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Food habits of the Crested Caracara (*Caracara plancus*) in the Andean Patagonia: the role of breeding constraints

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Crested caracara (*Caracara plancus*) in Patagonia have a generalist diet, feeding mainly on mammalian carrion and arthropods. Vertebrate prey (mammals, birds and reptiles) are primarily captured to feed nestlings and marginally as food for breeding or immature adults. Immature birds are less selective in their diet than breeding adults, consuming mainly large carrion and arthropods. This may be caused by intraspecific hierarchical interactions where immature birds are displaced by adult breeding birds to less profitable prey. On the other hand, differences between breeding adults and nestlings fit central place foraging theory predictions. Adults consume smaller prey (mostly arthropods), and take larger prey (mostly vertebrates) to the nest.

Keywords: Crested Caracara; Patagonia; diet; *Caracara plancus*; central place foraging

Introduction

Food habits of birds of prey are not usually well known in arid biomes in comparison to temperate areas. Reasons for this are the rarity of these species, and the difficulty to gather information and carry research in extreme conditions. It has been usually found that in these regions raptors tend to base their diet in fluctuating preys like small mammals (usually rodents) and invertebrates (see e.g. Donázar *et al.*, 1989), which in time seems to provoke their irregular spatial distribution and important inter-annual abundance fluctuations (Valverde, 1957).

Crested caracaras (*Caracara plancus*) are distributed along the Americas from the southern U.S.A. to Tierra del Fuego. Food habit studies are limited to anecdotal observations (Haverschmidt, 1947; Glazener, 1964; Azategui, 1975; Richmond, 1976; Layne *et al.*, 1977; Whitacre *et al.*, 1982; Wallace & Temple, 1987; Yosef & Yosef, 1992; Dickinson, 1995). They are described as dietary opportunists (Palmer, 1988;

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Del Hoyo *et al.*, 1994) feeding mainly on carrion, although live prey are also consumed (Whitacre *et al.*, 1982; Palmer, 1988; Del Hoyo *et al.*, 1994). Quantitative analyses of the diet in arid zones are limited to warm deserts of North America (Rodríguez-Estrella & Rivera-Rodríguez, 1992; 1997).

In this paper we describe the diet of Crested Caracaras in the cold arid lands of the north-western Argentine Patagonia. As the Crested Caracara is an opportunistic predator it can be expected that its diet vary somewhat in relation to constraints imposed by the breeding tasks (see Schoener, 1979). In particular we examine if the diet show differences between different habitats, and among individuals with different breeding status (territorial adults, nestlings, and non-breeding immature birds).

Study area and methods

The study area was in the Neuquén province, north-western Patagonia (70°30′–71°30′W; 39°30′–40°20′S) also called 'Precordillera' (Pearson & Pearson, 1982). The weather is normally dry and cold with frost throughout the year and frequent snowfall in winter. Topographically, the area consists of great plains at 800–900 m a.s.l., dissected by steep rugged valleys and large rivers. In general, the study area could be divided into two different zones: lowland piedmont (which coincides with river valleys) and highland piedmont. This division is based on an elevational (between 600 and 1400 m a.s.l.) and rainfall (between 300 and 700 mm) gradient. The area constitutes a portion of the total precordillera gradient. In lowland piedmont, range activity consists mainly of extensive sheep breeding, while in highland piedmont sheep have been replaced by cattle during the past 15 years. This has direct consequences on carrion availability, with sheep being abundant in the lowland because dead animals are abandoned by landowners. On the other hand, cattle carrion is seldom available because bovines have much lower mortality rates than sheep, and dead cattle are destroyed by landowners when detected.

