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THE RELATIONSHIP OF VEGETATIVE COVER TO DAILY RHYTHMS OF PREY CONSUMPTION BY AMERICAN KESTRELS WINTERING IN SOUTHCENTRAL FLORIDA

JOHN A. SMALLWOOD

ABSTRACT.—American Kestrels (*Falco sparverius*) wintering in southcentral Florida were captured in order to collect their pellets. Dry mass of pellets was used as an index to the accumulated mass of prey consumed between dawn, when pellets representing prey consumed the previous day were regurgitated, and time of capture. Kestrels holding territories covered by a large proportion of suitable hunting substrate (grasses and weedy forbs <25 cm in height) consumed greater prey mass during morning than did kestrels inhabiting territories of lesser foraging quality. No difference was found between territories of high and low foraging quality in terms of total prey mass consumed by the end of the day. For reasons unrelated to habitat preference, most territories of high foraging quality were occupied by females, but within habitats of either high or low foraging quality, the temporal patterns of prey mass accumulation by males and females were similar. These results are consistent with observed kestrel activity budgets, and lend further support to the hypothesis that observed temporal differences in foraging behavior between males and females were due to differences in foraging quality of their territories; there was no evidence of any inherent sex-specific differences in predatory behavior. Foraging quality of kestrel winter territories in the study area was a function of the extent to which locations were covered by open patches of mutually preferred foraging substrate.

Segregation by habitat in wintering American Kestrels (*Falco sparverius*) has been widely reported (Koplin 1973; Mills 1976; Stinson et al. 1981; Smallwood 1981, 1987; Bohall-Wood and Collopy 1986). Several lines of empirical evidence have been presented which strongly suggest that the solitary winter territories held by female kestrels in southcentral Florida differ substantially from those held by males in regard to foraging quality; 1) females were more common than males in habitats extensively covered by suitable hunting substrate, 2) the territories of females were characterized by fewer and smaller trees and shrubs (woody vegetation was negatively correlated with coverage by suitable hunting substrate and obstructed the views of foraging kestrels), 3) males were less likely than females to reject an opportunity to capture novel prey items, and 4) males suffered a greater absolute and relative weight loss

in response to weather-related decreases in prey availability (Smallwood 1987).

Differential habitat use by the sexes was shown to be related to the date of arrival on wintering grounds, most of the adult males arriving last, rather than to differences in habitat preference (Smallwood 1988). In fact males and females established territories in the same type of habitat, when available, and all kestrels utilized open patches of the same type of foraging substrate regardless of the overall vegetative structure of the territory. Diets of males and females were also similar; both sexes fed exclusively on arthropods during winter (Smallwood 1987).

In a study of kestrel activity budgets (Smallwood 1987), it was shown that males and females had virtually identical capture success, once a capture was initiated, and captured similar numbers of prey

each day. However, sexes exhibited markedly different daily rhythms of foraging activity. The rate at which males made capture attempts did not change significantly throughout the day. In females, however, rates increased during morning, reaching a peak before noon. Hunting activity of females was markedly lower during early afternoon, increased in mid-afternoon and then waned toward evening.

Differences in daily foraging rhythms were interpreted as evidence of differential foraging quality of the respective territories. Apparently, most males were constrained to forage actively throughout the day in order to capture a sufficient number of prey items. Because females were more likely to be occupying territories of relatively high foraging quality, they were able to meet a large portion of their prey requirements early in the day. Later in the day, females allotted more time toward nonforaging activities.

The above interpretation was based on the assumption that mean prey size did not differ for males and females, that is, the similar number of prey items consumed/d by males and females represented similar nutrient rewards. Given the observed differences in daily foraging rhythms between the sexes and the assumption of equal mean prey size, the cumulative prey mass (CPM) consumed by females should differ from the CPM of males in a predictable manner throughout the day. The CPM of females should be greater than that of males during morning, when female foraging rates reach a maximum. The much reduced foraging activity of females in the early afternoon, during which males still actively forage, and the similarity of the total daily number of prey captures should result in similar CPM values for males and females during afternoon. If differences in CPM values are due to differential foraging quality rather than to an inherent sex-specific difference in foraging behavior, then kestrels holding territories of similar foraging quality should exhibit similar temporal patterns of prey mass accumulation, regardless of gender.

The objective of this study was to examine the temporal patterns of prey mass accumulation by male and female kestrels occupying winter territories covered to various extents by grasses and weedy forbs <25 cm in height. In this manner, the importance of kestrel gender and territory habitat were compared in regard to foraging behavior. In addition percent coverage by suitable hunting substrate, as

defined above, was evaluated as a reliable indicator of the foraging quality of kestrel winter territories.

STUDY AREA AND METHODS

The study area was centered on 27°00'N, 81°20'W, west of Lake Okeechobee in southcentral Florida and included portions of Highlands, Glades and Hendry counties. Most of this land is covered by pastures, citrus groves and residential developments. Numerous ponds, slash pine (*Pinus elliotii*) plantations, scrubby flatwoods and cypress (*Taxodium distichum*) sloughs are situated throughout the area (see Smallwood 1987).

Kestrels do not begin their daily foraging activities until after regurgitation of the undigested material from prey consumed on the previous day (Balgooyen 1971; pers. obs.). Thus, kestrels begin foraging "on an empty stomach," and the indigestible food material which then accumulates is a record of that day's prey consumption. Pellet mass was considered an index of the mass of consumed prey.

Kestrels were captured with a modified *bal-chatri* trap (Berger and Mueller 1959) from 3 January–23 February 1984, and from 18 December 1984–2 February 1985. Time of day of capture was recorded, and captured birds were held in cages overnight and regurgitated pellets collected the following morning. Each kestrel was subsequently released near its capture site. Pellets were air-dried at least 96 h prior to being weighed to the nearest 0.0001 g (Mettler AE 163 digital balance, Mettler Instrument Corp., Highstown, NJ).

Because 97.5% of all observed capture attempts by kestrels directed toward naturally occurring prey were made onto substrates of grasses or weedy forbs <25 cm in height (Smallwood 1987), this category of ground vegetation was operationally defined as suitable hunting substrate. The foraging quality of kestrel territories was estimated by sampling a 1-ha circular plot centered on each kestrel's hunting perch at the time of capture, measuring percent coverage by suitable hunting substrate (see Smallwood 1987 for a detailed description of the sampling technique).

Data were analyzed in the following manner. Kestrel territories were ranked with respect to the estimate of percent coverage by suitable hunting substrate. The ranked list of territories was then divided arbitrarily into two groups of approximately equal sample size, the respective pellets representing territories with >50% coverage by suitable hunting substrate (high foraging quality) or territories with coverage ≤50% (low foraging quality). Each pellet thus represented either a male or female kestrel captured either before or after solar noon (i.e., either a morning or afternoon CPM value) from a territory of either high or low foraging quality. Association between kestrel gender and foraging quality of the territory was tested for significance with a Chi-square test of homogeneity (Fienberg 1977). With respect to mass, pellets representing high and low foraging quality habitats were compared with Wilcoxon's rank sum tests (Hollander and Wolfe 1973) separately for four combinations of kestrel gender and time of day. In addition, males were compared to females with respect to pellet mass with Wilcoxon's

rank sum tests separately for four combinations of foraging quality and time of day.

RESULTS

Pellets were collected from a total of 169 kestrels. Pellets from 33 individual kestrels were chosen at random and were sacrificed for a concurrent study. Thus, results were obtained from measurements of 136 pellet samples.

