagles (same time period) at Punta Banda (Bancroft 1932:44) and earlier nesting at Isla Los Coronados (presumably the 1902 record mentioned above).

Antero Diaz (Bahia de los Angeles) showed one of us (DWA) an abandoned Bald Eagle nest on Isla San Esteban (in Sonora), and said it was occupied in the late 1960s. The extremely large abandoned Bald Eagle nest was photographed by DWA several times during 1972–1978, but the nest has since deteriorated. In early January 1980 and early January 1984, T. Bowen and colleagues (San Jose State Univ. pers. comm.) observed and photographed a single adult Bald Eagle in a dense cardon cactus forest above the old site on Isla San Esteban, but no nest was ever seen.

Nesting in Baja California, 1977–1993. Nesting records in the Magdalena Bay region since 1977 can be divided into those on and near Isla Creciente and those from the remainder of the region (Table 1). Isla Creciente and southeastern Isla Santa Margarita were surveyed intensively and yielded comparable annual data. The two active sites (nests A and C) on Isla Creciente in January 1984 were later visited by Knoder and Boeker (unpubl. data) on 12 March 1984; nest C was still active (two eggs) and no eagles were at the other site. Nest D was first located by our survey in January 1986 (with 2 eggs; Table 1), but Boeker (pers. comm.) listed a possible Bald Eagle nest there on 12 March 1984 (unoccupied), and Amador-Silva and Guzman-Poo (in press) reported adult Bald Eagles in the area (apparently the nest was not located by them) as early as February 1985 (one adult), March 1985 (two adults), and April 1985 (three adults). Another (apparently temporary) inland nesting site in rocks at the northeast corner of Isla Santa Margarita (nest E) was not checked frequently enough in 1985 and 1986 to yield results (Amador-Silva and Guzman-Poo in press). They reported seeing Bald Eagles in the area but not perched at the nest, and we were not aware of the nest when we saw an adult in the same general vicinity on 28 March 1992. Although nest E is shown, all data referring to that nest were inconclusive and not included in our synthesis.

Both nesting effort and the number of Bald Eagles on Isla Creciente and southeast Isla Santa Margarita have progressively decreased. The nesting activity scores by 2-yr intervals for these islands were 3.0, 2.5, 3.0, 2.0, 2.5, 1.5. Also, the 2-yr intervals may be reviewed by known number of nesting attempts: 3, 2, 3, 1, 2, 1. The maximum number of pairs nesting there in any year was two and that occurred

Table 1. Occupancy of established nest sites by Bald Eagles in Magdalena Bay, Baja California Sur, Mexico, 1977–1993.

	Isla Creciente and Southeast Isla Santa Margarita				Remainder					Nest Score[b]	
Year	Nest A 2422-1139	Nest B 2422-11137	Nest C 2422-11133	Nest D 2422-11143	Nest E 2430-11150	Nest F 2534-11206	Nest G 2503-11208	Nest H[a] 2515-11206	Nest I 2446-11157	A–E	F–I
1977	XX					XX				1.0	1.0
1983	XX		XX							2.0	[c]
1984	XX		XX			XX				2.0	1.0
1985	X			(X)	(X)					0.5	[c]
1986	XX			XX	(X)		XX			2.0	1.0
1987	XX						XX			1.0	1.0
1988	XX		X				XX			1.5	1.0
1989			X				XX			0.5	1.0
1990	XX						XX			1.0	1.0
1991		XX	X				XX			1.5	1.0
1992		X			(X)		X		XX	0.5	1.5
1993	XX						XX		XX	1.0	2.0

Note: XX = incubating pair, or young in nest; X = adult near nest without eggs, young, or an incubating bird; (X) = adult in general vicinity of nest site (no direct association with nest observed).

[a] Remnant nest discovered in 1986 that was soon destroyed.

[b] See text for scoring procedures.

[c] No search effort in portion of study area called "Remainder" in 1983 and 1985.

in three of the first five years. The assigned score of 0.5 for 1985 is probably low for reasons mentioned regarding nest D. We are unsure if nest E was ever occupied by Bald Eagles.

The Bald Eagle population in the remainder of the region appeared stable. Nest G was consistently occupied and successful from 1986 to 1993. An alternate nest within the same coordinate was found in 1992 with an adult nearby, but with no evidence of breeding. Knoder and Boeker (unpubl. data) located an active nest with two adults and one recently fledged young on 13 March 1984 near Las Tinajas, but the exact coordinates were not given. It may have been the same site (nest F) that Henny et al. (1978) located in 1977. Knoder and Boeker (unpubl. data) also saw a subadult in the same vicinity on 12 March 1984. The waterfowl crew did not locate this nest in January 1984 (area with limited search effort), but did see an adult in the vicinity. The nest discovered in a large cardon cactus on 29 March 1992 (nest I) was found as the result of intensive search effort throughout the Magdalena Bay region. The nest appeared old and was in an area not intensively checked in recent years, although Henny et al. (1978) reported Bald Eagle observations from the vicinity (Medano Amarillo) in both 1971 and 1972. The nesting activity scores by 2-yr periods, in the remainder of the region (initially pooling 1977 and 1984) were: 2.0, 2.0, 2.0, 2.0 and 3.5. The number of known nesting attempts showed the same pattern: 2, 2, 2, 2, and 3. The increase in the last 2-yr period was the result of increased search effort in 1992 which led to the discovery of nest I.

Recent Reproductive Success. The 20 January 1993 survey recorded three active nests (all with eagles incubating), but only one bird flushed from the nest revealing two eggs. Two months later (24 March) each nest contained two large young. The only other March data were obtained in 1977 (a nest with two large young and another with one large young) and 1984 (a nest with one large young) for nests not observed in January. Average brood size for successful nests observed in March was 1.67 large young for six nests.

Colorado River Delta Wintering Population. We observed an adult Bald Eagle on the delta of the Colorado River in January 1990, but more important were 10 Bald Eagles (nine adults and one subadult) at Santa Clara Slough near the mouth of the Colorado River Delta (in adjacent Sonora) on 15 January 1993 (Fig. 1). No Bald Eagles were at the slough two months later (20 March 1993). This large wetland area (about 12 500 ha) was created in 1973 by the discharge of saline drainwater from the Welton-Mohawk Irrigation District in the United States (E.P. Glenn, Univ. Arizona pers. comm.). The water flows through an 80 km concrete canal.

