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DIETS OF BREEDING PEREGRINE AND LANNER FALCONS IN SOUTH AFRICA

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ABSTRACT.—The diets of breeding Peregrine (*Falco peregrinus*) and Lanner (*F. biarmicus*) Falcons in South Africa were determined from the analysis of prey remains collected at nest sites and through direct observations to determine the regional variation in Peregrine Falcon prey and to measure diet overlap, and the potential for competition between Peregrine Falcons and sympatric congeners. Direct observations suggested that remains under-sampled small prey by about 10% and over-sampled large prey by about 8%. Peregrine and Lanner Falcons preyed mostly on birds. Pigeons and *Streptopelia* doves comprised the bulk (38–66% by frequency; 68–85% by mass) of the Peregrine Falcon prey in each of three study areas. Columbids were supplemented by starlings (mostly European Starling [*Sturnus vulgaris*]) on the Cape Peninsula, sandgrouse (*Pterocles* spp.) and swifts (*Apus* spp.) on the Orange River, and mousebirds (*Colius* spp.) in the Soutpansberg. Cape Peninsula Peregrine Falcons had the least diverse diet, the narrowest feeding niche and they took the largest proportion of juvenile birds. Peregrine Falcons on the Orange River had the broadest feeding niche and preyed mainly on 'commuter' species rather than sedentary residents. Lanner Falcons in the Soutpansberg took mainly terrestrial or cursorial species, particularly young chickens (*Gallus gallus,* 40%; 37%) and charadriids, but columbids were also important. The diets of sympatric Peregrine and Lanner Falcons overlapped by about 35%. Peregrines Falcons concentrated their foraging on woodland and cliff-dwelling prey, while Lanner Falcons took mainly open-country species. Close-neighboring pairs of congeners did not obviously affect the food-niche parameters of either species suggesting that they were not actively competing for food.

KEY WORDS: *Peregrine Falcon*; Falco peregrinus; *Lanner Falcon*; Falco biarmicus; *diet*; *niche dimensions*; *competition.*

Dieta de *Falco peregrinus* y *Falco biarmicus* en reproducción en Suráfrica

RESUMEN.—Las dietas de *Falco peregrinus* y *Falco biarmicus* en reproducción en Suráfrica fueron determinadas a partir del análisis de restos de presas recolectados en los sitios de anidación y a través de observaciones directas para determinar la variación regional en las presas de halcón peregrino, medir su coincidencia y la competencia potencial entre halcones peregrinos y sus congéneres simpátricos. Las observaciones directas sugirieron que las presas pequeñas fueron subvaloradas en un 10% y que las presas grandes fueron sobrevaloradas en un 8%. Los halcones peregrinos y lanarios se alimentaron mas que todo de aves. Palomas y otras aves del género *Streptopelia* representaron la mayoría (38–66% de la frecuencia; 68–85% de la biomasa) de las presas de los halcones peregrinos en cada una de las tres áreas de estudio. Las Columbiformes fueron suplementadas por *Sturnus vulgaris* en la Península del Cabo, *Pterocles* spp. y *Apus* spp. en el Río Orange y *Colius* spp. en el Soutpansberg. Los halcones peregrinos de la Península del Cabo tuvieron la dieta menos diversa y el nicho alimenticio más restringido cazando aves juveniles. Los halcones peregrinos del Río Orange tuvieron el nicho alimenticio más amplio y depredaron en "especies pasajeras" contrario a las sedentarias. Los halcones lanarios en el Soutpansberg se alimentaron de especies terrestres particularmente de pollos. (*Gallus gallus,* 40%; 37%) y Charadriformes, las Columbiformes fueron también importantes. Las dietas de los halcones peregrinos y lanarios simpátricos coincidió en un 35%. Los halcones peregrinos concetraron su forrajeo en presas de bosques y riscos mientras que los halcones lanarios simpátricos coincidió en un 35%. Los halcones peregrinos concentraron su forrajeo en presas de bosques y riscos, mientras que los halcones lanarios en presas de espacios abiertos. La cercania de parejas de congéneres obviamente no afectó los parámetros del nicho alimenticio de ninguna de las dos especies lo que sugiere que estas dos especies no estan compitiendo por comida.

[Traducción de César Márquez]

Food habits of the Peregrine Falcon (*Falco peregrinus*) have been described for arctic and temperate regions (Mearns 1983, Hunter et al. 1988, Ratcliffe 1993, Rosenfield et al. 1995), and for southwestern Australia (Pruett-Jones et al. 1981, Marchant and Higgins 1993). However, in the tropics, the diet is poorly known and data for African populations are limited (Mendelsohn 1988). The only studies of Lanner Falcon (*F. biarmicus*) diets have been in the northern periphery of its range in southern Europe, eastern Sahara, and Israel (Massa et al. 1991, Yosef 1991, Goodman and Haynes 1992). Although Peregrine Falcons share many parts of their distribution with other large falcons having similar resource needs (Cade 1982), few studies have compared Peregrine Falcon diets with those of sympatric congeners (Cade 1960, Porter and White 1973). This paper describes the diets of breeding Peregrine and Lanner Falcons in South Africa, the type and diversity of prey taken by Peregrine Falcons in different environments, defines the feeding niches of the two species in an area of sympatry and assesses the potential for competition between these two congeners in terms of diet overlap.

METHODS

We conducted our study at sites in three areas of South Africa. Sixteen pairs of Peregrine Falcons were studied on the Cape Peninsula, Western Cape Province (34°10′S, 18°25′E) from 1989–95. This area had both inland and coastal nest sites dispersed in a mosaic of urban, forest, and heathland habitats. Altitude varied from 0–1100 m and the climate was temperate with locally variable winter rainfall (400–2000 mm per year). Seven pairs of Peregrine Falcons were also monitored annually from 1989–95 on the lower Orange River, Northern Cape Province (28°30′S, 17°00′–20°40′E). This is an arid, hilly to mountainous area, sparsely vegetated except for narrow strips of riparian bush or irrigated croplands along the river banks. Altitude varied from 30–700 m and the climate was hot and dry (mean annual rainfall 60–130 mm). Prey remains were collected at seven Peregrine Falcon nest sites in the Soutpansberg range, Northern Province (23°00′S, 29°40′E) from 1988–95, and the diet of these birds was compared with that of a sympatric population of nine pairs of Lanner Falcons over a 3-yr period from 1991–93. Evergreen forest and moist woodland occurred along the eastern foot of the Soutpansberg escarpment, with dry thornveld in the west and grassland with patches of scrub forest and protea woodland along the summit of the mountains (Tarboton 1990). Altitude ranged from 900–1700 m. There was low to moderate summer rainfall (400–1000 mm per year), increasing on a gradient from northwest to southeast, and temperatures are mild to warm.

Prey remains were collected from falcon nest ledges and from below roost sites and feeding perches. Uneaten remains, regurgitated pellets and plucked feathers were used in combination to minimize bias in diet analyses (Simmons et al. 1991, Oro and Tella 1995). Collections were made from just after egg laying to soon after fledging. The frequency of collections varied between sites, years, and areas (Table 1). Care was taken to remove all material on each collection to prevent duplication in subsequent samples. Pellets were broken up with tweezers and individual bone remnants were separated from the feather matrix.

All avian osteological material was identified using comparative skeletons in the South African Museum and additional material loaned from the Transvaal Museum, Pretoria and the National Museum, Bloemfontein. Individual body parts were separated according to taxon and recorded as the number of identified specimens (NISP). The minimum number of individuals (MNI) was calculated from the most common body part among the identified specimens, after accounting for paired elements (Klein and Cruz-Uribe 1984). Incompletely ossified bones were considered to be those of juveniles. Mammal remains were identified according to cranio-dental characteristics.