Foraging quality of territories was significantly associated with kestrel gender. Of the 82 females sampled, 67% occupied territories of high foraging quality; only 20% of the 54 males sampled were found in high quality habitats ($\chi^2 = 28.43$, $P < 0.001$).

For birds captured before solar noon, pellets representing locations of high foraging quality had significantly greater mass than those representing territories of lower foraging quality for both males and females (Wilcoxon's $Z = 1.81$, $P = 0.036$, and $Z = 1.69$, $P = 0.045$, respectively; Fig. 1a). No association between pellet mass and the foraging quality of the respective territories was found for pellets representing afternoon CPM values for either males or females ($Z = 0.68$, $P = 0.50$, and $Z = 0.88$, $P = 0.38$, respectively; Fig. 1b). No differences in pellet mass were found between males and females in high quality habitats during morning ($Z = 0.27$, $P = 0.80$) or afternoon ($Z = 0.93$, $P = 0.35$), or in low quality habitats during morning ($Z = 0.04$, $P = 0.97$) or afternoon ($Z = 0.91$, $P = 0.37$).

DISCUSSION

Several interrelated conclusions may be drawn from these results. First, these data support the model of prey mass accumulation rhythms for kestrels inhabiting territories of various foraging quality, as suggested by the observed difference in kestrel activity budgets (Smallwood 1987). Kestrels occupying the "best" habitats differed from those in poorer habitats in rate of prey mass accumulation early in the day, but not in total prey mass consumed by the end of the day. It is unlikely that a kestrel would normally occupy a territory of such poor foraging quality that a sufficient mass of prey could not usually be captured on a daily basis.

It has been demonstrated previously that males and females consume a similar number of prey items per day (Smallwood 1987), and the present study suggests that the total daily mass of prey consumed by males and females is also similar. If the relation-

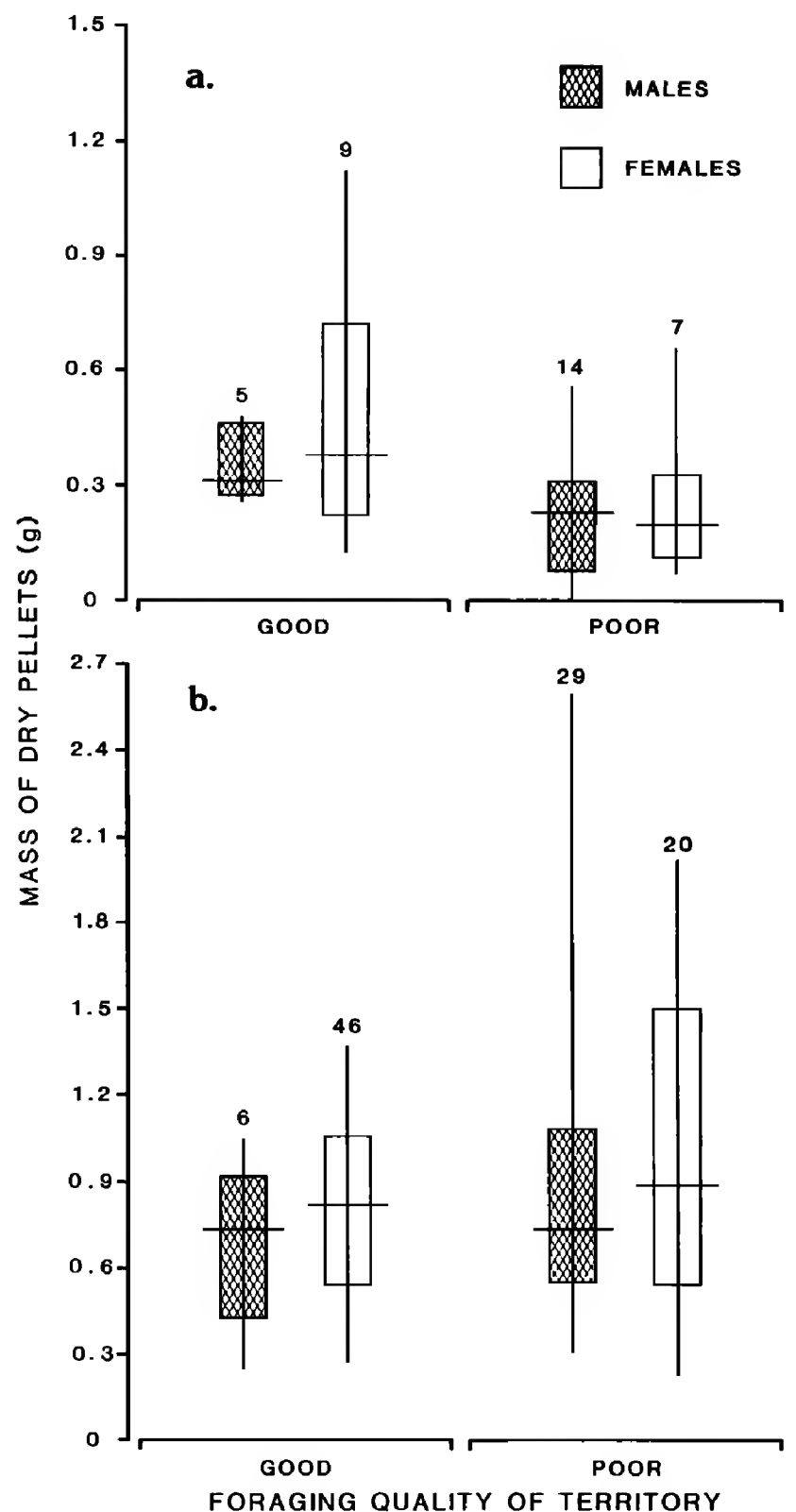


Figure 1. Cumulative mass of prey consumed a) before solar noon and b) throughout the day by American Kestrels occupying winter territories in southcentral Florida. Mass of dry pellets was used as an index of consumed prey mass. Ranges, quartile deviations and sample sizes are shown. Territories with $>50\%$ coverage by suitable hunting substrate (grasses or weedy forbs <25 cm in height) were considered to be of good foraging quality; territories with suitable hunting substrate coverage $\leq 50\%$ were considered poor.

ship between prey mass and pellet mass is the same for each sex, then mean size of prey captured by males and females must also be similar. In addition it appears that mean size of prey captured by kestrels is not dependent on foraging quality of a territory. Relative to large patches, small patches of suitable hunting substrate apparently support prey communities which are similar in terms of prey size. If prey density is a function of the type and height of ground vegetation, rather than of patch size, then total prey mass available to kestrels is proportional to patch size.

The amount of coverage by suitable hunting substrate was successfully used to predict differences in CPM values. This result corroborates that percent coverage by grasses or weedy forbs <25 cm in height is a biologically meaningful measure of the quality of a location in southcentral Florida with respect to foraging by kestrels. Preference for open patches of short ground vegetation by hunting kestrels has been well documented (e.g., Balgooyen 1976).

Results of this study lend further support to the hypothesis that observed temporal differences in foraging behavior between males and females (Smallwood 1987) were due to differences in the foraging quality of their territories rather than to inherent sex-specific differences in predatory behavior. Although males and females, on average, occupy different macrohabitats (Smallwood 1987, 1988), they depend on the same microhabitats for foraging. Both sexes feed on the same kinds of prey (see also Cade 1960; Balgooyen 1976) captured in open patches covered by the same kind of hunting substrate. It appears that the foraging quality of kestrel winter territories in southcentral Florida is a function of the extent to which locations are covered by open patches of grasses and weedy forbs <25 cm in height. Those kestrels which occupy territories of similar foraging quality forage similarly, regardless of gender.