Other Individual Bald Eagle Observations. In January 1991, two subadult Bald Eagles were observed at Ballenas Bay, just west of San Ignacio Lagoon (Fig. 1). This location is 250 km northwest of nest G where incubating adults or nestlings were seen almost annually between 1986 and 1993. We saw no Bald Eagles outside the Magdalena Bay region in March of 1992 during the Osprey survey (67 hr of flying time) when all of coastal Baja and adjacent islands were surveyed.

DISCUSSION

The small disjunct Bald Eagle nesting population in the Magdalena Bay region continues to exist, but it is vulnerable to human disturbance and appears to be declining in its former stronghold (Isla Creciente and southeast Isla Santa Margarita). The maximum number of pairs found nesting in the Magdalena Bay region was 3 in 1984, 1986 and 1993. The intensive effort in 1992 resulted in the location of five adult Bald Eagles (including the new pair); we doubt that many more than three pairs now live in the region. The excellent production in 1993 provides some cause for optimism; however, we urge that the Mexican government immediately afford the unique habitat in Magdalena Bay special protected status and more detailed monitoring and protection of individual nesting territories. Bald Eagle protection criteria for nesting territories, from experiences in the United States and Canada, are well-tested and established (e.g., Montana Bald Eagle Working Group 1986).

Nests with complete information on reproductive success were limited because, in most years, only one survey (January) was conducted. The three nests with incubating adults in January 1993 each contained two large young nearly ready to fledge in late March which was considered excellent production (see Sprunt et al. 1973). The average brood size of 1.67 large young for six successful nests observed in March was also considered excellent, but again the sample size was small.

The 10 Bald Eagles we observed on Santa Clara Slough near the mouth of the Colorado River Delta in January 1993, and the single one we observed on

the delta in January 1990 supplement other January observations in the region. Sada (1987) reported three Bald Eagles (one adult and two subadults) at Salada Lagoon south of Mexicali on 7–8 January 1987. Patten et al. (1993) reported a subadult along the Rio Hardy on 14 January 1989. Potential contamination of wildlife at Santa Clara Slough, including eagles, by drainwater pollutants needs to be investigated. This wintering concentration is closer to the nesting population on the Rio Yaqui drainage in Sonora, Mexico (Brown 1988, Brown et al. 1987), or perhaps the central Arizona nesting population (Haywood and Ohmart 1986), and we know Baja California pairs are already on eggs in mid-January. Also, the nesting cycle is too early in Arizona (Ohmart and Sell 1980) and Sonora (Brown 1988) for the adults to be from those populations. Therefore, the wintering adult eagles on the Colorado River Delta and at Santa Clara Slough must nest later and farther north in the United States or Canada.

We observed two subadult Bald Eagles at Ballenas Bay in Baja California and Wilbur (1987) reported two subadults on Isla Cedros (17 February 1982), and one subadult at Scammon's Lagoon (20 January 1971). The sightings were all north of Magdalena Bay. The source of these five subadults observed in Baja California is uncertain, but young Florida (similar latitude) and California Bald Eagles are known to migrate north following fledging (Broley 1947, Hunt et al. 1992). Therefore, they may be eagles from Magdalena Bay.

The last confirmed nesting in the Gulf of California occurred on Isla San Lorenzo and Isla San Esteban which are remote and may provide an opportune place for successful Bald Eagle reintroductions into the Gulf of California. No adults or old nests were seen on either island during the 1992 and 1993 surveys. However, these remote islands in the Gulf (which are in various Biosphere Preserves) could provide a second focus for nesting in the region.

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ROAD MORTALITY OF SAW-WHET AND SCREECH-OWLS ON THE CAPE MAY PENINSULA

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ABSTRACT.—During a 10-yr study in southern New Jersey, 250 road-killed raptors of six owl and six hawk species were found during 145 km of road travel between mid-October and early April. Northern Saw-whet Owls (*Aegolius acadicus*) and Eastern Screech-Owls (*Otus asio*) accounted for 45% ($N = 114$) and 36% ($N = 91$) of all road kills, respectively. A large percentage of the saw-whet (79%) and screech-owls (88%) found were less than 1 yr old. More than 87% of road-killed saw-whet owls and 71% of Eastern Screech-Owls were found between November and January. Slightly less than one-half of all road kills of these two species occurred within the southernmost 15 km of the Cape May peninsula. We conclude that southern New Jersey, especially the southern Cape May peninsula, hosts a large number of wintering and migrating saw-whet owls and resident screech-owls, and that collisions with automobiles kill a significant number of these owls.

Mortalidad en caminos de la Península de Cape May de *Aegolius acadicus* y *Otus asio*

RESUMEN.—En un estudio de 10 años en el sur de New Jersey, se encontró un total de 250 rapaces muertas por accidentes carreteros, que incluyeron seis especies de búhos y seis especies de halcones. Los ejemplares fueron encontrados a lo largo de una carretera de 145 km, entre mediados de octubre y los primeros días de abril. El 45% de los ejemplares muertos correspondían a *Aegolius acadicus* ($N = 114$) y el 36% a *Otus asio* ($N = 91$). Un gran porcentaje de los ejemplares de *A. acadicus* (79%) y *O. asio* (88%) colectados tenían menos de un año. El 87% de *A. acadicus* y el 71% de *O. asio* colectados fueron encontrados entre noviembre y enero. La mayoría de las muertes carreteras de estas dos especies ocurrieron 15 km al sur de la Península Cape May. Se concluye que el sur de New Jersey, especialmente al sur de la Península de Cape May, hospeda a un gran número de migrantes invernales de *A. acadicus* y del residente *O. asio*, y que las colisiones con automóviles matan a un número significativo de estos búhos.
[Traducción de Ivan Lazo]

Raptors and other birds are being killed in large numbers by automobiles (Hodson and Snow 1965, Hernandez 1988). To better understand the magnitude of automobile mortality on Northern Saw-whet Owls (*Aegolius acadicus*), Eastern Screech-Owls (*Otus asio*), and other raptors, we report the results of a 10-yr study done in southern New Jersey. In addition to quantifying raptors killed on the road, we present information on the abundance, distribution, seasonal incidence of road kills and the age composition of those road kills.