Bird and mammal remains were identified to the lowest possible taxonomic level. All prey were assigned to a size class based on bone size for unidentified prey and on body mass data from the literature (Brown et al. 1982, Smithers 1983, Maclean 1993) when prey were identified to at least the family level. Size classes were small (up to sparrow size, average about 20 g), small to medium (starling size, average about 60 g), medium (dove size, average about 130 g), medium-large (large dove size, average about 220 g), large (pigeon size and larger, average about 350 g), and very large (francolin size and larger, average about 600 g). In biomass calculations, unidentified prey were given these average mass values. Mean body mass values from the literature were used for prey identified to species. Prey identified only to higher taxonomic levels were assigned mass estimates based on published weights of similar or related forms.

Arthropod, amphibian and reptile remains were identified at a gross level only. A small number of nonavian remains were considered to be unlikely prey of falcons, particularly Peregrine Falcons, on the basis of size or habit. For example, observations suggest that African Peregrine Falcons hunt only flying prey (Hustler 1983, Tarboton 1984) and, therefore, are not likely to take terrestrial mammals and reptiles. These taxa (Appendix 1) were excluded from the analyses. Some relatively complete, easily identifiable prey were identified in the field and discarded. These were not included in the data and, to avoid duplication, only contributed to the total number of identified prey where fewer individuals of the relevant taxon were subsequently identified from other remains in the corresponding collection.

Pluckings were identified using study skins in the

Table 1. Samples of prey remains collected each year at falcon nest sites in three areas of South Africa. NISP denotes the number of identified specimens in the sample and MNI denotes the number of prey individuals identified. The MNI totals are the sum of prey individuals identified from skeletal remains, pluckings and remains identified *in situ* and discarded. Remains collected from consecutive years were pooled where sample sizes were small.

Year	Number Collections	Number Sites	NISP	MNI			
				Skeletal	Pluckings	Discarded	Total
Cape Peninsula Peregrine Falcons							
1989	8	1	318	37	3	22	62
1990	11	4	608	83	6	8	97
1991	7	2	187	33	8	0	41
1992	11	5	412	65	6	1	72
1993	10	5	46	63	10	1	74
1994	22	7	417	88	30	0	118
1995	7	4	161	44	4	1	49
Overall	76	10	2649	413	67	33	513
Orange River Peregrine Falcons							
1989–90	7	5	680	102	10	0	112
1991–92	4	4	410	72	8	1	81
1993–95	4	2	333	48	7	0	55
Overall	15	7	1423	222	25	1	248
Soutpansberg Peregrine Falcons							
1988–90	5	4	245	36	6	4	46
1991	13	6	719	113	8	0	121
1992	13	5	378	89	5	0	94
1993	14	4	585	93	10	0	103
1994–95	4	3	225	41	2	0	43
Overall	49	7	2152	372	31	4	407
Soutpansberg Lanner Falcons							
1991	14	9	178	65	5	0	70
1992	15	7	302	62	3	0	65
1993	10	7	188	38	0	1	39
Overall	39	9	668	165	8	1	174

South African Museum. No attempt was made to determine the number of individuals represented by the sum of pluckings of a particular species collected in each sample. To prevent duplication in these samples, species identified from feather remains contributed one individual to the total for a collection, but only when the relevant taxon was not recorded in the skeletal remains. Juveniles were identified from plumage characteristics where these differed from adult birds, and from the predominance of sheathed or incompletely grown tail or flight feathers, which indicated that nestling or recently fledged individuals had been taken.

Some dietary data were obtained from field observations. These were used to determine bias in the analyses of prey remains (Collopy 1983, Rosenberg and Cooper 1990). Nearly 1000 hr of observations were made at Peregrine Falcon nest sites on the Cape Peninsula, and over 200 hr were obtained each at nest sites on the Orange River and in the Soutpansberg and at Lanner Falcon sites in the Soutpansberg. Observations were made using 10 × 40 binoculars or a 20–60× spotting scope from distances of 200–400 m. Whenever a falcon was seen with food, an effort was made to identify or at least estimate the size of its prey. Size classes used were the same as those used for prey remains. Only largely intact prey could be identified or size classified.

Indices of diet breadth and overlap were calculated based on the relative frequency of taxa identified in prey remains at the species level wherever possible to refine the quality of these estimates (Greene and Jaksić 1983, Sherry 1990). Diet breadth (B_A) was calculated using Levins' (1968) standardized formula:

$$B_A = B - 1/n - 1,$$

where $B = 1/\Sigma\ p_i^2$ and p_i is the proportion of the diet contributed by the ith taxon. Values of B_A range from 0–1, with larger values indicating a broader diet. Also, the number of frequently used taxa (those comprising 3% or more of the total number of identified prey; Krebs 1989) was tallied for each falcon population as an additional

estimate of diet breadth. Diet overlap was measured using Morisita's (1959) index of similarity:

$$C = 2 \Sigma p_{ij}p_{ik} / \Sigma p_{ij}\left[\frac{(n_{ij} - 1)}{(N_j - 1)}\right] + \Sigma p_{ik}\left[\frac{(n_{ik} - 1)}{(N_k - 1)}\right]$$

where p_i and p_{ik} are the proportions that taxon i makes up of the diets of species j and k, respectively, n_{ij} and n_{ik} are the number of individuals of taxon i in the diets of species j and k, respectively, and N_j and N_k are the total number of individuals in the diets of species j and k, respectively. Values of C range from 0–1, with larger values indicating a greater dietary overlap. This index is considered the least prone to biases associated with sample size and the number of resources used (Smith and Zaret 1982). Multivariate cluster analyses were conducted to examine qualitative differences in the diet of sympatric Peregrine and Lanner Falcons, using the PRIMER software package (Plymouth Marine Laboratory, U.K.). Diet composition data were compared using the Bray-Curtis similarity coefficient (using group average linking) to generate a dendrogram of hierarchical clusters and a process of nonmetric multidimensional scaling to generate an ordination plot.

To examine the possible competitive influence of nearby Lanner Falcon pairs on the diet of Soutpansberg Peregrine Falcons and *vice versa,* the food niche parameters of falcon pairs with congeners as particularly close neighbors (pairs <1 km apart, Peregrine Falcons $N = 3$, average distance to nearest Lanner Falcon pair = 0.6 km, Lanner Falcons $N = 4$, average distance to nearest Peregrine Falcon pair = 0.7 km) were compared with those of relatively isolated pairs (>2 km apart, Peregrine Falcons $N = 4$, average distance to nearest Lanner Falcon pair = 6.5 km, Lanner Falcons $N = 5$, average distance to nearest Peregrine Falcon pair = 4.7 km). The mean distance between conspecific pairs was 9.7 km for Peregrine and 5.2 km for Lanner Falcons.

Two sampling techniques were used to estimate the abundance and distribution of potential avian prey in the vicinity of falcon nest sites in an attempt to make qualitative assessments of prey selection and habitat use. An estimate of local prey availability was made at nest cliffs by counting the number of potential prey per hour which flew across a sampling area prescribed by a 1 m^2 frame. This frame was positioned at the top of the cliff, looking out and down, or on the scree slope below the face looking up at the crest. An observer sat 2 m behind the frame, looking through it, to make the count. Prey counts were made at different times of the day at a cross-section of nest sites on the Cape Peninsula and in the Soutpansberg only, mostly from 1991–93.