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ROAD MORTALITY OF THE LITTLE OWL (*Athene noctua*) IN SPAIN

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ABSTRACT.—We studied the causes of road mortality of the Little Owl (*Athene noctua*) in Spain based on 418 road casualties and their relation to road characteristics and type of roadside cover. Road mortality presents a clear seasonal pattern and a summer peak (August) was found to be associated with postfledging dispersion. Road illumination decreases road mortality. Roadside cover has an important influence upon road casualties, possibly as a consequence of perching. Higher numbers of deaths occur in shrub type vegetation of <1 m height. These results and those obtained by other authors are discussed.

The Little Owl (*Athene noctua*) is the most generalist strigiforme in the Iberian Peninsula, and the most widely distributed and most common owl in Spain. In spite of this, many aspects of the biology of this species are unknown.

The Little Owl was poorly documented (Valverde 1967; Agelet 1979; Hoz 1982) until the studies of Mañez (1983a and 1983b). No information is available on the species' status in Spain, and mortality has never been studied in Spain (Clark et al. 1978). Mortality of strigiformes in Spain was poorly treated by Garzon (1977) and, particularly on *Bubo bubo* (see Gonzalez et al. 1980). Westernhagen (1962) reported on numerous road casualties of kites (*Milvus* sp.) in Andalusia (southern Spain) and Hass (1978) included Spanish roads in his study.

In Europe, particularly in Great Britain, Germany, the Netherlands and Denmark, road mortality among birds is well documented. Hodson (1962) studied the various types of roadside cover and its influence upon bird casualty numbers. Dunthorn and Errington (1964) made an attempt to measure the effects of such deaths on the bird population. Hansen (1969) divided roads into categories using traffic density as a norm and, lastly, Brautigam (1978) discussed the seasonal distribution of road deaths.

Nevertheless, the Little Owl appears only occasionally in those samples, and for this reason the results of these observers are dubious for application to the species and to Spain. The purpose of this study was to establish the causes of road mortality of the Little Owl in Spain and to advance knowledge on non-natural mortality of this species.

MATERIALS AND METHODS

Data were compiled in a 3-yr period (1984-1986) in

Central Spain. A total of 418 collisions with cars in Spain were studied. Position, date of death and, when known, age of each owl casualty were recorded. Features of the road and the type of roadside cover were also recorded, including the presence or absence of illumination, the presence or absence of road margin vegetation and its features, and the type road.

Road margin vegetation was studied only in non-illuminated roads in an area of 20 m width from the road border and 10 m length on each side from the location of the carcass. Vegetation >3 m in height was considered as woodland. If no homogeneous vegetation was found, the presence of only 1 tree was deemed sufficient for classification as woodland. The other class of vegetation was shrub vegetation which was ≤3 m height.

In many cases no information was available on the distance from where a bird was found to the next curve in the road, and so, the types of roads have been classified by calculating the number of curves in 10 km of road. On this basis, three road classes resulted as follows: 1) roads with no more than 10 curves/10 km; 2) roads having between 10 and 25 curves/10 km; and 3) roads with >25 curves/10 km.

RESULTS

Of 418 total collisions recorded during the study, 40 were excluded due to insufficient data being available. Mortality caused by car collisions represents 82% of non-natural deaths in *Athene noctua*, although in some cases this value may be considerably higher. The remaining 18% were attributed as follows: shot (4.3%); caught in nest (3.1%); trapped (0.9%); preyed upon (3.5%); unknown (1.9%) and other causes (4.3%), including falling from nest, being waterlogged, cannibalism and starvation.

Results concerning the seasonal variation in mortality are given in Figure 1. The time of greatest mortality was recorded in summer. Between 1 August and 15 August we found 63.2% of the 378 deaths studied; 17.1% between 15 July and 31 July, and

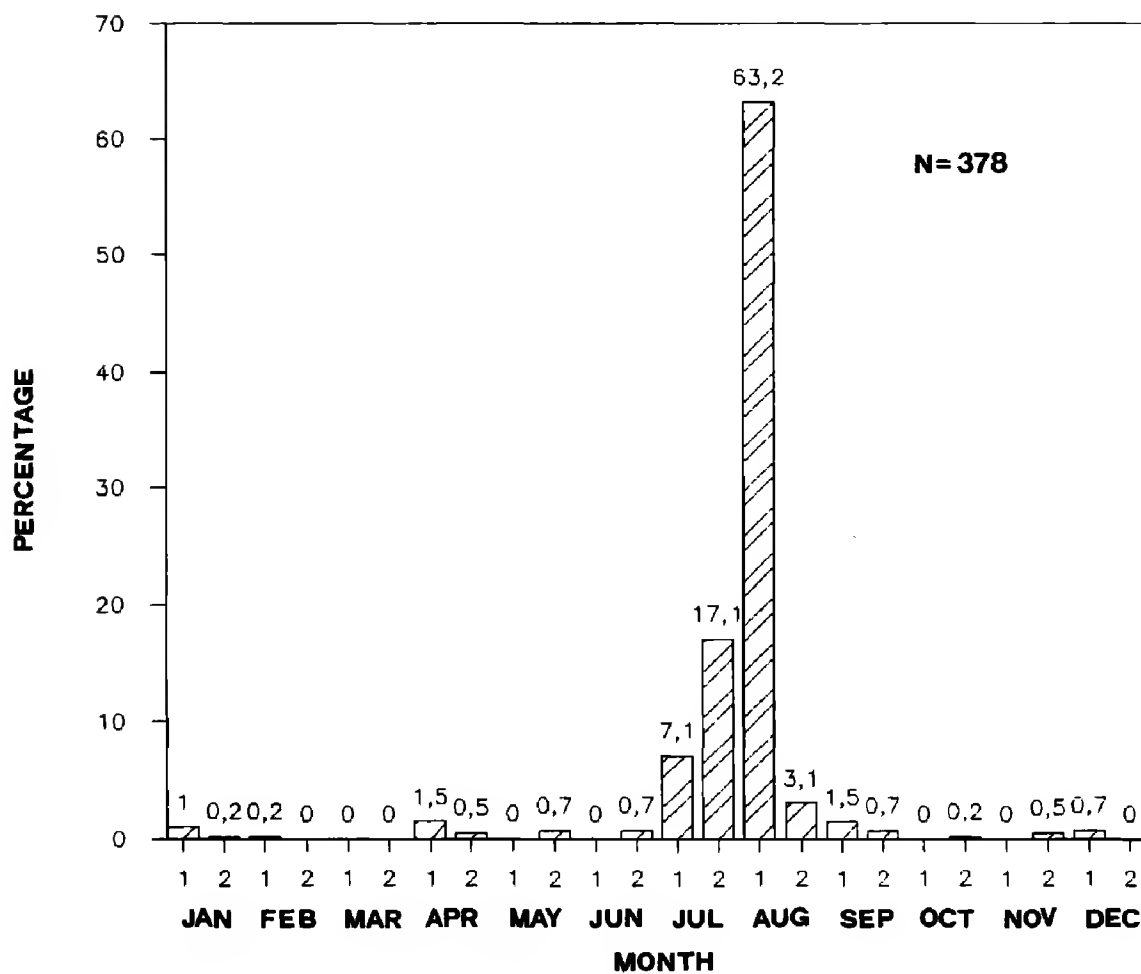


Figure 1. Histograms showing the pattern of seasonal mortality by half-month periods.