Crested caracaras are abundant and breed throughout the study area (Donazar *et al.*, 1993; Travaini *et al.*, 1994; 1995). Non-breeding immatures usually concentrate in roosts where more than 100 individuals may gather (pers. obs.). To determine diet, pellets were collected at two communal roosts (one in the lowland and one in the highland piedmont), 12 breeding adult perches (three in the lowland, and nine in the highland piedmont) and 10 active nests (three in the lowland and seven in the highland piedmont). We are reliable that pellets mainly correspond to the classes indicated, as breeding birds never use communal roosts and they seldom regurgitate at nests. Pellets were collected from September to December 1991 and 1992, and October to February 1994–1995. Only fresh and unbroken pellets were included in our samples in order to restrict our study to the breeding season (September–February) thereby avoiding seasonal variation. All pellets were dissected using standard techniques (Marti, 1987). Small mammal osteological remains were identified using taxonomic keys (Pearson, 1986), reference specimens collected in the study area and museum collections. Adult birds were classified into three size classes (< 100 g, 100–500 g and > 500 g). Reptiles were identified to the family or order level based on the examination of scales. Mammal carrion was identified by the appearance and structure of hair remains. Arthropods were identified to the order or family level.

Our results are expressed as a percentage of total prey (which enables our results to be compared with other studies) and percentage occurrence in relation to the total number of pellets. We did not expressed our results in terms of biomass because of difficulties in the evaluation of this parameter for the carrion portion in the diet.

We used correspondence analysis (CA) (Digby & Kempton, 1987) to analyse diet variations between sampling localities. We applied them on matrix data including percentages on the total prey and occurrence on the total number of pellets. This kind of

analysis permits plotting points for both rows and columns (here localities and prey categories) on the same plane (see e.g. Donázar *et al.*, 1989). Correspondence analysis is especially appropriate for matrices with numerical data (Cuadras, 1981) and does not normally require previous transformation of data (Digby & Kempton, 1987). The following prey categories were considered: Rodents (ROD), lagomorphs (LAG), edentates (EDE), carnivores (CAN), Birds (AVE), Reptiles (REP), arthropods (ART), garbage (GAR), ungulate carrion (CAR).

After CA ordination, we performed comparisons between groups of localities on the basis of the co-ordinates of localities. Then, Kruskal–Wallis tests were applied (Siegel & Castellan, 1988). Differences were considered significant when $p < 0{\cdot}05$.

Results

The feeding habits of Patagonian Crested Caracaras corresponded to that of a carrion and arthropod eater, with a high proportion of vertebrate prey only in the nestlings' diet (Table 1). Main vertebrate preys were rodents and lagomorphs. Within rodents *Ctenomys haigi* and *Akodon* spp. predominated. European hares (*Lepus europaeus*) were heavily represented reaching frequencies of 67% in pellets of adults birds; European rabbits (*Oryctolagus cuniculus*), were marginally consumed as also occurred in the case of carnivores (Table 1). Large mammals were mainly domestic sheeps (*Ovis aries)* and, well below it, guanacos (*Lama guanicoe*). Within birds, we were able to identify 14 specimens: five long-tailed meadowlark (*Sturnela loica*), one rufous-backed negrito (*Lessonia rufa*), two eared doves (*Zenaida auriculata*), one austral thrush (*Turdus falcklandii*), and five southern lapwings (*Vanellus chilensis*). Most consumed reptiles were small lizards (Iguanidae). Orthopterans (mainly Acrididae)and coleopterans (mainly Tenebrionidae).

The three axes of the CA carried out on percentage of total prey accounted for the 79·02% of the variance (Fig. 1). Axis I (41·15% of the variance) separated rodents, carnivores and reptiles in the positive zone, and the rest of prey in the negative part. Axis II (25·71% of the variance)separated garbage in the positive zone and rodents in the negative part. Axis III (12·16% of the variance) showed high frequencies of rodents in the positive zone and no clear tendencies in the negative part. Analytical comparisons of co-ordinates did not reveal significant differences between mountain and plain localities (Kruskal–Wallis test, $p > 0{\cdot}05$). On the contrary, comparisons between samples collected in nests, adult perches and communal roosts showed significant differences with respect to the Axis I (KW = 8·882, $p = 0{\cdot}0035$). The application of *a posteriori* multiple comparison Dunn's tests revealed significant differences between adult perches and nests ($p < 0{\cdot}01$). Comparisons of co-ordinates of these groups on axes II and III did not show significant differences.