Line-transect counts were walked in the Soutpansberg to estimate bird densities in seven habitats identified in terms of a broad-scale classification of the character and structure of vegetation present (*sensu* Edwards 1983). Plains to the south of the mountain range comprised either short, semi-open savanna woodland or short, sparse denuded woodland, often found adjacent to rural settlements and heavily impacted by clearing and cultivation. Forest and plantation included tall, closed stands of both indigenous evergreen and exotic eucalyptus or pine forest. Areas of montane grassland and scrub forest were typical of the upper slopes of the mountains and featured low, open grassland with patches of short deciduous forest. Deciduous woodland comprised short, moderately closed woodland and occurred on the northern backslopes and on the middle and upper slopes at the western end of the range. The lower scree slopes of the escarpment were thickly vegetated with low, closed woodland or moist thornscrub in the east and short, moderately closed woodland or dry thornscrub further west. One or two sites were selected as typical of each habitat type and at least three 1 km line transects were walked at these sites each breeding season from 1991–93. Transect sites were located between 150–3000 m from the main escarpment. Transects were completed at various times of day, but mostly in the morning or in late afternoon. Transects were walked briskly so only the birds which were conspicuously active in the area, and hence most likely to provide falcons with hunting opportunities, were recorded. High, overflying birds unlikely to be resident in the habitat being sampled were not counted, and species considered too large for falcons to catch and subdue under normal circumstances (>800 g in weight) were also excluded. The species, number of individuals and approximate perpendicular distance from the transect line were recorded for each sighting (Bibby et al. 1992).

RESULTS

A minimum of 1168 individuals of at least 82 species from 34 families were identified as prey from the remains collected at Peregrine Falcon nest sites, and a minimum of 174 individuals of at least 24 species from 15 families were identified from Lanner Falcon prey remains (Table 1, Appendix 1). Samples of remains collected at Peregrine Falcon sites in the Soutpansberg were more substantial than those from sympatric Lanner Falcon sites, yielding more specimens per collection (Peregrine Falcon $\bar{x} = 45.6$, range = 2–211, $N = 47$ collections; Lanner Falcon $\bar{x} = 18.6$, range = 1–60, $N = 36$ collections; Mann-Whitney $Z = 3.01$, $P = 0.003$) and more identified individuals per collection (Peregrine Falcon $\bar{x} = 8.0$, range = 1–31, $N = 49$ collections; Lanner Falcon $\bar{x} = 4.5$, range = 1–10, $N = 39$ collections; $Z = 2.77$, $P = 0.006$).

Peregrine Falcons were observed catching or feeding on 296 prey individuals, about half of which could be identified at least to family. Fifteen species from eight families were identified. Only one species, Black-eyed Bulbul (*Pycnonotus barbatus*) was observed as Peregrine Falcon prey and not recorded in prey remains. Only 36 prey individuals were identified during observations at Lanner Falcon sites in the Soutpansberg. These comprised one locust, one 1–3 day-old chicken (*Gallus gallus*), one *Streptopelia* dove, one unidentified murid rodent, seven unidentified small birds, nine small-

medium birds, 12 medium birds, and four medium-large birds.

Because relatively few prey items were identified in the field, and the sample of observed prey at Lanner Falcon sites was so small, the quality of the diet information provided by the analysis of prey remains could only properly be assessed in terms of the size of prey observed at Peregrine Falcon sites in each area. These comparisons suggested that remains collected on the Cape Peninsula provided the least accurate diet estimate, while those from sites in the Soutpansberg were the most accurate (Fig. 1). On average, prey remains underrepresented smaller prey by about 10% and overrepresented larger prey by about 8%. Taxonomically the samples were similar with birds, and particularly columbids, predominating in all.

The relative importance of key species in the diets of both falcons was fairly consistent between years, so data on prey remains for each year were pooled. Dominant species in the diet of Peregrine Falcons on the Cape Peninsula were Laughing Dove (*Streptopelia senegalensis,* 28% by frequency and 20% by biomass), European Starling (*Sturnus vulgaris,* 14 and 7%, respectively), and Cape Turtle Dove (*Streptopelia capicola*). Peregrine Falcons on the Orange River took Rock Pigeons (*Columba guinea,* 15 and 41%, respectively), Namaqua Sandgrouse (*Pterocles namaqua,* 10 and 13%, respectively), and Laughing Dove (8 and 6%, respectively). Peregrine Falcons in the Soutpansberg took Laughing Doves (19 and 16%, respectively), Red-faced Mousebirds (*Urocolius indicus,* 10 and 4%, respectively), and Red-eyed Doves (*Streptopelia semitorquata,* 8 and 16%, respectively). During 1991–93, Peregrine Falcons in the Soutpansberg preyed mainly on doves (35 and 45%, respectively) and mousebirds (15 and 7%, respectively), while sympatric Lanner Falcons took chickens (40 and 30%, respectively), doves (20 and 25%, respectively), and Crowned Plovers (*Vanellus coronatus,* 9 and 12%, respectively; Appendix 1).

The relative importance of juvenile birds in the diets of Peregrine Falcons varied significantly ($\chi^2 = 19.5$, $P < 0.001$) among the three study areas. Most of the juveniles recorded were columbids (Appendix 1) and juveniles were more frequent in the diet on the Cape Peninsula (32 of 513 individuals or 6.2%) than in the Soutpansberg (3 of 407 or 0.7%; χ^2_1 with Yates' correction = 15.3, $P < 0.001$), and comprised 3.2% of the diet of Peregrine Falcons on the Orange River. The relative frequency of juveniles in the diet of Cape Peninsula Peregrine Falcons increased through the breeding season from 1.7% by frequency in late October to 6.2% in early November, 6.8% in late November, and 8.1% in early December. A high proportion of the remains recovered from Lanner Falcon nests were young chickens, and juvenile birds comprised 39.7% of identified prey from these sites.

Columbids made up the majority of prey taken by Peregrine Falcons in all three study areas (Table 2). Other consistently important taxa were species in the families Apodidae, Sturnidae and Ploceidae. Soutpansberg Lanner Falcons took mainly phasianids, charadriids and columbids. The average size of prey taken by Peregrine Falcons in each of the three study areas varied (Kruskal-Wallis $H = 26.8$, $P < 0.001$). Cape Peninsula Peregrine Falcons took significantly larger prey (average mass = 144.5 g, range = 15–390 g, $N = 513$ individuals) than Orange River Peregrine Falcons (average mass = 128.3 g, range = 3–347 g, $N = 248$ individuals; Mann-Whitney $Z = 4.33$, $P < 0.001$) and Peregrine Falcons in the Soutpansberg (average mass = 123.3 g, range = 3–600 g, $N = 407$ individuals; $Z = 4.11$, $P < 0.001$). On average, Soutpansberg Peregrine Falcons took significantly smaller prey (average mass = 116.9 g, range = 3–600 g, $N = 318$ individuals) than sympatric Lanner Falcons (average mass = 123.7 g, range = 3–500 g, $N = 174$ individuals; $Z = 2.41$, $P = 0.02$). Peregrine Falcon diet included a greater proportion of small and large prey individuals, while Lanner Falcons tended to concentrate on medium-sized prey.

Of the three Peregrine populations studied, those on the Cape Peninsula had the least diverse diet (30 species were identified from prey remains; Appendix 1) and the narrowest diet breadth ($B_A = 0.17$). Peregrine Falcons in the Soutpansberg fed on a wide diversity of prey (≥50 species) but concentrated on a few taxa and had a moderate diet breadth ($B_A = 0.21$). On the Orange River, only 38 species were taken but there was less emphasis on particular families so the diet was relatively broad-based ($B_A = 0.34$).