7.1% between 1 July and 15 July. During the remainder of the year (21 2-wk periods) were found the remaining 12.6% (47 deaths).

With respect to age of Little Owls found, among 353 (93.3%) found between 1 July and 1 November, only 25 (7.0%) were adults, the remainder being juvenile birds identified by their characteristic plumage.

All car collisions occurred during the night. On illuminated roads only 9 Little Owl deaths (2.3%, $N = 378$) were recorded, all of them being young owls; 369 (97.6%) were found on non-illuminated roads.

Power transmission or telephone lines parallel to roads were not associated with car collisions and are generally placed <20 m from the road.

Of the 369 deaths found on non-illuminated roads, in 75 cases (20.3%) there was woodland vegetation in the road margin area and in the remainder (294 cases, 79.6%) the vegetation was of the shrub type. We found 184 deaths (62.5%) occurred on roads with vegetation of no more than 0.5 m height and 110 deaths (37.4%) occurred on roads with a vegetation of 0.5–1 m height in road margins. On roads with a vegetation height of 1–3 m no deaths were found.

Often in the margin of several roads the two types

of vegetation defined were alternatively distributed in which case carcasses were found only in areas of shrub vegetation.

DISCUSSION

According to the available data, road casualties are the most important cause of non-natural mortality of the Little Owl in Spain. Nevertheless, it is possible that road deaths may have been over represented since birds killed on the road are more likely to be found than those killed in most other ways (Hodson and Snow 1965). In Europe deaths on roads are not as frequent but represent an important fraction of owls killed by human influence (Glue 1971; Weir 1971; Glue and Scott 1980; Exo and Hennes 1980).

Collisions with cars can be produced when bright lights at night cause temporary blindness of owls (Labisky 1960, *in litt.*) and as a result of owls swooping towards a moving light (Hodson 1962). Sutton (1927) suggested this as a cause of Screech Owls (*Otus asio*) being killed by cars. For these reasons and perhaps others, all road casualties occurred at night (M. Mañez, pers. comm.) and are also the main differences in road deaths between diurnal and nocturnal birds. Along illuminated roads, mortality

is less (only 2.3%), and possibly Little Owls are not blinded in illuminated areas or are so with less critical intensity.

Hansen (1969) suggested that bird behaviour determines whether a species is liable to be killed in traffic or not, and perhaps this can explain why the Little Owl is more frequently killed by cars than other owls. Road mortality presents a clear seasonal pattern. In the first half of August we found a very conspicuous increase in mortality (Fig. 1) producing 63.2% of the annual deaths in only 15 d approximately. Summer mortality has also been reported by Glue (1973, *in litt.*) and Exo and Hennes (1980). In our study, however, the summer peak occurred late in August and was not associated with stress of the breeding season as suggested by Exo and Hennes (1980) due to a greater proportion of young in our sample (92.9% between 1 July and 1 November), but to postfledging dispersion occurring during this time (Glue and Scott 1980). Glue and Scott (1980) found that between 1 July and 1 September 40% of young died, most of them on roads. Dunthorn and Errington (1964), Haas (1964), Hodson and Snow (1965) and Hansen (1969) have also reported an increase in road casualties during this time frame and note the influence of a greater proportion of inexperienced young on the observed increase.

The trend of the Little Owl to frequent open areas influences the relationship between number of deaths and roadside cover. Nevertheless, we think that, in this study, the influence is very small due to the small amount of open regions of the study area. The influence of road margin vegetation on casualties is a consequence of perch availability because owls are rarely killed while crossing roads. Vegetation of <1 m is classified as shrub and is not adequate for perching and causes Little Owls to use the pavement as a perch. Hodson (1962) established that much higher number of deaths occur opposite gaps and openings than along stretches of roadway with uniform border, because most birds are killed while attempting to fly from one side of the road to the other through these gaps (Dunthorn and Errington 1964).

The presence of trees in the proximity of a road (<20 m) was associated with decreased road mortality (20.3%). However, the most adequate vegetation, according to the information obtained is that between 1 and 3 m height and located at <20 m from the road and not woodland as found by Hodson (1962) for other birds. In many cases the perch was not a tree or a shrub but a wall or a barrier.

Table 1. Number and percentage of deaths of the Little Owl in Spain associated with various roadway conditions.

ROAD CONDITION	N	%
Road Characteristic		
Illuminated	9	2.3
Non-illuminated	369	97.6
Total	378	99.9
Roadside Cover		
Woodland	75	20.3
Shrub	294	79.6
Total	369	99.9
Shrub Height		
0.0–0.5 m	184	62.5
0.5–1.0 m	110	37.4
1.0–3.0 m	0	0
Total	294	99.9
Road Classification		
Class 1	32	8.4
Class 2	281	74.4
Class 3	65	17.1
Total	378	99.9

Speed and density of traffic have an important influence upon bird road casualties (Dunthorn and Errington 1964) and the greatest mortality is registered on roads where traffic is dense and fast moving (Hansen 1969). The number of casualties on Class 2 roads (Table 1) is higher than on those of Class 3 and Class 1. Nevertheless, the speed of traffic is the highest on Class 1 roads and is the lowest on Class 3. This may be explained by the fact that on Class 2 roads there are enough curves to prevent the owls from seeing cars far away, and also preventing cars from reaching high speed, while on Class 3 roads the speed should be low and on Class 1 roads cars are seen by the owls with time enough to leave the road.

Finally, as a practical measure to avoid car collisions of Little Owls, it is advisable to place trees or shrubs near roads, or if it is possible, 2 m height perches should be placed 5 m from the road border and 10 to 15 m apart.

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Raptor Protection and Research—Albemarle Farms of Charlottesville, Virginia, in conjunction with Virginia Polytechnic Institute and State University (VPISU) in Blacksburg, is establishing a preserve to be used as a training facility for interns in wildlife management at VPISU. Raptor research and education foundations, along with organizations concerned with the protection of hawks and other migratory birds are invited to make proposals and initiate discussions for cooperative efforts aimed at the development of further techniques for protecting predatory birds. For more information, contact **John Williamson, Albemarle Farms, Route 6, Box 69, Charlottesville, Virginia 22901 (804)293-3978 or Fred Garcia (212)557-0100.**

SHORT COMMUNICATIONS

NESTING OF *Falco tinnunculus* IN NATURAL SITES IN CANARY PINES ON EL HIERRO ISLAND*

JOSÉ CARRILLO, MANUEL NOGALES AND MANUEL PADRÓN

In Europe the reproductive behaviour of the Kestrel (*Falco tinnunculus*) is similar to that of other Falconidae: no nest building occurs although some individuals scrape the surface where their eggs will be laid (Cave 1968). According to Cramp and Simmons (1980), nesting occurs most frequently in trees, using old nests left by Corvidae (Dementiev et al. 1951), Columbidae (Labitte 1932), Picidae (Geroudet 1978), as well as by larger birds of prey, and even in those of arboreal mammals (i.e., *Sciurus vulgaris*) (Kuusela 1983).

The behavioural flexibility of the Kestrel is also shown in its utilization of a wide variety of nesting sites such as ledges on cliffs or building (Geroudet 1978), nest boxes (Cave 1968) and occasionally the ground (Balfour 1955). Use of such varied nest sites is probably one of the factors contributing to the species' success as the commonest of the diurnal birds of prey in most of the Palearctic and African regions (Cade 1982), including the Canary Islands.