The CA on frequencies of appearance in pellets generated three axes that accounted for 75·22% of the variance (Fig. 1). Axis I (34·33%) of the variance separated in the positive zone high frequencies of reptiles and garbage, and edentates in the negative zone. Axis II (25·86% of the variance) separated garbage in the positive zone against carnivores in the negative part. Finally, axis III (15·10%) separated rodents in the positive zone and garbage in the negative zone. Analytical comparisons of co-ordinates revealed similar results to the former case. There were no differences between mountain and plain diets but there were it did between adults and nestslings (KW = 7·521, $p = 0{\cdot}0104$; multiple comparison Dunn's test, $p < 0{\cdot}05$).). Comparisons of co-ordinates of these groups on axes II and III neither showed significant differences.

Summing up, attending to percentages on the total prey, adult birds consumed more invertebrates while bringing rodents and medium sized mammals carrion to the nestlings. If we consider percentages on total pellets adults consumed edentates whereas young in the nest consume small prey (rodents and reptiles).

Table 1. *Feeding habits, estimated from pellet analyses, of the Crested Caracara in two habitats (lowland and highland Piedmont) and three age categories (roost, breeding adults and nestlings) in the Andean Patagonia*

	Lowland						Highland piedmont					
	Roost		Breeding adults		Nestlings		Roost		Breeding Adults		Nestlings	
	%TP*	%OC†	%TP	%OC	%TP	%OC	%TP	%OC	%TP	%OC	%TP	%OC
Mammals												
Rodents	**54·54**	**91·89**	**37·42**	**96·15**	**54·95**	**92·31**	**14·22**	**92·25**	**29·46**	**93·82**	**43·48**	**93·55**
Ctenomys haigi	3·03	5·41			7·21	13·46			0·15	0·56	0·52	1·43
Akodon spp.	3·03	5·41	2·04	5·77	2·70	5·77			0·15	0·56	0·78	2·15
Auliscomys micropus					0·90	1·92						
Eligmodontia typus					0·90	1·92					0·13	0·36
Phyllotis darwini					1·80	3·85					0·26	0·72
Reithrodon auritus					0·90	1·92					0·13	0·36
Unidentified rodent					4·50	9·62	0·20	1·42	2·75	10·12	6·77	17·56
Insectivors												
Marmosa pusilla											0·13	0·36
Edentata												
Chaetophractus pilosus									1·07	3·96	0·65	1·79
Zaedius pichi												
Lagomorpha									0·15	0·56		
Lepus europaeus	9·09	16·22	12·93	36·54	16·22	34·62	7·01	50·35	18·17	66·85	22·14	60·58
Oryctolagus cuniculus									0·31	1·12		
Carnivora												
Conepatus chinga					0·90	1·92	0·10	0·71			0·13	0·36
Dusicyon spp.											0·91	2·51
Ungulates												
Cervus elaphus					0·90	1·92	0·10	0·71	0·15	0·56	1·04	2·87
Lama guanicoe					5·41	11·54			1·07	3·93	1·04	2·87
Ovis aries	39·39	70·27	17·01	48·04	9·91	21·15	0·99	7·09	1·68	6·18	1·69	4·66
Capra hircus											0·13	0·36
Bos taurus-Equus caballus					2·70	5·77			0·76	2·81	0·52	1·43
Unidentifies ungulate			5·44	15·38			5·82	41·84	3·05	11·24	6·51	17·92