Overall, Peregrine Falcons in the Soutpansberg had a broader feeding niche than sympatric Lanner Falcons and there was some overlap in the diets of the two species ($C = 0.34$). On a per site basis (excluding one peregrine site and one lanner site with insufficient samples), the difference in

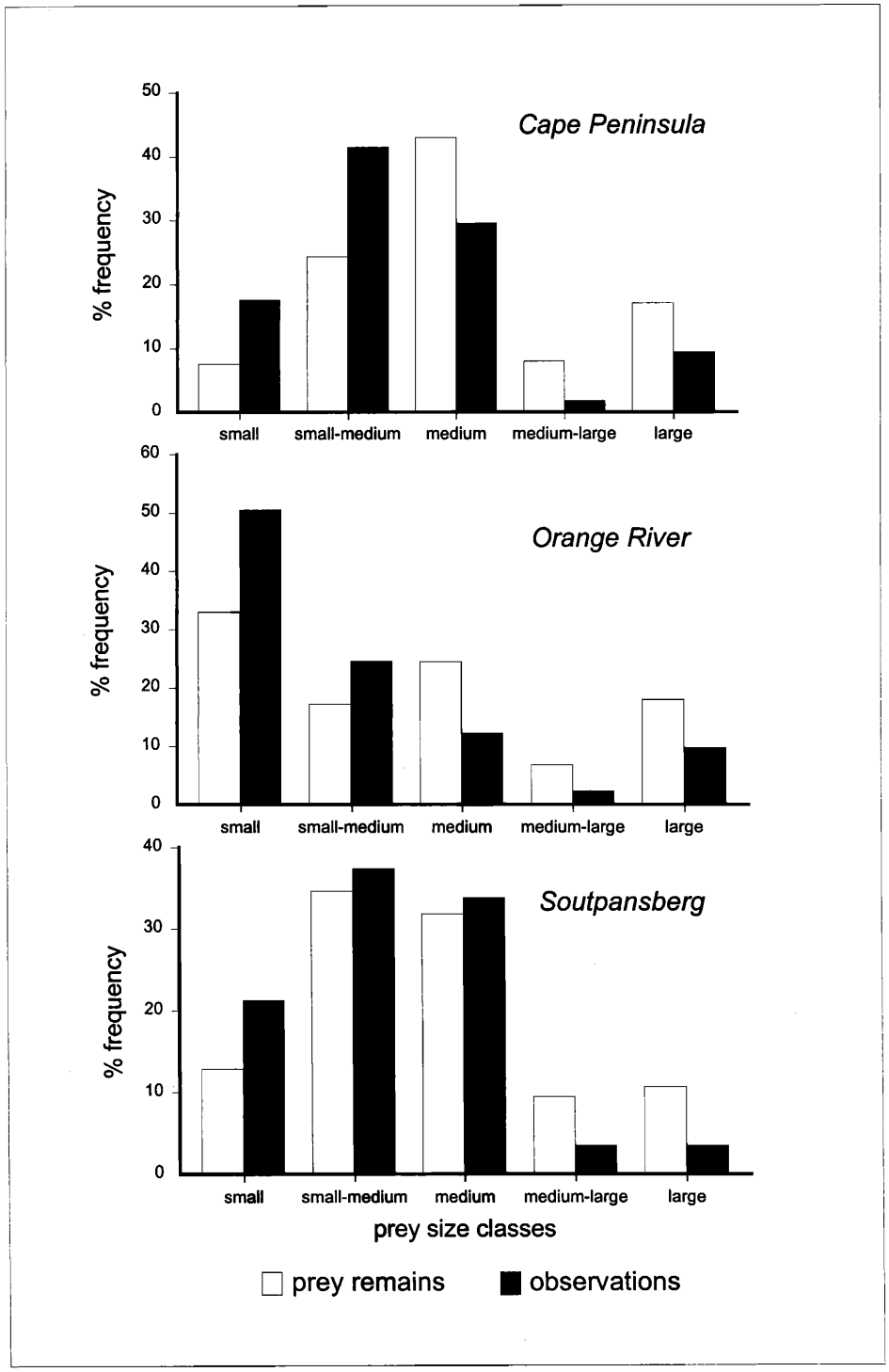

Figure 1. The relative frequency of prey of different size classes in the diets of Peregrine Falcons in three areas of South Africa determined from the analysis of prey remains and direct observations. Prey remains differed significantly from observations on the Cape Peninsula (remains $N = 513$, observations $N = 159$, $\chi^2_4 = 42.0$, $P < 0.001$) and on the Orange River (remains $N = 248$, observations $N = 81$, $\chi^2_4 = 14.0$, $P = 0.007$) but not in the Soutpansberg (remains $N = 407$, observations $N = 56$, $\chi^2_4 = 7.3$, $P = 0.12$).

Table 2. Summary of falcon diets from the analysis of prey remains collected at nest sites (see Appendix 1 for raw data). The importance of each taxon is expressed in terms of its relative frequency in the sample of individuals (%F) and in terms of its contribution to the total biomass of prey in each sample (%M). Families comprising 1% or more of the diet in each sample are listed. Peregrine Falcons (all years): Cape Peninsula $N = 513$ individuals, 74 107 g; Orange River $N = 248$ individuals, 31 811 g; and Soutpansberg $N = 407$ individuals, 50 193 g. Soutpansberg (1991–93): Peregrine Falcons $N = 318$ individuals, 37 188 g; Lanner Falcons $N = 174$ individuals, 21 532 g.

	PEREGRINE FALCONS (1989–95)						SOUTPANSBERG (1991–93)			
	CAPE PENINSULA		ORANGE RIVER		SOUTPANSBERG		PEREGRINES		LANNERS	
FAMILY	%F	%M	%F	%M	%F	%M	%F	%M	%F	%M
Phasianidae	—	—	—	—	1.5	3.6	1.3	3.6	40.2	37.4
Charadriidae	1.0	—	—	—	3.9	5.3	3.5	4.9	9.2	12.4
Recurvirostridae	—	—	—	—	—	—	—	—	1.2	1.6
Glareolidae	—	—	—	—	1.0	—	—	—	—	—
Laridae	—	—	2.4	2.1	—	—	—	—	—	—
Pteroclididae	—	—	9.7	14.0	1.0	1.9	—	1.3	—	—
Columbidae	66.1	85.1	37.5	69.9	48.2	68.4	46.5	67.2	28.2	39.1
Psittacidae	1.0	—	—	—	—	—	—	—	—	—
Apodidae	6.2	1.9	10.1	4.1	6.1	2.9	5.4	2.7	1.2	—
Coliidae	1.0	—	1.2	—	13.5	6.1	14.8	7.0	—	—
Alaudidae	—	—	7.7	1.0	1.0	—	1.3	—	—	—
Hirundinidae	—	—	6.1	—	—	—	—	—	—	—
Sturnidae	15.0	8.2	1.6	1.4	3.2	2.3	3.1	2.1	—	—
Ploceidae	4.5	1.1	4.4	—	4.2	1.0	4.4	1.2	4.6	1.2
Estrildidae	—	—	1.2	—	—	—	—	—	—	—
Fringillidae	—	—	1.6	—	1.0	—	—	—	1.2	—
Molossidae	—	—	6.5	—	—	—	—	—	—	—
Pteropodidae	—	—	—	—	1.5	1.6	1.3	1.4	—	—
Muridae	—	—	—	—	—	—	—	—	1.2	—

diet breadth was statistically significant (Peregrine Falcon average $B_A = 0.14$, range = 0.11–0.18, $N = 6$; Lanner Falcon average $B_A = 0.04$, range = 0.01–0.14, $N = 8$; Mann-Whitney $Z = 2.52$, $P = 0.01$). Cluster analyses on diet composition data clearly separated Peregrine and Lanner Falcon sites (Fig. 2). Food-niche widths of falcon pairs with pairs of congeners as close neighbors did not differ significantly from those of more isolated pairs (Peregrine Falcon pairs with close neighboring Lanner Falcon pairs average $B_A = 0.14$, $N = 3$, isolated pairs average $B_A = 0.14$, $N = 3$, $Z = 1.00$, $P = 1.00$; Lanner Falcon pairs with close neighboring Peregrine Falcon pairs average $B_A = 0.08$, $N = 4$, isolated pairs average $B_A = 0.05$, $N = 4$, $Z = 0.72$, $P = 0.47$). However, collectively, interspecific diet overlap was greatest between pairs with close neighboring congeners (close pairs $C = 0.44$, distant pairs $C = 0.26$).