The reproduction of the Kestrel in the Canary Islands has been discussed, though not in depth (Koenig 1890; Bannerman 1914; Carrillo and Trujillo in press). Moreover, studies on the nesting sites are scarce, and lack quantitative information (Bannerman 1963; Perez Padrón 1983), apart from the record of 17 nests on Tenerife (Martín 1987).

In the Canary Islands the Kestrel usually breeds in holes and on ledges on cliffs. Nesting in trees is occasional (Cabrera 1893; Polatzek 1908), though in the Eastern Islands nesting in palm trees seems to be a more frequent phenomenon (Meade-Waldo 1889; Bannerman 1963). Other sites where we have also found Kestrel clutches are in walls pertaining to houses and along roadsides, in holes of disused quarries, in old nests of domestic pigeons (*Columba* sp.) in rural buildings or earth slopes, and in nests of ravens (*Corvus corax*) on rocks, or in Canary Pines (*Pinus canariensis*).

Also, in El Hierro Island the Kestrel breeds normally (approximately 70-80% of cases) in ledges and holes on rocky walls. We have found, however, that on this island

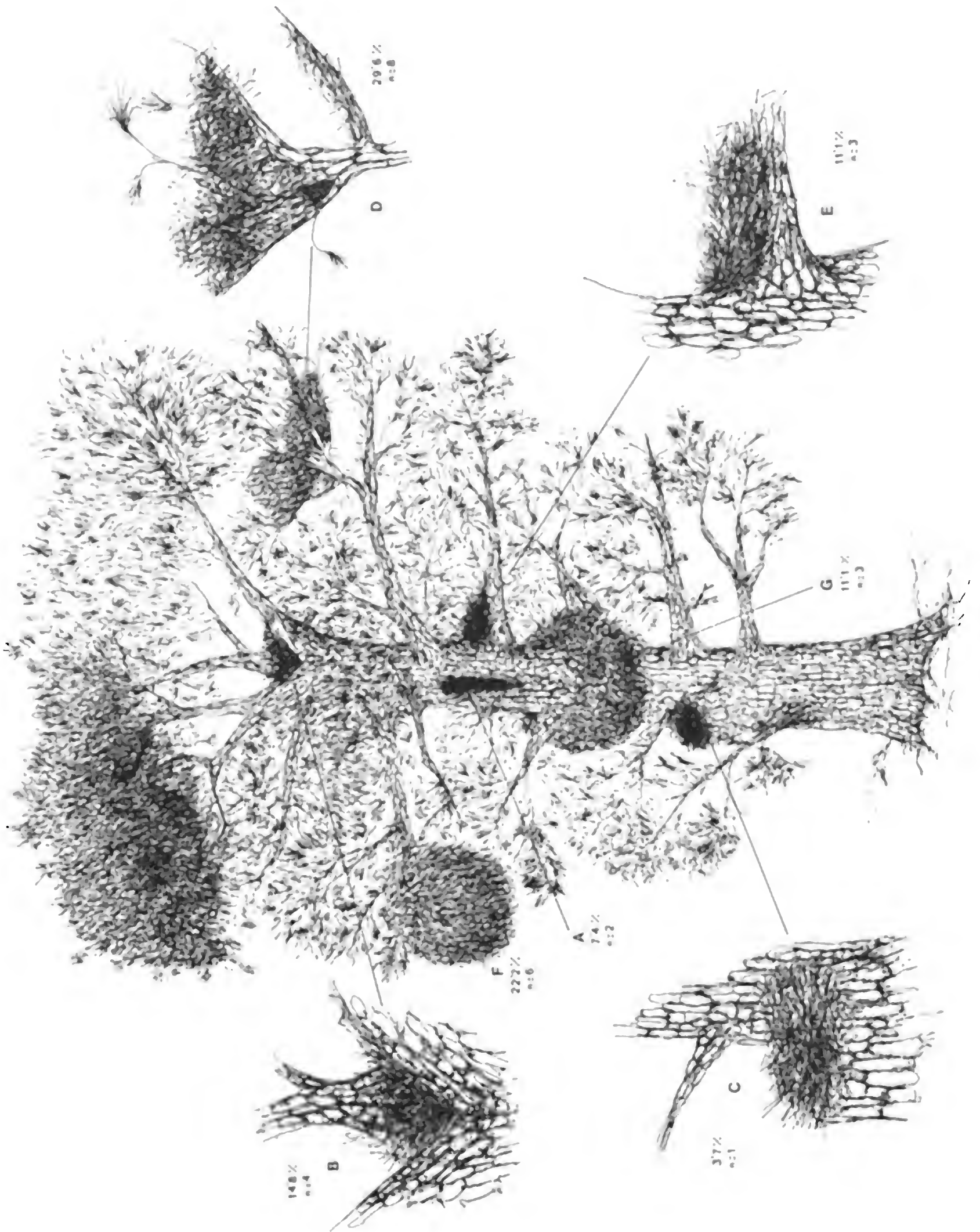
the Kestrel breeds in the forests of Canary Pines by laying its eggs on or in the masses of pine needles that accumulate naturally in various parts of mature pine trees. Pine forests on El Hierro Island are characterized by a fairly high density of trees and an almost total lack of undergrowth. Although the forests have been extensively modified by human activities, they contain a substantial number of mature trees, and these are used for nesting by kestrels. Nesting occurred both near the outer borders of the forest and in the interior, apparently without preference.

Our observations on El Hierro were carried out during the spring of 1987. The 27 nests that we studied in pine trees were classified according to 7 nest site types (Fig. 1), and distance to the tree trunk and height above ground were also measured. The most frequently utilized sites were the masses of dead pine needles near the ends of lateral branches (Fig. 1, type D). Such accumulations, once initiated, are well situated to catch falling needles from the upper parts of the tree, and thus often reach a large size. The malformations on the tips of the branches (type F), including both living and dead needles, form a more regular type of structure, but in our sample they were used a little less commonly than type D sites. These malformations are sometimes formed at the tops of the trees, and in one there was a small tunnel through which the Kestrel entered to breed. These large and compact foliage concentrations in the tree tops are somewhat comparable to the bulky nests of the Hamerkop (*Scopus umbretta*) in South Africa, which also has interior tunnels that are occasionally used by nesting kestrels (Steyn 1985). Both type D and type F sites are favourable for nesting, probably because the fragility of the branches is a deterrent to human interference which kestrels often suffer on the islands.

The remaining types of nest sites (types A, B, C, D, G) were associated with the trunk and less frequently used by the Kestrel. Accumulations of needles in such sites were usually smaller than those on the branches and may be more vulnerable to human interferences.

From a total of 27 nests surveyed the average height from the forest floor surface was 10.3 m (S.D. = 3.15; range = 3-17 m). This height was slightly greater to what Soler et al. (1983) exposed on kestrels nesting on old nests of the Carrion Crow (*Corvus corone*) on trees in Granada

* Presented at the IX Jornadas Ornitológicas Españolas (Madrid, December 1987).



(south of the Iberian Peninsula). The average distance from the nests to the tree trunks was 2.9 m (N = 13; S.D. = 2.19; range = 0.5–8 m), a distance similar to that described by Soler et al. (1983).