METHODS

Every weekday from 1980–1990, a 145 km route was driven by GL (Fig. 1) between the North Cape May Ferry Terminal and Atlantic City in southern New Jersey. The drive was part of the route to (starting at about dawn) and from (ending near dusk) work. The route includes two county roads and a state road from the ferry terminal in North Cape May to the beginning of the Garden State Parkway; the Garden State Parkway; and the Atlantic City Expressway for about 5 km east of its intersection with the Garden State Parkway (Fig. 1). The study route was changed slightly in 1987 when the starting point moved from North Cape May to a location 24 km northward on the Parkway, although the entire route was done every day. Cruising speed during the study was between 80 and 88 km/hr.

When a dead raptor was seen on the road, its location was noted as the nearest one-tenth mile road marker along with the date and species. Birds that were not damaged badly were collected, and sex was determined by examining gonads. Age was determined by plumage characters, the presence of two or more primary or secondary feathers of different ages indicated birds greater than 1-yr of age as opposed to birds less than a year old whose primary and secondary feathers were all the same age.

RESULTS

A total of 250 road-killed raptors representing six owl and six hawk species were found along the Garden State Parkway and other roads during the 10-year study period (Table 1). Owls predominated (88% of all raptors) with Northern Saw-whet Owls and Eastern Screech-Owls being most numerous. Saw-whet owls accounted for 52% of all owls and

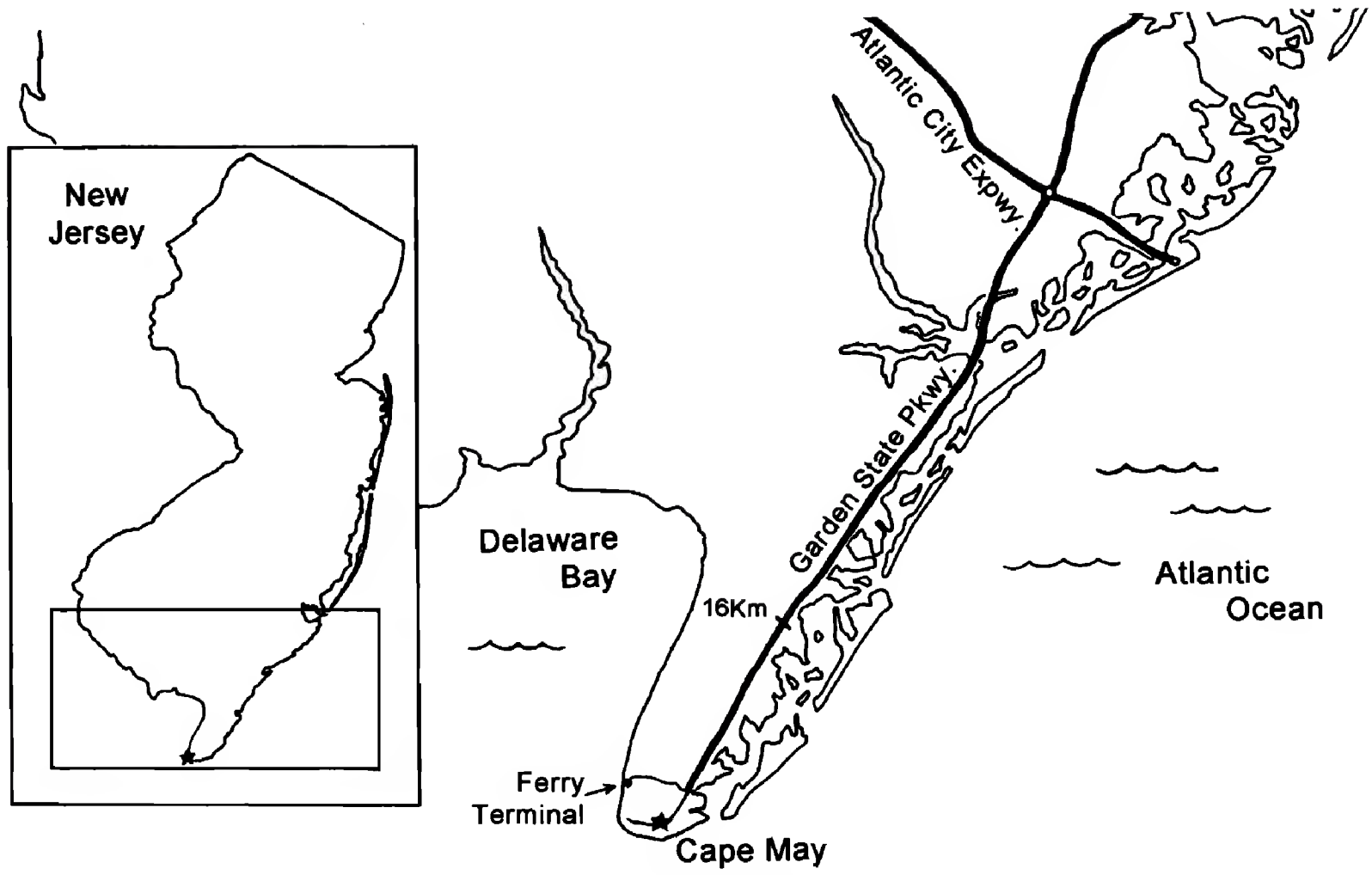

Figure 1. Map of Cape May peninsula, New Jersey, showing the roads where road kills were collected.

screech owls for 42%. The number of road kills per year averaged about 25, although numbers varied greatly from year to year. The smallest number of saw-whet owls found in one year was one in 1984–1985 and the largest was 34 in 1988–1989.