Counts at cliffs on the Cape Peninsula and in the Soutpansberg had similar average prey passage rates in terms of numbers of individuals counted (Cape Peninsula average = 116.3 birds per hour, range = 2–542 birds per hour, $N = 64$ counts; Soutpansberg average = 119.0 birds per hour, range = 0–929 birds per hour, $N = 114$ counts). A significantly greater biomass of birds per hour was recorded in counts on the Cape Peninsula (average = 8567 g per hour, range = 405–33 479 g per hour, $N = 64$ counts) than in the Soutpansberg (average = 7104 g per hour, range = 0–56 669 g per hour, $N = 114$ counts; Mann-Whitney $Z = 3.09$, $P = 0.002$). Mostly cliff-dwelling species were included in these counts (e.g., Rock Pigeons, Alpine Swifts [*Apus melba*] and Red-winged Starlings [*Onychognathus morio*]). Larger species were more abundant at cliffs on the Cape Peninsula than in the Soutpansberg (e.g., Rock Pigeons were recorded in 72 vs. 18% of counts at cliffs on the Cape Peninsula and in Soutpansberg, respectively, with an average of 3.9 vs. 0.6 individuals per count), whereas aerial insectivores were more abundant in

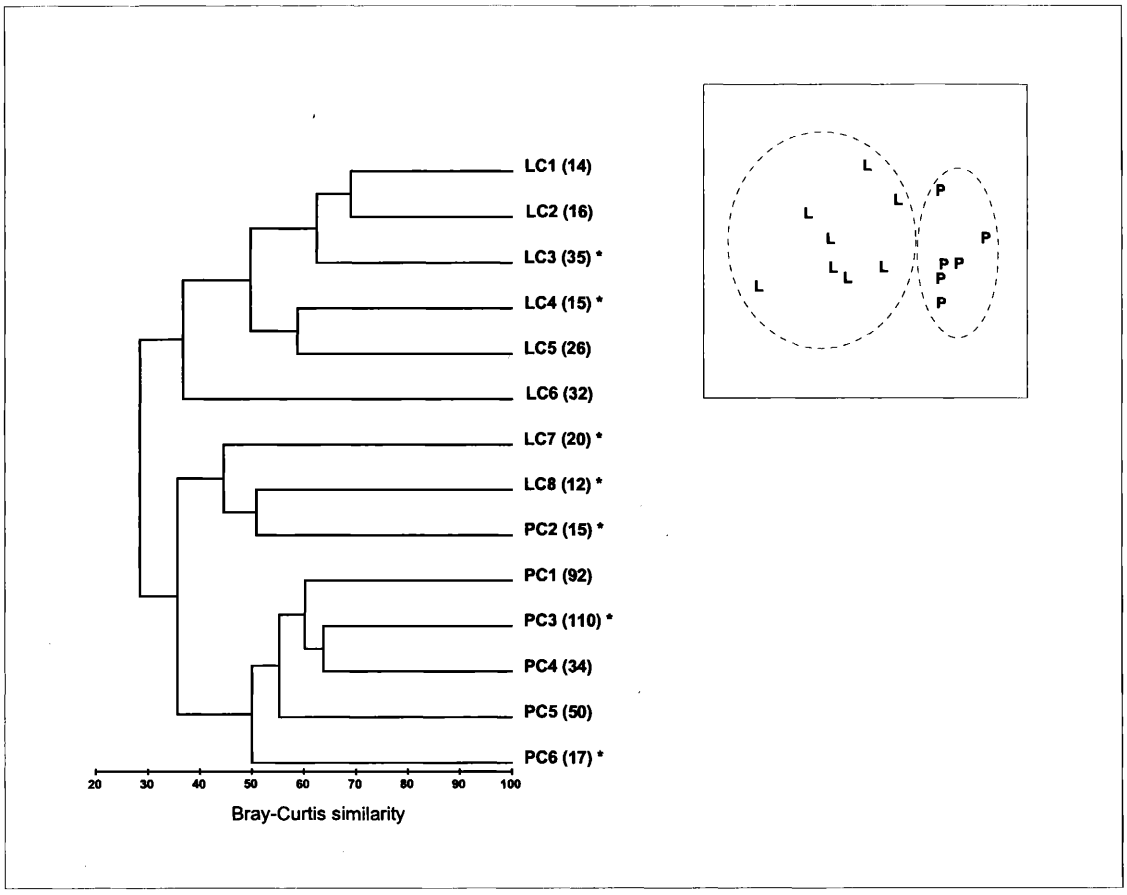

Figure 2. Results of cluster analyses on diet composition data for Peregrine (P) and Lanner (L) Falcon sites in the Soutpansberg. The dendrogram groups sites according to the Bray-Curtis similarity coefficient (with the number of prey individuals identified from each site in parentheses). Sites with close neighboring pairs of congeners are marked with an asterisk. The ordination plot (inset) illustrates the relatedness of each site to the others in terms of a multidimensional scaling procedure.

the Soutpansberg (e.g., Rock Martins [*Hirundo fuligula*] were recorded in 19 vs. 52%, respectively, with an average of 0.8 vs. 10.2 individuals per count).

Of the habitats identified in the Soutpansberg, the woodlands on the plain below the escarpment supported the highest diversity and the greatest number and biomass of birds (average = 6–7 species, 20–30 individuals and 800–1300 g per transect, respectively), while the dense thornscrub on the scree slopes of the mountains featured the most depauperate avifauna (average = <2 species, 2–6 individuals and 40–200 g per transect). Transect data extrapolated to avian density estimates ranging from 1441–1690 individuals/km^2 in savanna and denuded woodland to only 189 individuals/km^2 in moist thornscrub.

Some species which were recorded regularly in the diet of falcons in the Soutpansberg were not common in the environment. In particular, Red-faced Mousebirds made up about 10% of the Peregrine Falcon diet by frequency but were not encountered on any of the transect counts. Three species (Chestnut-backed Finchlark [*Eremopterix leucotis*], Melba Finch [*Pytilia melba*] and Blue Waxbill [*Uraeginthus angolensis*]) were common on the plains at the foot of the escarpment ($\bar{x}$ = 13.6, 1.5, and 8.5 individuals, respectively, of each species were recorded per transect through savanna or denuded woodland) but were infrequent or did not

Table 3. Foraging habitat use by breeding Peregrine and Lanner Falcons in the Soutpansberg as inferred from the habitat affinities of prey species identified in food remains. (A) only indicates prey species which were recorded in passage-rate or line-transect counts. (B) combines the species in (A) with a number of important prey species which were not sighted on sample counts (e.g., domestic chicken, Namaqua Dove and Red-faced Mousebird). Habitat preferences in species in (A) were determined from count data. The additional species in (B) were assigned to habitats on the basis of incidental observations in the area. Both comparative distributions were significantly different: (A) $\chi^2_6 = 12.6$, $P = 0.049$; (B) $\chi^2_6 = 79.7$, $P < 0.001$.