According to Newton (1979) the density of birds of prey is generally restricted by the availability of breeding sites or food. The high relief of El Hierro, the abundant food supply during the breeding season (Nogales, in prep.) and the versatile feeding habits of the Kestrel on El Hierro Island (Carrillo et al., in press) are all factors that combine to ensure the success of this species on the island. This success probably ensures the saturation of all trophically optimal areas that also contain breeding sites in rocky places (these are in the area of El Pinar). Thus, the use of pine trees for nesting probably increases the overall breeding density of the species on El Hierro. Similar effects have been produced artificially by providing nest boxes (Cave 1968) and artificial nests of Corvidae (Village 1983). It is noteworthy, however, that the use of natural nesting sites in pine trees has not been recorded up to now in any of the other islands in the Canary archipelago.

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Figure 1. Diagram showing the different types of nest sites used by *Falco tinnunculus* in *Pinus canariensis* on El Hierro, with number of cases and percentages frequency of each type. Types of nest sites shown in the figure are A, nest on trunk hole; B, nest on the trunk ending fork; C, nest on the platform of a main trunk; D, nest on needle accumulation of lateral branches; E, nest on stretched base axillary branch; F, nest on malformation of terminal branch; G, nest on trunk malformation.

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RED FOX PREDATION ON FLEDGLING EGYPTIAN VULTURES

JOSÉ ANTONIO DONÁZAR AND OLGA CEBALLOS

Reports of predation on nestlings of Old World vultures are rare (see Brown, L. and D. Amadon, Eagles, hawks and falcons of the world. Feltham, Middlesex, 1968; Mundy, P., The comparative biology of Southern African Vultures. Vulture Study Group, Johannesburg, 1982). The Egyptian Vulture (*Neophron percnopterus*) nests frequently in narrow cliff cavities where the possibility of mammalian predation is low (Ceballos, O. and J. Donazar, *Munibe*, in press). Only one reference (Rodríguez-Jiménez and Balcells, *P. Cent. Pir. Biol. Exp.* 2:159–187, 1968) reports the capture of a nestling in an accessible nest by a mammalian predator of unknown species. Killing of fledglings by predators are not known. In this note we report an Egyptian Vulture–Red Fox (*Vulpes vulpes*) incident and two cases of fledgling predation by Red Foxes. The research was done in Bardenas Reales-Navarra (northern Spain).

On 11 August 1987, while observing an Egyptian Vulture nest with 2 fledged chicks, we saw a fox approaching the nest along the cliff edge close to where the younger fledgling (81 d old) was perched. Immediately, the female vulture placed herself between the fox and the chick and displayed much nervous excitement. A few seconds after, the fox moved away. Meanwhile, the nestling, very frightened, flew hurriedly to a nearby ravine.

On 28 August 1987, the remains of an 83 d old fledgling were found under the nest-cliff. On the ground there was a great pool of blood and plucked feathers with cut quills. Fox tracks were very common, and a den was located 150 m away from the nest.

On 30 August 1987, a fledgling provided with a radio transmitter flew from the nest at sunset and did not return, roosting on the ground under the nest-cliff. Next morning the young had disappeared. It was 82 d old and its flights

were still very short, no more than 50 m around the nest. Searching with receivers we found the radio transmitter together with the nestling remains at the burrow entrance of a fox den, which was 650 m away from the nest. The remains, only wings and body, had signs of carnivore feeding.

It is difficult to evaluate the real importance of fox predation in our study area. Of 7 fledglings provided with radio transmitters, 1 was killed (last reported case). The chance for predation would be enhanced by foxes wandering around vulture nests searching for food remains. Predation seems more probable during the days following the initial flight, which occurs when the chick is around 75 d old. In this period, fledglings are not able to return to the nest at night (unpubl. obs.) and are thus being exposed to possible mammalian predation.

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RED-TAILED HAWK "CAPTURED" BY A STRIPED WHIP SNAKE

CLYDE L. PRITCHETT AND JAMES M. ALFONZO

During the last 50 yrs, there have been many reports of birds being preyed upon by snakes (Wythe 1933; Austin et al. 1972; Blem 1979). Most reports are of moderate to large snakes preying upon small birds (Ervin and Rose 1973), nestlings (Jackson 1970; Cink 1977) or eggs (Best 1974; 1977), or occasional reports of birds as large as California Quail (*Callipepla californica*) killed by "rattlesnakes" (Jewett 1939) and "gopher snakes" (Wythe 1933). Fendley (1980) reported a rat snake consumed several Hooded Merganser (*Lophodytes cucullatus*) eggs in a nest box which also contained a dead female merganser. Whitfield (1934) observed a gopher snake capture a roosting Western Screech Owl (*Otus kennicottii*). However, we could not find a reference of a snake as small as a Desert Whip Snake (*Masticophis t. taeniatus*) capturing a bird as large as an adult Red-tailed Hawk (*Buteo jamaicensis*).

On 15 August 1984 a near-dead Red-tailed Hawk was reported to officials at Fish Springs National Wildlife Refuge in western Utah. The hawk was found encoiled by a desert striped whip snake ca. 1 m in length. The snake was wrapped twice around the hawk's body underneath its wings, and once completely around the hawk's neck rendering it completely incapacitated. After removing the snake from the bird, a careful examination revealed that the hawk had no serious injuries, other than appearing to be in shock. The bird was released at the refuge and after a recovery period of 35 min flew away.

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FIRST RECORD OF THE MISSISSIPPI KITE FOR BOLIVIA

DENICE SHAW AND TERRY C. MAXWELL

An adult male Mississippi Kite (*Ictinia mississippiensis*) was banded by DS on 6 July 1984 (USFWS #0745-69057) at a nest in San Angelo, Tom Green Co., Texas. The nest was located in a Mulberry tree (*Morus microphylla*) near a home in a residential area. On 11 November 1986, the kite was shot at San Miguel de Velasco (16°4'S, 61°0'W) Department of Santa Cruz, Bolivia. San Miguel de Velasco is in a region of semihumid lowland forest in eastern Bolivia.

The migratory and wintering range of the Mississippi Kite is poorly understood (AOU 1983) but is known to include portions of Central and South America. A band recovery has been reported from Guatemala (Parker 1977) and the species has been collected in Paraguay (Blake 1949) and northern Argentina (Eisenmann 1963; Olrog 1968). The San Miguel de Velasco record is the first confirmation of the species from Bolivia (J. V. Remsen, Jr., pers. comm.; Meyer de Schauensee 1966, 1970; Blake 1977; Mayr and Cottrell 1979) and the first Mississippi Kite band recovery from South America (D. Bystrak, pers. comm.).

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NOCTURNAL FLIGHT BY TURKEY VULTURES (*Cathartes aura*) IN SOUTHCENTRAL TEXAS

STEPHEN P. TABOR AND CHRIS T. MCALLISTER

Large flocks of Turkey Vultures (*Cathartes aura*) typically gather before nightfall on a single open roost after searching for carrion during the day (Chase 1982). L. Griscom (in Bent 1937) noted that "the vulture is a late riser, seldom being on the wing until an hour after sunrise." The following account describes an episode of nocturnal flight by Turkey Vultures.

On 28 September 1985 at 2200 H (CDT) in Real County, Texas, 18.6 km NE of Leakey (elevation 625 m) along Silver Creek, a tributary of the East Frio River, we observed 12 Turkey Vultures gliding, soaring and spiraling in characteristic fashion at a height of ca 61 m. Meteorological conditions were: 27°C, full moon, slightly cloudy-overcast sky, intermittent, misty rain, ground wind speed SE 15–20 mph. The birds remained above us for 15–20 min before flying off in a northwesterly direction. As the vultures flew to the NW, we climbed to the top of an adjacent ridge and, with the aid of binoculars, watched the birds fly completely out of visual range (visual conditions were excellent due to the full moon) and away from the river and its tributaries.