Birds	**3·04**	**5·40**	**2·04**	**5·77**	**4·50**	**7·69**	**0·69**	**4·93**	**6·58**	**22·47**	**7·02**	**16·83**
Unidentified bird							0·49	3·55	0·46	1·69	1·82	5·02
Small (< 100 g)	1·52	2·70			0·90	1·92			1·22	4·49	1·30	3·58
Medium-sized (100g–500 g)	1·52	2·70	1·36	3·85			0·20	1·42	1·38	5·06	1·56	4·30
Large (> 500 g)					1·80	3·85			0·92	3·93	0·26	0·72
Chick			0·68	1·92	0·90	1·92			2·14	7·87	1·56	4·30
Eggs					0·90	1·92			0·46	1·69	0·52	1·43
Reptiles	**4·55**	**8·11**			**10·81**	**23·08**	**0·20**	**1·42**	**1·38**	**5·06**	**2·99**	**8·24**
Iguanidae	4·55	8·11			10·81	23·08	0·20	1·42	0·92	3·37	2·21	6·09
Ovids									0·46	1·69	0·78	2·15
Arthropods Insecta	**37·89**	**37·84**	**60·55**	**59·62**	**29·72**	**40·38**	**83·52**	**75·35**	**61·54**	**65·73**	**44·53**	**35·13**
Unidentified	1·52	2·70			0·90	1·92			0·46	0·56	0·26	0·36
Formicidae							34·65	0·71	0·31	0·56		
Dermaptera									0·31	1·12	0·78	0·72
Ortoptera	1·52	2·70	41·50	30·77	2·70	3·85			9·01	3·93	0·13	0·36
Coleoptera unidentified	34·85	35·14	18·37	36·54	24·32	30·77	18·07	32·62	12·52	21·91	29·17	19·00
Curculionidae									1·83	4·49		
Scarabeidae							2·86	7·09	3·21	1·69		
Tenebrionidae					1·80	3·85	27·94	56·74	33·59	47·19	14·06	18·64
Quelicerata												
Escorpionide									0·15	0·56	0·13	0·36
Solifuga									0·15	0·56		
Garbage							**1·38**	**9·93**	**0·92**	**3·37**	**1·95**	**5·38**
Pellets	37		52		52		142		178		279	
Prey items	66		147		111		1013		655		768	

* %TP, percent of total prey.

† %OC, percent occurrence in pellets.

Measurements made during the breeding seasons of 1991, 1992 and 1994. Lowland (which coincides with river valleys) and highland piedmont correspond to a division of our study area based on an elevational (between 600 and 1400 m a.s.l.) and rainfall (between 300 and 1000 mm) gradient. Pellets collected at roosts correspond to nonbreeding animals.