Favored Habitat of Prey Species	% Frequency in Peregrine Diet		% Frequency in Lanner Diet	
	(A)	(B)	(A)	(B)
Savanna woodland	26.7	39.0	19.0	19.5
Denuded woodland	7.9	12.3	12.1	49.4
Forest and plantation	0.3	0.3	—	—
Grassland and scrub forest	5.4	5.4	1.4	1.4
Moist thornscrub	—	—	—	—
Deciduous woodland	0.3	0.3	1.4	1.4
Dry thornscrub	0.3	0.3	—	—
Cliffs	9.1	9.1	5.2	5.2

occur in falcon diets, perhaps because these small birds were underrepresented in prey remains. Similarly, Black-eyed Bulbuls were ubiquitous in the area (0.5–1.6 individuals per transect in all habitats except denuded woodland), but were recorded as falcon prey only once. There was a significant difference in the foraging habitats used by Peregrine and Lanner Falcons in the Soutpansberg, as inferred from the habitat preferences of their prey (Table 3). While both species favored the wooded plains below the mountain range, Peregrine Falcons took more woodland species from relatively pristine habitats whereas Lanner Falcons took open-country species from denuded woodland and free-range chickens from around human settlements. Also, Peregrine Falcons preyed more heavily than Lanner Falcons on cliff-dwelling species (Table 3). Soutpansberg Peregrine Falcons took significantly more 'commuter species' (aerial insectivores, migrants or species which regularly commute between distant resources, e.g., sandgrouse, large columbids) than sympatric Lanner Falcons (76 of 318 or 23.9% vs. 19 of 174 or 10.9% commuters, respectively; $\chi^2_1 = 11.3$, $P < 0.001$), but fewer overall than Cape Peninsula Peregrine Falcons (27.0 vs. 31.6% commuters, respectively) and significantly fewer than Peregrine Falcons on the Orange River (110 of 407 or 27.0% vs. 114 of 248 or 46.0% commuters, respectively; $\chi^2_1 = 23.7$, $P < 0.001$).

Discussion

Columbids and particularly *Streptopelia* doves appear to be the staple food of Peregrine Falcons in southern Africa (Hustler 1983, Tarboton 1984, Mendelsohn 1988, this study). A similar preference for columbiforms has been recorded in many other areas of the Peregrine Falcon's distribution where pigeons and doves are available prey (Cade 1982, Ratcliffe 1993). Small, aerially dexterous species such as swifts and bats appear more consistently in the diet of African Peregrine Falcons than has generally been reported for other populations (Hustler 1983, Brown 1988, Mendelsohn 1988). Conversely, relatively large, terrestrial species such as anatids, galliforms, and charadriiforms are less frequently taken in Africa than in other areas (Cade 1960, Porter and White 1973, Pruett-Jones et al. 1981, Mearns 1983, Ratcliffe 1993). These differences may partly reflect differences in prey availability, but may also be due to a greater tendency for African Peregrine Falcons (and perhaps other small, tropical forms of the species) to 'catch and carry' prey rather than strike it to the ground and retrieve it (Cade 1982).

Three *Streptopelia* doves comprised nearly half (by frequency and mass) of the diet of Peregrine Falcons on the Cape Peninsula. British Peregrine Falcons specialize to a similar degree on larger columbids (Mearns 1983, Ratcliffe 1993). Typical of peri-urban peregrine populations around the

world (Cade and Bird 1990), Cape Peninsula pairs also took substantial numbers of commuting feral or domestic pigeons (*Columba livia*) and European Starlings, and occasionally preyed on escaped aviary birds. Inexperienced, newly-fledged birds are particularly vulnerable to predation by raptors (Newton and Marquiss 1982, Rosenfield et al. 1995), and young doves and starlings were taken quite frequently by Cape Peninsula Peregrine Falcons. As observed in other temperate falcon populations (Newton et al. 1984, Parr 1985), juvenile birds became more prevalent in the diet as the breeding cycle progressed. This supports the contention that breeding by Peregrine Falcons on the Cape Peninsula may in part be timed to exploit the period of maximum productivity of their principal prey species (Jenkins 1991, 1998)

Streptopelia doves featured least prominently in the diet of Peregrine Falcons on the Orange River, the most generalized feeders of the three Peregrine Falcon populations studied. These falcons usually foraged in the river valley (Jenkins 1995), which was the focus of bird movements in the area. Aerial insectivores (swifts, hirundines, and microchiropteran bats) and obligate drinkers (sandgrouse, columbids, and granivorous passerines) were the groups most frequently taken and were probably exposed to attack crossing rocky gorges or open stretches of the river, or traveling over arid flats adjacent to the floodplain.

Soutpansberg Peregrine Falcons preyed on a wide variety of species, most of which were secured in bird-rich woodlands at least 2 km from the base of the escarpment. Relatively fewer transient or commuter species, and more sedentary residents, were taken by these pairs than by Peregrine Falcons in the other two areas. However, the woodland species recorded as prey were generally those likely to fly furthest from, and highest above, the protective canopy of trees (e.g., Red-faced Mousebirds, *Lamprotornis* starlings). Mousebirds were more common Peregrine Falcon prey in the Soutpansberg than has been found in studies at other woodland sites, whereas rollers and woodpeckers were not taken (Hustler 1983, Tarboton 1984), perhaps because they were less common in the environment. Francolins are among the largest species regularly taken by African Peregrine Falcons, and those recorded as prey of Soutpansberg Peregrine Falcons were probably all caught by females. These essentially cursorial birds may have been caught in flight as they descended from the top of the cliff-line to the scree slopes below, as suggested by Hustler (1983).

Diet breadth indices calculated for South African Peregrine Falcons are comparable with equivalent data for populations in other areas (Table 4). These figures suggest that peregrines in temperate areas (e.g., the Cape Peninsula [this study], southern Scotland [Mearns 1983], Victoria, Australia [Pruett-Jones et al. 1981]) are relatively specialized feeders. In contrast, Peregrine Falcons appear to become more generalized in extreme environments such as deserts (e.g., this study), taiga and tundra (Cade 1960, Cade et al. 1968).

Relatively small samples of identifiable prey remains were recovered from Lanner Falcon nest sites, perhaps because much of the prey they consumed was completely digestible. Few data are available on the diet of southern African Lanner Falcons. The only quantitative studies, based on small samples, suggest that phasianids (including domestic fowl) and columbids are important prey groups (Barbour 1971, Tarboton and Allan 1984, Kemp 1993). Lanner Falcons in the Soutpansberg were relatively specialized feeders, with young chickens comprising nearly 40% of the prey recorded in remains. Given the greater susceptibility of juvenile bones to damage and acid erosion, chickens may have been underrepresented in these samples. Columbids were also important, and contributed more than phasianids to the biomass of identified prey. Sources of free-ranging poultry were a considerable distance from most Lanner Falcon nest sites, and their frequency in prey remains suggests that Lanner Falcon hunting ranges extended well beyond those of nearby Peregrine Falcon pairs. One radio-tracked male Lanner Falcon foraged over rural settlement areas >10 km from the main escarpment. Terrestrial or cursorial species predominated in the diet of Soutpansberg Lanner Falcons, and most prey were probably taken on or close to the ground.