The above observation may represent an unprovoked case of nocturnal flying by Turkey Vultures. On the other hand, it is possible that the birds could have been disturbed from a riverside roost and were simply taking the prevailing SE winds away to the NW. However, we believe this is an unlikely explanation due to the following reasons: Prior to dusk, we observed some Turkey Vultures lighting in trees on a roost situated above the river. This roost site was located on the edge of a sheer bluff overlooking the river valley below. It is unlikely that the birds were disturbed by human or other intrusion in such an inaccessible location. The following morning at dawn, we again observed the birds at a roost (ca 2 km from our original observation post). Because the birds were not marked or followed through the night continually, we can only assume that they are the same ones we observed flying at night, as we are quite familiar with the study site and surrounding area.

Alternatively, the vultures may have been flying at night to exploit thermals, the sufficient lighting from the full moon or other favorable environmental factors. As pointed out by Kendeigh (1934) and reiterated by Moore (1945), additional information needs to be obtained about the night habits of birds.

Although the time of year and location are appropriate, this event was probably not a case of nocturnal migration (K. A. Arnold, pers. comm.). Neither the related Black Vulture (*Coragyps atratus*) nor other New World vultures, are known to migrate at night (Eisenmann 1963). Oberholser (1974) reported that Turkey Vulture autumnal migratory trips in Texas are carried out entirely diurnally, over a period of 2 wks. In California, Turkey Vultures migrate for a period lasting over 3 mos (96–111 d) from September through November (Binford 1979). However, in Arkansas, Turkey Vultures are still present through mid-December (McAllister, unpubl. observ.) and may not represent birds migrating in from other localities.

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INCIDENCE OF BLACK-PHASE PLUMAGE IN FERRUGINOUS HAWKS NESTING IN CENTRAL NORTH DAKOTA

PAUL M. KONRAD AND DAVID S. GILMER

Distinct plumage phases for the Ferruginous Hawk (*Buteo regalis*) include normal, black and red (Brown and Amadon 1968). During a three-yr (1977-79) study of nesting Ferruginous Hawks in central North Dakota (Gilmer and Stewart 1983), we observed only normal and black-phase plumage in adults and in nestlings with well-developed plumage.

A total of 12 (1.1%) of 1050 adult Ferruginous Hawks we observed at nest sites had black-phase plumage. The number of nest sites occupied by black-phase adults was five of 200 (3%) in 1977, five of 184 (2.7%) in 1978 and two of 245 (0.8%) in 1979 (Table 1). All black-phase adults were paired with normal-colored mates, and mixed pairings produced broods that varied from all black to all normal. Sixteen (47%) of 34 mixed-pair nestlings had black-phase plumage. In addition one black nestling was produced by a normal pair. Only 17 (1.2%) of 1407 nestlings we observed had black-phase plumage.

Observations of one mixed pair and its broods are especially noteworthy. A pair consisting of a black-phase

female and a normal-colored male was observed for five consecutive yrs (1977-81) at the same nest site. During this period, five broods were produced which contained zero of four, one of four, three of three, one of two, and two of four black-phase nestlings.

Our data indicate that, compared with most other regions, adult black-phase Ferruginous Hawks are relatively rare breeders in central North Dakota. The incidence of Ferruginous Hawks with black plumage reported in other regions was 9.4% in southeastern Alberta (Schmutz and Schmutz 1981), 5.7% in southeastern Washington (Fitzner et al. 1977), about 4% in southern Idaho (Howard 1975; Thurow et al. 1980), 3% in northeastern Colorado (Olen-dorff 1973) and <1% in northcentral South Dakota (Lokemoen and Duebbert 1976).

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Table 1. Plumage characteristics of adults and nestlings at nest sites occupied by black color phase Ferruginous Hawks in central North Dakota.

YEAR	NO. BLACK ADULTS	NO. BLACK NESTLINGS	NO. NORMAL NESTLINGS
1977	1	2	1
	1	2	3
	0 ^a	1	2
	1	0	4
	1	0	1
	1	— ^b	— ^b
1978	1	1	2
	1	1	2
	1	1	3
	1	3	1
	1	— ^b	— ^b
1979	1	3	0
	1	3	1
Total	12	17	20

^a Only normal-phase adults observed at nest site.

^b Nesting attempt failed. No brood information.

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GREAT HORNED OWL OBSERVED "HAWKING" INSECTS

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On 20 October 1986 at 1848 H we observed a Great Horned Owl (*Bubo virginianus*) perched atop one of many snags in a flooded bog alongside a forestry fire road of the Sandilands Provincial Forest, Manitoba, Canada. A second Great Horned Owl was perched approximately 30 m distant. The "pair" maintained vocal contact intermittently, which suggested that the second owl was a male, having a lower pitched call (Austing, G. R. and J. B. Holt. The world of the Great Horned Owl. Lippincott Co., 1966).

The male made several short flights of varying heights (one to four m) over the bog and returned to the same perch or one nearby. These occurred during the first 30 of the 45 min we observed the owls. Using a 45x spotting scope we observed the male owl consuming large beetle-like insects while perched. The beetles were most likely *Dytiscus* sp. which were observed to emerge from a ditch adjacent to the fire road with an audible "plop," and the hum of their wings could be heard up to 5 m away. The male caught at least five beetles in his bill during observed "hawking" flights, but the female was not observed to do so. However, at 1918 H both birds landed on the fire road and consumed live beetles. At 1933 H there was insufficient light to continue observations.

Our observed "insect hawking" provides further evidence of the opportunistic feeding behavior of this generalist owl. Remains of at least four genera of beetles, including *Dytiscus* and other invertebrates, have been found in Great Horned Owl pellets (Hamerstrom and Mattson,

Am. Midl. Nat. 22(3):700-702, 1939; Errington et al., *Iowa Agric. Exp. Stn. Res. Bull.* 277:758-850, 1940; Bent, A. C., Life histories of North American birds of prey, Part II. U.S. Nat. Mus. Bull. 162, Washington, DC. 1961). Errington et al. (1940) could not conclude if insects were eaten directly by owls or consumed along with the stomach contents of other prey. Where insects were undoubtedly owl prey they are considered conspicuous crawlers, carrion feeders or predators, etc., attracted to carcass fragments about feeding places (Errington et al. 1940). Errington et al. (1940) also explained insect fragments in pellets as reflecting the partial dependence of inexperienced young owls upon types of prey that are easy to catch, including invertebrates. Our observation provides evidence that direct captures of flying insects may explain the occurrence of some of the insect matter found in Great Horned Owl pellets. Insect foraging would be more economical energetically for smaller sized males with greater aerial maneuverability (Mueller, H. C., *Wilson Bull.* 98(3):387-406, 1986), although both sexes were observed consuming insects on the ground.