Of the 68 saw-whet owls for which age was determined, 54 (79%) were birds in their first year and the remainder were older than 1 yr. The sex ratio was almost even, with 20 (49%) of 41 owls for which gonads were checked, being female. Among the 32 screech owls for which age was determined, only 13% were older than 1 yr. Males outnumbered females almost two to one (11 males, 6 females), although the sample size was too small to analyze statistically.

More than 87% of the road-killed saw-whet owls were found from November–January, with December accounting for 41% of all road kills (Fig. 2). Five percent of road kills were found in the months of October, March, and April. For screech-owls, November–January also accounted for a majority (72%) of road kills.

The distribution of saw-whet and screech-owls along the study route was not uniform. A much

Table 1. Summary of road mortality of hawks and owls during the study period, 1980–1990, in southern New Jersey. The numbers reflect raptors found on the regular route and other roads during the study period.

SPECIES	NUMBER FOUND
Sharp-shinned Hawk (*Accipiter striatus*)	7
Cooper's Hawk (*Accipiter cooperii*)	1
Red-shouldered Hawk (*Buteo lineatus*)	1
Broad-winged Hawk (*B. platypterus*)	6
Red-tailed Hawk (*B. jamaicensis*)	7
American Kestrel (*Falco sparverius*)	9
Common Barn Owl (*Tyto alba*)	1
Eastern Screech-Owl (*Otus asio*)	91[a,b]
Great Horned Owl (*Bubo virginianus*)	9
Barred Owl (*Strix varia*)	3
Long-eared Owl (*Asio otus*)	1
Northern Saw-whet Owl (*Aegolius acadicus*)	114[c]

[a] Includes 73 found on regular route and 18 found on other roads in Cape May County.

[b] The ratio of red to gray morph owls was 2.15.

[c] Includes 109 found on regular route and 5 found on other roads in Cape May County.

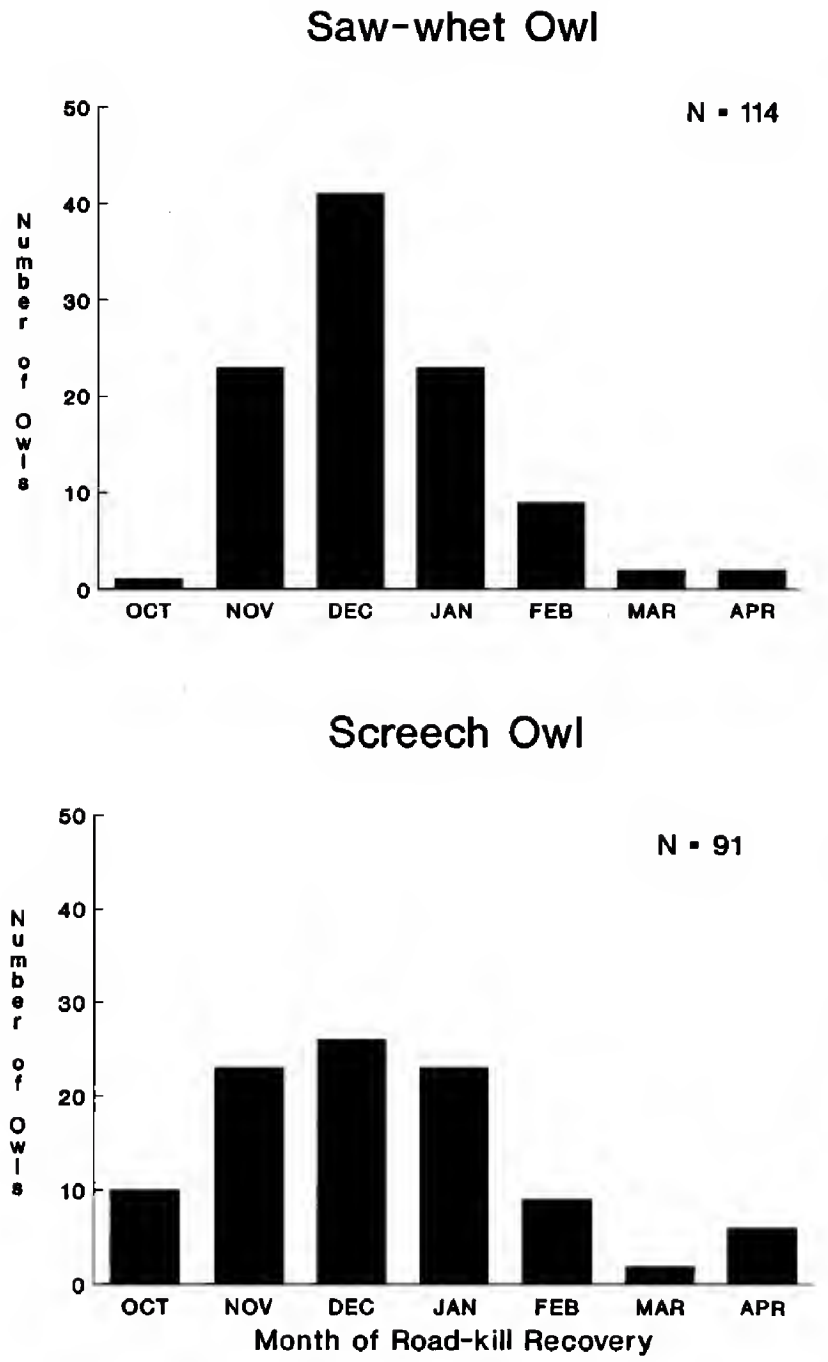

Figure 2. Seasonal distribution of the occurrence of Northern Saw-whet Owl and Eastern Screech-Owl road kills in the Cape May peninsula, New Jersey, during the period 1980–1990.

greater percentage of road kills of both saw-whet and screech-owls were found near the tip of the Cape May peninsula than farther north on the Parkway. The southernmost 10 km of the Garden State Parkway and the road between the ferry terminal and the base of the Parkway accounted for nearly one-half (53 of 111, 47.7%) of all saw-whet owls and 41.2% of all screech-owls found dead. Smaller numbers of owls were found on the Parkway in the region of two stoplights (16–19 km from the end of the Parkway), near the toll booth (32 km)—where cars slow down, and near the bridge over the Great Egg Harbor River (46 km) and its associated toll booth. North of mile-marker 6 (10 km) on the Parkway, the distribution of screech-owls appeared to be uniform. Although north of the Egg Harbor River, very few were found.