Southern African Peregrine and Lanner Falcons are of approximately equal body mass and comparisons of key food handling and flight performance measurements yield ratios consistently lower than values traditionally considered minimum for noncompetitive coexistence (Jenkins 1998). Despite these structural similarities, diet overlap between Soutpansberg Peregrine and Lanner Falcons was moderate relative to those calculated using data from other studies of Peregrine Falcons and sympatric congeners, and fell well below the

Table 4. Indices of Peregrine Falcon diet breadth for a number of locations around the world, and measures of diet overlap between Peregrine Falcons and sympatric congeners.

STUDY POPULATION	NUMBER OF TAXA USED	NUMBER OF TAXA >3%	DIET BREADTH (B_A)
Southern Scotland[1]	90	5	0.04
Victoria, Australia[2]	77	6	0.12
Cape Peninsula, South Africa[3]	39	6	0.17
Soutpansberg, South Africa[4]	63	9	0.21
West Greenland[5]	11	6	0.24
NW Territories, Canada[6]	19	7	0.34
Orange River, South Africa[7]	45	10	0.34
Taiga zone, Alaska[8]	61	11	0.81
Sympatric Peregrine Falcons and Gyrfalcons (*F. rusticolus*), Colville River, Alaska[9]			
Peregrine Falcon	55	12	0.33
Gyrfalcon	55	2	0.004
Diet overlap: $C = 0.07$			
Sympatric Peregrine and Lanner Falcons, Soutpansberg, South Africa[10]			
Peregrine Falcon	67	10	0.20
Lanner Falcon	67	6	0.07
Diet overlap: $C = 0.34$			
Sympatric Peregrine and Prairie Falcons (*F. mexicanus*), Wasatch Mountains, Utah[11]			
Peregrine Falcon	33	9	0.31
Prairie Falcon	33	6	0.26
Diet overlap: $C = 0.58$			

Food niche parameters were calculated using data from: [1] Mearns 1983, [2] Pruett-Jones et al. 1981, [3] this study, [4] this study (all years), [5] Rosenfield et al. 1995, [6] Bradley and Oliphant 1991, [7] this study, [8] Cade et al. 1968, [9] Cade and White 1971, [10] this study (1991–93), [11] Porter and White 1973.

suggested critical value for competing species of about 0.62 (Bosakowski and Smith 1992). Also, while competition theory predicts narrower food niches and reduced diet overlap between close pairs of competing species vs. distant pairs (Nilsson 1984, Korpimäki 1987), the diet of falcon pairs in this study was not obviously affected by the presence of nearby pairs of congeners. Therefore, there was little evidence suggesting active competition for food between Peregrine and Lanner Falcons in the Soutpansberg. As concluded in previous studies of Peregrine Falcons and sympatric congeners (e.g., Cade 1960, Porter and White 1973), relatively subtle differences in morphology, flying performance, and hunting techniques (Jenkins 1995) are evidently sufficient to segregate foraging habitat and diet of Peregrine and Lanner Falcons in South Africa.

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Appendix 1. Invertebrate and vertebrate taxa identified from remains collected at Peregrine and Lanner Falcon nest sites in South Africa. Remains were collected at 10 Peregrine Falcon sites on the Cape Peninsula, seven Peregrine Falcon sites on the Orange River, and seven Peregrine Falcon sites and nine Lanner Falcon sites in the Soutpansberg. Data provided are the average mass of each taxon and the number of individuals identified, with the number of nest sites at which each taxon was collected in parentheses. Items marked with an asterisk were not considered as falcon prey in the diet analyses.

Prey Taxon	Average Mass (g)	Cape Peninsula	Orange River	Soutpansberg	
				Peregrines	Lanners
Insects					
Unidentified orthopterans	3	—	1 (1)	12 (2)	3 (2)
Unidentified coleopterans	3	—	1 (1)	2 (1)	—
Amphibians					
Unidentified frogs	20	—	—	*2 (1)	—
Birds					
Little Sparrowhawk—male *Accipiter minullus*	80	—	—	1 (1)	—
Peregrine Falcon—nestling	250	—	—	*2 (2)	—
Lanner Falcon—nestling	250	—	—	—	*1 (1)
Coqui Francolin *Francolinus coqui*	230	—	—	1 (1)	—
Crested Francolin *F. sephaena*	340	—	—	2 (1)	1 (1)
Grey-wing Francolin *F. africanus*	390	1 (1)	—	—	—
Cape Francolin—pullus *F. capensis*	150	—	1 (1)	—	—
Natal Francolin—female *F. natalensis*	425	—	—	2 (2)	—
Natal Francolin—unsexed	520	—	—	—	1 (1)
Unidentified adult francolin	500	—	—	—	2 (2)
Unidentified pullus francolin	150	—	—	—	1 (1)
Domestic chicken—<3days old *Gallus gallus*	60	—	—	—	41 (8)
Domestic chicken—±7 days old					
Domestic chicken—±14 days old	150	—	—	—	23 (3)
Harlequin Quail *C. delegorguei*	250	—	—	—	1 (1)
White-fronted Plover *Charadrius marginatus*	49	2 (2)	—	—	—
Kittlitz Plover *C. pecuarius*	43	2 (1)	—	—	—

Appendix 1. Continued.

Prey Taxon	Average Mass (g)	Cape Peninsula	Orange River	Soutpansberg	
				Peregrines	Lanners
Crowned Plover—adult *Vanellus coronatus*	167	1 (1)	—	16 (5)	14 (6)
Crowned Plover—immature	167	—	—	—	2 (2)
Greenshank *Tringa nebularia*	191	—	1 (1)	—	1 (1)
Curlew Sandpiper *Calidris ferruginea*	57	3 (1)	—	—	—
Little Stint *C. minuta*	24	—	1 (1)	—	—
Black-winged Stilt *Himantopus himantopus*	175	—	—	2 (1)	2 (2)
Temminck's Courser *Cursorius temminckii*	74	—	—	4 (3)	—
Common Tern *Sterna hirundo*	124	2 (1)	3 (1)	—	—
White-winged Tern *Chlidonias leucopterus*	57	—	1 (1)	—	—
Unidentified Tern	100	—	2 (2)	—	—
Namaqua Sandgrouse *Pterocles namaqua*	185	—	24 (6)	—	—
Burchell's Sandgrouse *P. burchelli*	235	—	—	1 (1)	—
Double-banded Sandgrouse *P. bicinctus*	235	—	—	3 (2)	—
Feral or domestic pigeon—adult *Columba livia*	320	47 (7)	8 (4)	17 (3)	—
Feral or domestic pigeon—young	320	1 (1)	—	—	—
Rock Pigeon—adult *C. guinea*	347	28 (7)	35 (6)	20 (5)	6 (2)
Rock Pigeon—fledgling	347	8 (3)	2 (2)	1 (1)	1 (1)
Rameron Pigeon *C. arquatrix*	415	—	—	2 (2)	—
Unidentified pigeon—adult	330	1 (1)	—	—	—
Unidentified pigeon—young	330	2 (2)	—	—	—
Red-eyed Dove—adult *Streptopelia semitorquata*	235	40 (7)	16 (5)	34 (6)	10 (4)
Red-eyed Dove—fledgling	235	1 (1)	—	—	—
Cape Turtle Dove *S. capicola*	153	61 (7)	5 (4)	25 (5)	8 (5)
Laughing Dove—adult *S. senegalensis*	102	140 (8)	20 (5)	79 (7)	21 (7)
Laughing Dove—fledgling	102	4 (2)	—	—	2 (2)
Unidentified dove—fledgling	130	3 (3)	—	—	—
Namaqua Dove *Oena capensis*	40	3 (3)	7 (5)	15 (5)	—
Green-spotted Dove *Turtur chalcospilos*	65	—	—	1 (1)	1 (1)
Small unidentified columbid	50	—	—	1 (1)	—
Medium unidentified columbid	160	—	—	1 (1)	—
Cockatiel *Nymphicus hollandicus*	90	1 (1)	—	—	—

Appendix 1. Continued.