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DISSERTATION ABSTRACTS

WINTER TERRITORIALITY AND PREDATION ECOLOGY OF AMERICAN KESTRELS (*Falco sparverius*) IN SOUTHCENTRAL FLORIDA

Migrant American Kestrels (*Falco sparverius*) wintering in southcentral Florida showed marked segregation of sexes due to differential habitat use. Females typically occupied territories in pastures, mowed hayfields and recently planted citrus groves. Males were observed primarily along the margins of slash pine (*Pinus elliotii*) woodlots, eucalyptus (*Eucalyptus* spp.) plantations and cypress (*Taxodium distichum*) sloughs, and within scrubby flatwoods, mature citrus groves and residential areas. Although most males were found in less open habitats, both sexes foraged in open patches of the same type of hunting substrate, grasses or weedy forbs <25 cm in height (herein, suitable hunting substrate). Pellet analysis revealed that both sexes fed exclusively on arthropods. Male and female territories differed in the proportion of area covered by suitable hunting substrate (median values of 0.30 and 0.60, respectively). Additionally, more numerous and larger trees or shrubs characteristic of male territories formed a visual barrier such that a smaller proportion of the available hunting substrate was visible from any one perch. Differential prey availability was evident from differences between male and female activity budgets. Males were similar to females in capture success, once a prey item was detected, and in the total number of prey items captured per day. However, most males were constrained to forage actively throughout the entire day while females were able to satisfy most of their daily food requirements earlier in the day and thus had a substantial amount of time remaining to allot toward nonforaging activities. In addition males were more likely to attack novel prey items and experienced a greater loss of body mass during a period when ambient temp <0°C reduced arthropod prey availability. The evidence supports the hypothesis that most female territories were of superior foraging quality.

Kestrels wintering in the study area were captured in order to collect their pellets. Dry mass of pellets was used as an index of accumulated mass of prey consumed between dawn, when pellets representing prey consumed the previous day had been regurgitated, and time of capture. Kestrels holding territories of superior foraging quality (those with >50% coverage by suitable hunting substrate) consumed a greater prey mass during morning than did kestrels inhabiting territories of lesser foraging quality. No difference was found between territories of high and low foraging quality in terms of the total prey mass consumed by the end of the day. Most territories of high foraging quality were occupied by females, but within habitats of either high or low foraging quality, the temporal patterns of prey mass accumulation by males and females were similar. These results are consistent with observed kestrel activity budgets, and lend further support to the hypothesis that the temporal differences in foraging behavior between males and females were due to differences in the foraging quality of their territories; there was no evidence of any inherent sex-specific differences in predatory behavior. The foraging quality of kestrel winter territories in the study area was a function of the extent to which locations were covered by patches of a particular foraging substrate.

The establishment of 240 winter territories by kestrels on a 293-km census route in the study area was observed during autumn 1985. Most females arrived before males. Analysis of 18 367 USFWS records of kestrels banded during autumn in eastern North America revealed that immatures of both sexes and adult females preceded adult males in migration, thus skewing the sex ratio of early arrivals toward females. In the south Florida study area territorial kestrels occupied habitats in decreasing order of foraging quality, as measured by percent cover of suitable hunting substrate and by woody canopy cover (which was negatively correlated with suitable hunting substrate and obstructed the view of a hunting kestrel). Although most females arrived first, early-arriving males also occupied habitats of superior foraging quality and were as successful as females in defending territories against same-sex and opposite-sex kestrels as space in high quality habitats became limited. There was no evidence that a kestrel of either sex, once established, was ever displaced by a later-arriving conspecific. Results of experiments in which free-flying intruder kestrels were released into defended territories suggest that males, which typically held territories with smaller surpluses of prey resources and therefore stood to suffer more from an intrusion by a food competitor, defended winter territories more tenaciously than did females. Because there was no evidence of male submissiveness on wintering grounds, a female dominance hypothesis is not a plausible explanation for sexual segregation by habitat in wintering kestrels. Each kestrel's arrival date was apparently the principal determinant of which habitats were still available for occupancy, foraging quality was negatively correlated with arrival date for both adult males and for females and immatures. Delayed molt in adult males, associated with differential sex roles on breeding grounds, may result in delayed migratory departure and thus late arrival onto wintering grounds.

An examination of relative importance of three prey characteristics, size, color and activity, with respect to prey selection by wild kestrels wintering in the study area was conducted using House Mouse (*Mus musculus*) as prey. Results suggest that prey activity was more important than either prey size or prey coat color with respect to selection

by kestrels. Active prey were selected more often apparently because they were more easily detected. Although conspicuous coloration did not appear to enhance detectability of prey in the present study, conspicuousness may be important in prey detection under certain environmental conditions. **Smallwood, John A. 1987. Ph.D. Dissertation. Department of Zoology, The Ohio State University, Columbus, OH 43210, U.S.A.**

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THESIS ABSTRACTS

BEHAVIORAL DEVELOPMENT OF YOUNG GOLDEN EAGLES AT A HACK SITE: A COMPARISON TO WILD EAGLETS

A project was begun in 1981 to establish a breeding population of Golden Eagles (*Aquila chrysaetos*) in the southern Appalachians by hacking captive produced young near the Shining Rock Wilderness Area in Haywood County, North Carolina. The study attempted to determine behavioral differences between wild and hacked eaglets.

Performance levels of 35 "key" behaviors were quantified and entered into an electronic data recorder, allowing data to be analyzed by computer. Behavioral performance levels of hacked eaglets were statistically compared to wild eaglets (Ellis 1973) by *t*-Tests.

Some behavioral differences seem to be due to the effect of hacking (e.g., lower bout numbers for postures and higher Flap and Spread-hold performances), while other differences seem to be caused by abnormal physical development (e.g., slow transition from Lie to Stand and higher performance levels of Preening). Alternate hacking methods and uses of behaviors as indicators of proper development are discussed. **Roberts, Dan Allan, 1985. M.Sc. Thesis (under the direction of Dr. Richard D. Brown), Department of Biology, The University of North Carolina at Charlotte, Charlotte, NC 28216.**

NEWS AND REVIEWS

Chevron Conservation Awards Program and 1988 Honorees. The Conservation Awards Program is the oldest privately-sponsored program of its kind in the United States. Founded in 1954 by Ed Zern, the program has been sponsored by Chevron since 1986. Anyone in the United States or Canada can nominate an individual or a nonprofit organization for a Conservation Award. An independent committee of distinguished conservationists, representing a variety of conservation activities in North America, evaluates the nominees. From this list, the panel and Ed Zern select ten volunteer citizens, ten professionals and five nonprofit organizations. Honorees receive \$1000 and a bronze plaque in honor of their conservation achievements.

Among the 1988 honorees were **Gerald R. Craig** of the Colorado Division of Wildlife Resources for his work in the Peregrine Falcon recovery program in the western United States, and **Hope Carpenter** who is director of the Pennsylvania Raptor Association and has led a 20-year campaign to gain public awareness and acceptance of avian wildlife.

For further information on nominating procedures for 1989 contact **W. C. Roper, Corporate Program Director, Chevron Conservation Awards, P.O. Box 7753, San Francisco, CA 94120-7753; Telephone (415) 894-2457.**

1989 Annual Meeting of The Raptor Research Foundation, Inc.—A joint meeting of The Raptor Research Foundation, Inc., and the ICBP World Working Group of Birds of Prey will take place 8–14 October 1989 at the Hotel Mocambo in Veracruz City, Veracruz, Mexico. Approximate costs will be \$420.00 U.S. for single and \$300.00 U.S. for double occupancy, including breakfast and dinner. Major themes of the joint meeting will be Biology and Conservation of Tropical Raptors. Mario A. Ramos is Chairman of the Local Committee. All individuals interested to attend should write to **Mr. Romeo Domínguez Barradas, Local Arrangement Committee, RRF/WWGBP Meeting INIREB, P.O. Box 63, Xalapa, Veracruz, 91000 MEXICO.** Those requesting additional information will receive the formal meeting announcement and the call for papers.

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