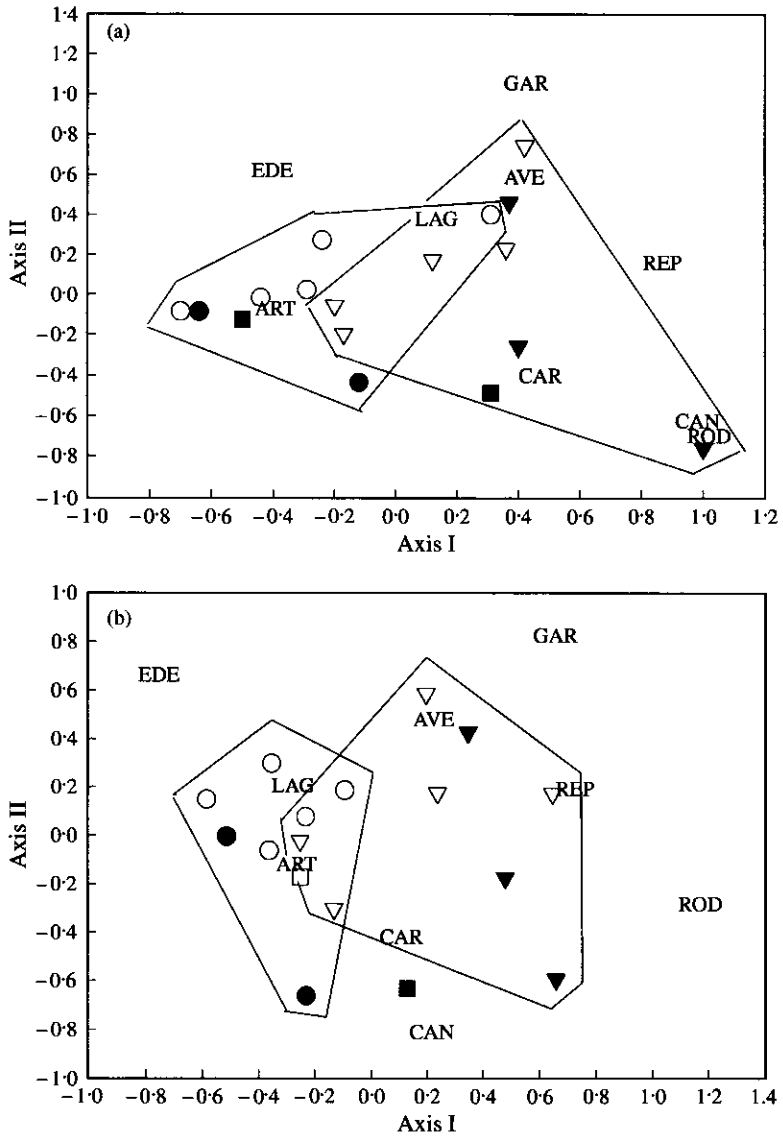

Figure 1. Variations in the composition of the diet of the Crested Caracara in the Andean Patagonia. Plots of the correspondence analyses carried out on percentages of total prey (a), and total pellets (b). Points representing adult perches and nests (which differed significantly in position on axis I) have been delimited by minimum polygons. Adult perch mountain (●), adult perch plain (○), nest mountain, (▼) nest plain (▽), Communal roost mountain (■), Communal roost plain (□). Prey categories: rodents (ROD), lagomorphs (LAG), edentates (EDE), carnivores (CAN), birds (AVE), reptiles (REP), arthropods (ART), garbage (GAR), ungulate carrion (CAR).

Discussion

Crested Caracaras in our study area behave as food generalists, as was well known for other regions of its distribution area (see references in Introduction). In the Andean Patagonia the species depends mainly on carrion and invertebrate prey, and, in a lesser extent, on vertebrates (mammals, birds and reptiles). Lagomorphs are probably

captured as live prey when they are young but large individuals may be taken as carrion, mainly as road-killed corpses (pers. obs.). Probably, other medium-sized mammals as edentates and carnivores are also consumed as carcasses, as occurs evidently with large ungulates. The appearance of European Hare carrion in a relatively high proportion of Caracara nestling diets reported in this study could be due to the very high availability of carcasses of this newly introduced species (Grigera & Rapoport, 1983) in our study area (e.g. Novaro *et al.*, 1992). In addition, carcases of this species are easily dismembered and then carried to the nest, mostly using the beak (Travaini *et al.*, 1998).

The higher frequency of appearance of arthropods and European Hare in highland piedmont coincides with the higher rainfall and primary productivity of this habitat. Nevertheless, this tendency is opposed to that found for small mammals and reptiles. Rodents are more abundant in lowland valleys (Pearson & Pearson, 1982); reptiles, as in other areas of the world, are probably more common in more arid lowland zones, with higher insolation and temperature (Schall & Pianka, 1978).

Non-breeding birds living in roosts consume a high proportion of arthropods and carrion (large carrion compared to sheep in the lowland and to bigger ungulates in the highland piedmont, according to differential availability). This does not support the prediction of the optimal foraging theory (Schoener, 1971): non-breeding birds should be more selective. The reason for this discrepancy can obey to intraspecific competence when feeding. In the study area the breeding density of Crested caracara is high (Travaini *et al.*, 1994). Adult birds displace immatures from their territories and prey (unpublished data, Wallace & Temple, 1987, Travaini *et al.*, 1998). Thus, immatures are relegated to exploitation of less profitable prey.

Differences between breeding adults and nestlings could be interpreted in the context of the central place foraging theory (Orians & Pearson, 1979; Schoener, 1979). Adult Caracara, like other birds of prey (Franco & Andrada, 1977; Rudolph, 1982; Veiga, 1982; Espina, 1984; Masman *et al.*, 1986; Donázar, 1988), brings larger sized prey (vertebrates) to the nest, consuming most of the arthropods themselves. In this way, the birds can minimize the number of trips, and thereby lower the energetic expenditure necessary to feed nestlings (Rudolph, 1982; Carlson, 1983). Additionally, differences between breeding adults and nestlings could be influenced by differential requirements in nutrients (Lacher *et al.*, 1972; Pullian, 1975; Reichman, 1977; Westoby, 1978; Hughes, 1979). Carrion of large ungulates may be a less profitable food resource because of its low calcium availability, an important element for osteosynthesis. The lack of calcium may determine disfunction in nestling development in scavenging birds (Houston, 1978).

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