PREY TAXON	AVERAGE MASS (g)	CAPE PENINSULA	ORANGE RIVER	SOUTPANSBERG	
				PEREGRINES	LANNERS
Budgerigar *Melopsittacus undulatus*	28	4 (1)	—	1 (1)	—
Grey Loerie *Corythaixoides concolor*	269	—	—	1 (1)	—
Freckled Nightjar *Caprimulgus tristigma*	60	—	2 (1)	—	—
Unidentified nightjar	60	—	—	1 (1)	—
Black Swift—adult *Apus barbatus*	45	13 (5)	—	12 (3)	—
Black Swift—fledgling	45	1 (1)	—	—	—
Bradfield's Swift *A. bradfieldi*	45	—	18 (6)	—	—
Little Swift *A. affinis*	26	12 (3)	—	2 (2)	—
Alpine Swift *A. melba*	77	6 (4)	6 (5)	11 (3)	2 (2)
Unidentified swift	35	—	1 (1)	—	—
Speckled Mousebird *Colius striatus*	53	—	—	14 (6)	1 (1)
White-backed Mousebird—adult *C. colius*	41	1 (1)	2 (2)	—	—
White-backed Mousebird—fledgling	41	—	1 (1)	—	—
Red-faced Mousebird *Urocolius indicus*	56	4 (3)	—	41 (7)	—
Narina Trogon *Apaloderma narina*	65	—	—	1 (1)	—
Pied Kingfisher *Ceryle rudis*	82	—	1 (1)	—	—
European Bee-eater *Merops apiaster*	55	—	—	1 (1)	—
Hoopoe *Upupa epops*	57	—	1 (1)	1 (1)	—
Scimitar-billed Woodhoopoe *Phoeniculus cyanomelas*	35	—	1 (1)	—	—
Red-billed Hornbill *Tockus erythrorhynchus*	130	—	—	—	1 (1)
Black-collared Barbet *Lybius torquatus*	57	—	—	2 (2)	—
Red-capped Lark *Calandrella cinerea*	26	—	—	1 (1)	—
Chestnut-backed Finchlark *Eremopterix leucotis*	14	—	—	1 (1)	1 (1)
Grey-backed Finchlark *E. verticalis*	17	—	19 (1)	—	—
Unidentified lark	20	—	—	2 (1)	—
European Swallow *Hirundo rustica*	18	1 (1)	—	—	—
Rock Martin *H. fuligula*	22	1 (1)	4 (4)	—	—
Brown-throated Martin *Riparia paludicola*	13	—	11 (3)	—	—

Appendix 1. Continued.

PREY TAXON	AVERAGE MASS (g)	CAPE PENINSULA	ORANGE RIVER	SOUTPANSBERG	
				PEREGRINES	LANNERS
Black-headed Oriole *Oriolus larvatus*	69	—	—	1 (1)	—
Unidentified sylviid	20	—	2 (2)	—	—
Fiscal Shrike *Lanius collaris*	41	—	—	1 (1)	—
Unidentified shrike	60	—	1 (1)	—	—
European Starling—adult *Sturnus vulgaris*	76	68 (9)	—	—	—
European Starling—fledgling	76	5 (3)	—	—	—
Pied Starling *Spreo bicolor*	107	1 (1)	—	—	—
Plum-colored Starling *Cinnyricinclus leucogaster*	46	—	—	1 (1)	—
Cape Glossy Starling *Lamprotornis nitens*	84	—	—	6 (3)	—
Greater Blue-eared Glossy Starling *L. chalybaeus*	76	—	—	1 (1)	—
Unidentified starling	80	—	—	2 (1)	—
Red-winged Starling—adult *Onychognathus morio*	135	3 (3)	—	1 (1)	—
Red-winged Starling—fledgling	135	—	—	1 (1)	—
Pale-winged Starling *O. nabouroup*	107	—	4 (2)	—	—
Unidentified starling	80	—	—	1 (1)	1 (1)
White-browed Sparrow-weaver *Plocepasser mahali*	48	—	—	3 (3)	1 (1)
Sociable Weaver *Philetairus socius*	27	—	1 (1)	—	—
House Sparrow *Passer domesticus*	24	2 (1)	—	—	—
Cape Sparrow *P. melanurus*	26	10 (3)	4 (3)	4 (3)	2 (2)
Cape Weaver *Ploceus capensis*	45	7 (4)	—	3 (2)	—
Masked Weaver *P. velatus*	27	1 (1)	1 (1)	—	1 (1)
Unidentified weaver	35	—	—	1 (1)	1 (1)
Red-billed Quelea *Quelea quelea*	19	—	2 (2)	6 (3)	1 (1)
Red Bishop *Euplectes orix*	23	—	2 (2)	1 (1)	—
Yellow-rumped Widow *E. capensis*	45	2 (1)	—	—	—
Unidentified ploceid	40	1 (1)	1 (1)	—	2 (2)
Common Waxbill *Estrilda astrild*	8	—	3 (3)	—	—
Red-headed Finch *Amadina erythrocephala*	23	—	—	3 (3)	—
Yellow-eyed Canary *Serinus mozambicus*	13	—	—	1 (1)	—

Appendix 1. Continued.

PREY TAXON	AVERAGE MASS (g)	CAPE PENINSULA	ORANGE RIVER	SOUTPANSBERG	
				PEREGRINES	LANNERS
Forest Canary *S. scotops*	16	—	—	1 (1)	—
Bully Canary *S. sulphuratus*	26	—	—	—	1 (1)
Yellow Canary *S. flaviventris*	17	1 (1)	1 (1)	—	—
White-throated Canary *S. albogularis*	27	—	2 (1)	—	—
Unidentified canary	15	1 (1)	—	1 (1)	—
Unidentified fringillid	15	—	1 (1)	1 (1)	1 (1)
Unidentified small birds—adults	20	4 (3)	2 (2)	9 (3)	2 (2)
Unidentified small birds—young	20	1 (1)	—	—	—
Unidentified small-medium birds	60	6 (4)	—	11 (4)	8 (6)
Unidentified medium birds	130	5 (3)	4 (4)	2 (2)	4 (2)
Unidentified very large birds	600	—	—	1 (1)	—
Mammals					
Unidentified shrew	10	—	—	—	1 (1)
Unidentified fruit bat	130	—	—	6 (2)	—
Flat-headed free-tailed bat *Sauromys petrophilus*	14	—	8 (1)	—	—
Egyptian free-tailed bat *Tadarida aegyptiaca*	15	—	8 (1)	—	—
Hildebrandt's horseshoe bat *Rhinolophus hildebrantii*	30	—	—	1 (1)	—
Unidentified insectivorous bats	15	1 (1)	6 (4)	3 (3)	—
Multimammate mouse *Mastomys natalensis*	65	—	—	*1 (1)	—
Namaqua rock mouse *Aethomys namaquensis*	45	—	*1 (1)	—	—
Small unidentified murid	25	—	—	—	1 (1)
Medium unidentified murid	45	*2 (2)	*3 (3)	*2 (2)	1 (1)
Large unidentified murid	120	—	—	*2 (2)	—
Unidentified squirrel	160	—	—	*1 (1)	—
Small unidentified bovid	5000	—	—	*1 (1)	—
TOTAL		515 (10)	252 (7)	418 (7)	175 (10)