DISCUSSION

Our data suggest that a large number of saw-whet owls migrate into and winter in the Cape May peninsula and other portions of southern New Jersey. Our observations, together with recently discovered saw-whet owl roosts in other parts of South Jersey (E. Manners, T. Bailey, and W. Dasey pers. comm.) and the large numbers banded during autumn migration at Cape May Point (Duffy and Kerlinger 1992), suggest that saw-whet owls may winter in greater numbers in this area than in any other area in North America.

The average of 25 road-killed raptors per year seems to be a large number considering that this study was done by one person over a small portion of the peninsula. Furthermore, we know of no other North American studies that report such large numbers of road kills. The fact that most saw-whet owls were recovered after autumn migration suggests that these birds remain in the peninsula for the winter. The preponderance of Eastern Screech-Owls found during November–January and the fact that a large proportion of immature males were in the sample, suggests that this class may be particularly vulnerable to road injuries, especially while dispersing. Road-killed owls are commonplace in the Cape May peninsula. During the same 10-yr period, more than 50 other road-killed raptors, mostly owls, were acquired by the Cape May Bird Observatory. None of these were included in the study. The actual number of saw-whet owls killed on South Jersey roadways is impossible to access, but in areas such as Gloucester County, where communal-type roosts occur, road kills are common (E. Manners pers. comm.).

More than 700 saw-whet owls were banded in Cape May Point during the autumns of 1980 to 1990 (Duffy and Kerlinger 1992). Four of these birds, all banded in November, were recovered by GL from 4–8 km up the peninsula from the banding sites. Of these birds banded in November, one was recovered in April the next year, one in November of the same year, and two in December of the same year. This may indicate that an appreciable number of the owls that migrate into Cape May Point remain on the peninsula for the winter.

The fact that such a large number of Northern Saw-whet Owls, Eastern Screech-Owls, and other

raptors were killed by automobiles demonstrates the magnitude of the threat. It is probably fortuitous for the owls and many other birds that traffic in autumn and winter is much less than in warmer, tourist months. With recent suburban development on the peninsula, habitat has become more limited and local traffic has increased. This could pose an even greater threat to some wintering raptors.

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SHORT COMMUNICATION

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FOOD HABITS OF THE RUFOUS-LEGGED OWL (*STRIX RUFIPES*) IN TEMPERATE RAINFORESTS OF SOUTHERN CHILE

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The Rufous-legged Owl (*Strix rufipes*) is the least known owl species inhabiting the temperate rainforest region of southern South America. The scarce biological knowledge about this species is either anecdotal (Housse 1945, Johnson 1967) or consists of brief accounts on taxonomy and distribution (e.g., Humphrey et al. 1970, Vuilleumier 1985, Jaksić and Feinsinger 1991). There is no published information on the diet of Rufous-legged Owls. Here, I report the first quantitative data on the food habits and prey selection by these owls.

STUDY AREA AND METHODS

I studied Rufous-legged Owls at two sites located in the Valdivian Rain Forest Region of Southern Chile (*sensu* Veblen et al. 1983). One was San Martín Experimental Forest (39°38′S, 73°07′W; 20 m elevation), located on the coastal ranges of Valdivia Province. This 80 ha area was covered by multilayered forests dominated by *Aextoxicum punctatum* and *Podocarpus saligna* with substantial presence of *Gevuina avellana* and some scattered old individuals of emergent *Nothofagus dombeyi*. The understory was sparse, and the soil was covered with a thick layer of mosses and litter. The other site was a 25 ha second-growth forest surrounding the experimental fish hatchery at Lake Rupanco (40°39′S, 72°38′W; 150 m elevation). This site was contiguous with dense riparian forests running toward pre-Andean forests east of Osorno Province. It was an almost pure stand of old *Aextoxicum punctatum*, with minor amounts of *Laurelia sempervirens*, *Gevuina avellana*, and *Nothofagus dombeyi* trees. It had a sparse shrub undergrowth of *Chusquea quila* and a thin layer of mosses and litter.

Owl pairs remained in both areas year-round, and their pellets were collected under roosting trees. At San Martín, I collected 78 pellets from April (early autumn) 1988 to February (late summer) 1990, and in January 1992. At Rupanco, I collected 83 pellets from February 1992 to January 1993. From the whole sample (161 pellets), I measured and weighed 78 intact pellets. I identified and quantified most vertebrates in the pellets on the basis of skulls (Reise 1973) or dentary pairs (whichever gave the highest count). For other remains, such as hairs and feathers, I used reference collections and quantified these prey assuming the smallest possible number of individuals (e.g., hair or feathers of a given species were deemed as representing only one individual). For insect identification, I followed Peña (1986) and quantified these prey by counting head capsules and mandibles. I identified prey items to the finest possible taxonomic category.

The mass of most prey was determined by weighing individuals captured at the study area. Some mass estimates were taken from the literature (Pearson 1983, Jaksić et al. 1986). I estimated the biomass contribution of each prey type to the owls' diet by multiplying the number of individuals in the pellets by the mean body mass of that item. I assumed that masses of unidentified prey were similar to the average mass of the most closely related identified taxa.

Because there were no important differences in the contents of pellets collected at both sites, I pooled these data and analyzed the combined diet on a seasonal and year-round basis.

RESULTS AND DISCUSSION

The 78 whole pellets averaged 35.4 ± 0.86 mm × 21.8 ± 0.55 mm and had a mean dry mass of 2.8 ± 0.36 g ($\bar{x}$ ± SE).

The 161 pellets analyzed yielded 376 prey items (Table 1), of which small mammals were the most frequent. The arboreal mouse (*Irenomys tarsalis*) was the most common item in the diet in all seasons other than summer. The long-tailed mouse (*Oryzomys longicaudatus*) was consistently preyed upon year-round, and was the staple food of owls during spring and summer both by number and biomass. The colocolo opossum (*Dromiciops australis*) was better represented during spring and summer than during autumn and winter. Other mammalian prey included the introduced black rat (*Rattus rattus*), the long-haired mouse (*Akodon longipilis*), the olivaceus field mouse (*Akodon olivaceus*), the austral greater mouse (*Auliscomys micropus*), Darwin's leaf-eared mouse (*Phyllotis darwini*) and an unidentified bat, probably a big-eared bat (*Histiotus montanus*).

Birds from the family Furnariidae made minor contributions in biomass. At least two of the unidentified Furnariidae were probably White-throated Treerunners (*Pygarrhychas albogularis*).

The contribution of amphibians to total biomass consumed was negligible, and the remains observed (long

Table 1. Food habits of the Rufous-legged Owl (*Strix rufipes*) in primary growth temperate rainforests of southern Chile. B% is percent by biomass and *N* is prey number. Mass[a] of prey items in grams.

PREY	MASS (g)	SUMMER B% (*N*)	AUTUMN B% (*N*)	WINTER B% (*N*)	SPRING B% (*N*)	TOTAL B% (*N*)
Mammals						
Akodon longipilis	41	0.0 (0)	2.8 (2)	0.0 (0)	0.0 (0)	1.4 (2)
Akodon olivaceus	23	0.0 (0)	0.0 (0)	4.1 (3)	3.0 (1)	1.5 (4)
Auliscomys micropus	58	0.0 (0)	1.9 (1)	0.0 (0)	0.0 (0)	1.0 (1)
Irenomys tarsalis	42	0.0 (0)	55.4 (39)	37.6 (15)	10.8 (2)	39.2 (56)
Oryzomys longicaudatus	26	35.6 (8)	13.2 (15)	31.0 (20)	33.4 (10)	23.0 (53)
Phyllotis darwini	66	0.0 (0)	4.4 (2)	0.0 (0)	0.0 (0)	2.2 (2)
Rattus rattus	40[b]	13.7 (2)	1.3 (1)	2.4 (1)	5.1 (1)	3.3 (5)
Unident. rodents	42.2	14.4 (2)	11.4 (8)	17.6 (7)	5.4 (1)	12.7 (18)
Dromiciops australis	34	23.3 (4)	6.9 (6)	4.1 (2)	26.2 (6)	10.2 (18)
Unident. bat	15	0.0 (0)	0.0 (0)	0.0 (0)	1.9 (1)	0.2 (1)
Subtotal mammals		87.0 (16)	97.3 (74)	96.8 (48)	85.8 (22)	94.7 (160)
Birds						
Aphrastura spinicauda	18	0.0 (0)	0.6 (1)	1.1 (1)	0.0 (0)	0.6 (2)
Unident. Furnariidae	18	3.1 (1)	0.6 (1)	0.0 (0)	2.3 (1)	0.9 (3)
Subtotal birds		3.1 (1)	1.2 (2)	1.1 (1)	2.3 (1)	1.5 (5)
Amphibians						
Leptodactylidae	10	1.7 (1)	0.0 (0)	0.5 (1)	1.3 (1)	0.5 (3)
Subtotal amphibians		1.7 (1)	0.0 (0)	0.5 (1)	1.3 (1)	0.5 (3)
Insects						
Carabidae	0.84	0.0 (0)	0.1 (1)	0.0 (0)	0.0 (0)	0.1 (1)
Cerambycidae	1.04	1.2 (7)	0.1 (1)	0.1 (2)	0.4 (3)	0.2 (13)
Curculionidae	0.22	0.0 (0)	0.0 (0)	0.1 (2)	0.0 (0)	0.1 (2)
Lucanidae	2.04	1.1 (3)	0.2 (3)	0.1 (1)	0.5 (2)	0.3 (9)
Scarabaeidae	0.48	1.6 (20)	0.1 (2)	0.0 (0)	3.2 (52)	0.6 (74)
Silphidae	0.45	0.0 (0)	0.0 (0)	0.1 (1)	0.0 (0)	0.1 (1)
Acrididae	0.69	0.2 (2)	0.0 (0)	0.1 (1)	0.7 (8)	0.1 (11)
Stenopelmatidae	1.35	0.5 (1)	0.7 (15)	0.6 (7)	0.2 (1)	0.5 (24)
Blattidae	1.12	3.6 (19)	0.3 (7)	0.5 (8)	5.6 (39)	1.3 (73)
Subtotal Insects		8.2 (52)	1.5 (29)	1.6 (22)	10.6 (105)	3.3 (208)
Total prey items		70	105	72	129	376
Total biomass (g)		584.8	2954.7	1674.5	778.9	5992.8
Total pellets		23	55	45	38	161

[a] Masses for mammals were obtained from Pearson (1983) for *Irenomys* and *Auliscomys,* from Jaksić et al. (1986) for *Phyllotis,* and from D.R. Martínez (unpubl. data) for the remaining taxa. Masses for insects are the average of representative members of each family collected at the study sites (D.R. Martínez unpubl. data).

[b] Juveniles.

femora) could be of arboreal frogs (*Hylorina sylvatica*), a scarce anuran that climbs up vegetation using its opposable halluces.

Insects outnumbered mammals in the diet only during spring and summer, but their biomass contribution was unimportant on a year-round basis. Individuals of Blattidae (cockroaches) as well as Scarabaeidae (beetles), were the most frequent items, followed by camel crickets (Stenopelmatidae) and grasshoppers (Acrididae). During autumn and winter insects were uncommon in the diet, likely because only Blattidae and Stenopelmatidae were available in low numbers during these seasons.

Based on my data the Rufous-legged Owl may be considered a generalist feeder, taking a variety of prey available within the restrictions imposed by its hunting tactics (it is a sit-and-wait predator), and by prey size and behavior. Nevertheless, the most frequent vertebrate prey were arboreal or scansorial small mammals. Terrestrial

small mammals, despite their similar or higher field abundance (Murúa and González 1986), and higher number of species present in temperate rainforests (Meserve and Jaksić 1991), were poorly represented as food items of Rufous-legged Owls, both by numbers and biomass. This apparent differential utilization of prey resources by Rufous-legged Owls warrants further examination.

RESUMEN.—Este es el primer estudio cuantitativo de los hábitos alimentarios del Concón (*Strix rufipes*), producto del análisis de 161 egagrópilas recolectadas en dos ambientes no intervenidos de bosque templado en el sur de Chile. La composición de la dieta fluctuó estacionalmente e incluyó varias especies de mamíferos, aves, anuros e insectos. Las presas más comunes fueron micromamíferos (roedores y una especie de marsupial) e invertebrados (principalmente Blattidae y Scarabaeidae). Sin embargo, el aporte en biomasa de los primeros fue muy superior al de los insectos. El consumo de invertebrados fue más frecuente durante primavera y verano, mientras que en otoño e invierno los Concones depredaron casi exclusivamente sobre micromamíferos. Los micromamíferos de hábitos arborícolas y escansoriales fueron más depredados que los de hábitos terrícolas. Así, los Concones parecen seleccionar las presas que constituyen su dieta.

[Traducción Autor]

ACKNOWLEDGMENTS

I thank Susan Chaplin for sponsoring me as a member of RRF. Eric D. Forsman kindly sent me some of his invaluable articles and unpublished papers on Spotted Owls (*Strix occidentalis*). Theodore J. Cohn sent me hard-to-retrieve reports on owls, and his authoritative descriptions of South American crickets helped me identify those prey. This work was funded by FONDECYT 92-327 and DI-IPO 304-75.

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LETTERS

DO FALCONS BUILD NESTS?

Except for excavation of the egg cup, falcons are not now generally believed to build nests (L. Brown and D. Amadon 1968, Eagles, hawks and falcons of the World, McGraw-Hill, NY:839 and 842). The best (albeit indirect) evidence for nest building in the genus *Falco* is G. L. Richards' (1970, *Condor* 72:476) report that captive American Kestrels (*F. sparverius*) arranged wood chips that had been placed near the scrape during incubation. Although many old publications make reference to falcons furbishing nests (e.g., G.P. Dement'ev and N.A. Gladkov 1954, Birds of the Soviet Union. Vol. 1. Moscow State Publishing House, Moscow, Russia), few recent references do so (e.g., J. Cupper and L. Cupper 1981, Hawks in focus: a study of Australia's birds of prey. Jaclin Enterprises, Mildura, Australia).

I know of only one detailed published account of any falcon actually bringing nest materials to the eyrie (J.C. Barber 1979, *Raptor Res.* 13:16). Because I urged Barber to publish the record *if* he could retrieve the stick, I am partly responsible for the original publication and feel obligated, for the record, to contest the published version of that observation. I visited the Prairie Falcon (*F. mexicanus*) site in question with John C. Barber (JCB) on 7 April 1976, eleven days after he made the reported stick delivery observation. On that visit, I learned: (1) that this was the first Prairie Falcon eyrie JCB had ever visited, (2) that JCB was unaware until my visit that Prairie Falcons were not known to build nests, and (3) that the stick was not taken to the eyrie as JCB later reported in print, but rather it was deposited on a ledge over 30 m from the true eyrie which we located on 7 April.

If the object actually was a stick (versus the dangling tail of a prey item), a likely explanation for its transport to the cliff is not as nesting material as JCB asserted. Rather, it is much more likely that the falcon inadvertently clutched the twig while grasping prey. I have repeatedly seen other raptors clutch a stick or clump of grass along with prey and subsequently fly with vegetation trailing.

An unquestionable observation of a large falcon transporting nesting material (alone, without prey) to its eyrie would be truly remarkable, but JCB's account is not of that quality and should no longer stand uncontested to confuse students of raptor behavior.—**David H. Ellis, U.S. National Biological Survey, Patuxent Wildlife Research Center, Laurel, MD 20708 U.S.A.**

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OSPREYS USE BALD EAGLE NESTS IN CHESAPEAKE BAY AREA

Ospreys (*Pandion haliaetus*) and Bald Eagles (*Haliaeetus leucocephalus*) share similar breeding habitat in the Chesapeake Bay area and elsewhere. The nests of these species are similar in size and appearance. Ospreys typically build large stick nests in dead trees or on man-made structures (C.J. Henny et al. 1974, *Chesapeake Sci.* 15:125–133; A.F. Poole 1989, Ospreys: a natural and unnatural history, Cambridge Univ. Press, NY), while Bald Eagles usually build larger nests in live trees (P.B. Wood et al. 1989, *J. Wildl. Manage.* 53:441–449; Maryland Dept. of Natural Resources, unpubl. data). Osprey nests are usually placed in the open at the top of dead trees or structures, while Bald Eagle nests are usually beneath the tree canopy obscured from view. Both select nest sites close to large bodies of water or wetlands (J.M. Andrew and J.A. Mosher 1982, *J. Wildl. Manage.* 46:383–390; Poole 1989). Eagles nest earlier than Osprey; in the Chesapeake Bay area eagles are on eggs when Ospreys return in March.

Since 1977, the Maryland Department of Natural Resources has monitored all known eagle nests in the state by aerial survey. Starting in February of each year, nest sites were monitored for activity at 3–4 wk intervals ending in early June. Since 1977, 449 nests were monitored totaling 1971 known outcomes.

During the 1991 aerial survey, a pair of Ospreys was observed at an unoccupied Bald Eagle's nest in Kent County, Maryland on 25 March. During the next survey flight, on 26 April, the Osprey pair was standing on the nest and two eggs were noted in the nest cup. On 30 May, an adult Osprey was observed in incubating posture on the nest. One young was in the nest on 9 June.

The nest we observed was built by a pair of Bald Eagles and was first used during the 1980 breeding season (Maryland Dept. of Natural Resources, unpubl. data). It was used by eagles each year through 1989, with the exception of 1982. The eagles nested successfully in six of those years, producing a total of 12 young. In 1985, gypsy moth

(*Porthetria dispar*) defoliation killed the white oak (*Quercus alba*) in which this nest was located. The eagles continued to nest in the dead tree for the next four years, then built an alternate nest 0.5 km away and used it in 1990 through 1993. The nest in the dead tree was used by Osprey in 1991 but not thereafter.

This may be the first published case of Ospreys successfully using a Bald Eagle's nest for nesting, although the reverse has been reported (J.C. Ogden 1975, *Wilson Bull.* 87:496–505). A search of the literature found no reports of Ospreys using eagle nests. While numerous raptor species are known to utilize the nests of other raptors (A.C. Bent 1937, Life histories of North American birds of prey. Part I. U.S. Natl. Mus. Bull. 167. Washington, DC U.S.A , R.S. Palmer 1988, Handbook of North American birds. Vol. 4. Diurnal raptors (parts 1 and 2). Yale Univ. Press, New Haven, CT U.S.A.), we could find no documentation of Ospreys exhibiting this behavior. Sergei Postupalsky (pers. comm.) observed Ospreys nesting in abandoned Bald Eagle nests a few times in Michigan but never published these observations. Several of the nests were used for a number of years by Osprey, but in one instance a pair of eagles repossessed the nest.

Only two other instances of Ospreys nesting in Bald Eagle nests in the Chesapeake Bay area are known. Jackson Abbott (unpubl. data) reported an Osprey sitting in the very deep egg cup of a Bald Eagle's nest in Kent County, Maryland in 1969, but did not follow up on the outcome of this attempt. Bald Eagles had used the nest the previous two years. In the early 1970s, Mitchell Byrd (pers. comm.) observed a Bald Eagle in apparent incubating posture at a nest in Middlesex County, Virginia that was subsequently abandoned. The nest was then occupied by Ospreys in the same year who successfully raised young. Additionally, there are anecdotal reports of Ospreys nesting in Bald Eagle's nests in the Chesapeake Bay area (Maryland Dept. of Natural Resources, unpubl. data), but there was no specific evidence that the nests were built or used by Bald Eagles.

The use of Bald Eagle nests by Ospreys for nesting is rare as indicated from monitoring hundreds of eagle nests in the Chesapeake Bay area since the 1960s. Since 1977 in Maryland, unoccupied Bald Eagle nests were available 695 times as potential nest sites for Osprey with only one actually used. Many of these nests were in live trees and probably not open enough for Osprey use. The presence of nesting Bald Eagles in an alternate nest nearby could also have reduced the availability of some of these nests to Osprey. However, many nests appeared suitable for Osprey with no eagles nearby but only the one unoccupied nest was used.

We thank E.A.T. Blom, J.D. Fraser, A.F. Poole, S. Postupalsky, and S.A. Smith for reviewing the manuscript.—
Glenn D. Therres, Maryland Department of Natural Resources, P.O. Box 68, Wye Mills, MD 21679 U.S.A.; Sheri K. Chandler, Department of Fisheries & Wildlife Sciences, Virginia Polytechnic Institute and State University, Blacksburg, VA 24061 U.S.A.

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BONELLI'S EAGLE (*HIERAAETUS FASCIATUS*) KILLING A BLACKBUCK (*ANTILOPE CERVICAPRA*) FAWN

On 12 September 1992 at 0900 H, a Bonelli's Eagle (*Hieraaetus fasciatus*) was scanning a grassland plot in the Pandit Jawaharlal Nehru Great Indian Bustard Sanctuary in Nannaj, District Solapur (71°41′N, 75°56′E) of Maharashtra, India. After about 40 min, the eagle attacked a blackbuck (*Antilope cervicapra*) fawn entering a scrubland adjacent to the grassland. The eagle repeatedly struck the fawn with its talons, frequently flying 15–16 m away to gain momentum prior to striking. Over a period of 35 min, the eagle caught the fawn five times and struck in 17 times The first four times the fawn was caught it escaped, probably because the eagle thought it was dead. Finally the bird seized the prey by the neck, standing on it with wings open to maintain balance. After killing the fawn, the eagle stood beside it for a few seconds and then flew off, possibly because of my close proximity. After 15 min, the eagle returned and ate about one fourth of the fawn after first removing the alimentary canal from the ventral side. M.K. Ranjitsinh (1989, The Indian blackbuck. Natraj Publ., Dehradun, India) reported the average weight of blackbuck fawns at birth as 3.27 kg ($N = 33$).

Like other "booted" eagles, the Bonelli's Eagle did not use its beak while killing the fawn. The fawn had talon scratches on the neck region that were bleeding, but there was no injury to the eyes. During the episode described above the eagle's beak was used only four or five times when the bird lost its balance while standing on the fawn.

On a second occasion, on 27 November 1992, a Bonelli's Eagle was seen feeding on a blackbuck carcass which I had put out to bait wolves. The eagle fed on the carcass for 30 min.

These observations represent the first report of Bonelli's Eagle killing a blackbuck fawn and scavenging on carrion. According to Ali and Ripley (1987, Handbook of the birds of India and Pakistan. Oxford Univ. Press, Bombay, India), "food of this eagle varies from the Myna (*Acridotheres tritis*) to as large as injured Greylag Geese (*Anser anser*). It seldom if ever descends to carrion-eating." L. Brown et al. (1982, The birds of Africa. Vol. 1, Academic Press, New York, NY U.S.A.) reported Bonelli's Eagle killing no mammals other than mice and rabbits; the latter being the most important food. According to S. Cramp and K.E.L. Simmons [Eds.] (1979, The birds of the western Palearctic. Vol. 2, Oxford Univ. Press, New York, NY U.S.A.), less usual prey of this species includes young foxes (*Vulpes* spp.) and bushbuck (*Tragelaphus scriptus*). T.J. Roberts (1991, The birds of Pakistan. Vol. 1, Oxford Univ. Press, Karachi, Pakistan) twice saw this eagle capture hares.

I express my thanks to Vibhu Prakash of the Birds of Prey Project for identifying the raptor and Asad R. Rahmani, Grassland Ecology Project, who made helpful comments on earlier versions of this manuscript. The Birds of Prey Project and Grassland Ecology Projects of the Bombay Natural History Society were funded by the U.S. Fish and Wildlife Service.—**Satish Kumar, Grassland Ecology Project, Bombay Natural History Society, Shaheed Bhagat Singh Road, Bombay 400 023, India.**

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JOURNAL OF RAPTOR RESEARCH

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