# Diet Plasticity of Cinereous Vulture Aegypius monachus in Different Colonies in the Extremadura (SW Spain)

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# Diet plasticity of Cinereous Vulture *Aegypius monachus* in different colonies in the Extremadura (SW Spain)

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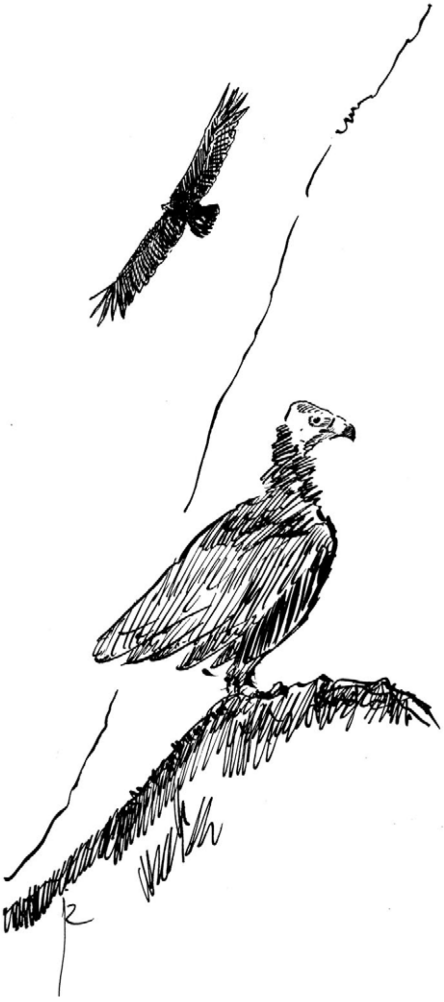

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The current feeding habits of the Cinereous Vulture *Aegypius monachus* remain largely unknown since most studies were carried out in the 1970s. To update the information, we studied the diet of the species in different colonies in Extremadura by analyzing the frequency of presence of 378 prey items observed in 283 pellets. In all colonies, sheep carcasses formed the staple food. Nevertheless, there were major differences between colonies in supplementary prey: farm poultry and swine in Sierra de Gata, swine and deer in Sierra de San Pedro and Granadilla. There were also variations between subcolonies within a colony and differences with colonies elsewhere in the Iberian Peninsula. In colonies situated in areas with a high abundance of lagomorphs and deer, such as Cabañeros and Sierra de Andujar, the diet is based on wild animal populations. In other colonies, the diet depends to a large extent on livestock farming: sheep in Sierra de Gata, Granadilla and Sierra de San Pedro, and swine and sheep in Sierra de Guadarrama. The Cinereous Vulture thus shows great trophic plasticity, taking advantage of new resources (such as carcasses of poultry from poultry farms) and responding to variations in prey availability in the area surrounding the colonies. These circumstances need to be taken into consideration for the conservation of the species, in particular when the vultures depend on human resources, which are prone to drastic changes in availability. The recent outbreaks of veterinary diseases (like BSE, foot-and-mouth disease, Rift Valley fever and bluetongue disease) and reforms related to the Common Agricultural Policy, are a point in case.

Key words: *Aegypius monachus,* diet, intracolony variation, trophic plasticity

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## INTRODUCTION

The Cinereous Vulture *Aegypius monachus* extends throughout the Palearctic in a wide geographical band from the Iberian Peninsula in the west to Mongolia, Siberia, Korea and China in the east (Del Hoyo *et al.* 1994). In spite of its wide distribution, it is worldwide classified as 'near-threatened' (Collar *et al.* 1994) and in Europe as 'vulnerable' (Tucker & Heath 1994). The population of Extremadura (SW Spain), which is the object of this study, has undergone a major increase (Tucker & Heath 1994, Sánchez 1998, Costillo *et al.* 2001), totalling 722 pairs in 2004 (Caldera 2004). This represents a large proportion of the population in Spain (1511 pairs in 2004) and in the western Palearctic (1704–1897 pairs) (Arenas & Dobado 2004).

Raptors are at the top of trophic pyramids, with vultures as necrophages playing a fundamental role in ecosystems. Their specialization in consuming carrion has determined unique adaptations in many aspects of their biology (Houston 1979, Donázar 1993). However, the feeding habits of the Cinereous Vulture are poorly known. Cramp & Simmons (1980) provided a qualitative description of diet variation across its range. Apart from dietary studies of single colonies (Guzmán & Jiménez 1998, Moleón *et al.* 2001, Grefa 2004), not much has been published for the Iberian Peninsula since the 1970s (Bernis 1966, Valverde 1966; Garzón 1973, Hiraldo 1976). The latter found a carrion-dominated diet of small- and medium-sized mammals (mostly Rabbit *Oryctolagus cuniculus* and domestic ungulates) in all studied colonies.

In the last decades, however, there have been major quantitative and qualitative changes in the Mediterranean ecosystems of the Iberian Peninsula which constitute the habitat of the species. These changes involve both livestock farming (fewer equids, more sheep and pigs) (Arroyo *et al.* 1990, MAPA 2002) and wildlife populations (fewer Rabbits and more of the big game species) (Soriguer *et al.* 1994, Villafuerte *et al.* 1995, Carranza 1999). Viral haemorrhagic pneumonia continues to have a severe impact on Rabbit populations (Villafuerte *et al.* 1995), and there are insistent calls for greater control of livestock carcasses due to diseases such as bovine spongiform encephalopathy (BSE), foot-and-mouth disease and bluetongue disease. The establishment of carcass removal programs could affect the stability and future development of vulture populations (Camiña & Montelío 2006). The reform of the Common Agricultural Policy (CAP) will also generate major changes in livestock production. These circumstances presumably influenced the availability of Cinereous Vulture's food in the past and may be expected to do so in the near future.

For all these reasons, the study of the diet of the Cinereous Vulture is of special relevance. The objective of the present study is to unravel diet plasticity under present conditions in the Extremadura. To this end we analyse the diet of Cinereous Vultures in different colonies, and study spatial variation of diet within colonies. These data may shed light on the resilience of the species in a rapidly changing landscape.

## METHODS

### Study sites

Pellets were collected for analysis from five different colonies of Cinereous Vulture in the Autonomous Community of Extremadura (Fig. 1). The data from the areas of Sierra de Gata, Granadilla, and Sierra de San Pedro (Fig. 1), constituting the largest samples and representing different types of Cinereous Vulture colonies in Extremadura regarding habitat, land use and nesting type (Table 1, see also Costillo *et al.* 2001, Morán-López *et al.* 2006), were included in the statistical analysis.

The hypothesis was that, given the large size of the colonies, there could be dietary differences indicative of different feeding areas. There were no prior hypotheses concerning spatial partitioning, so the objective spatial delineation of Morán-López *et al.* (2006) was used and denominated the resulting nest groups as 'subcolonies'. A cluster analysis was performed to delimit the subcolonies objectively and spatially explicitly, with each nest being assigned to a subcolony. The algorithm used was simple Euclidean distance clustering ('nearest neighbour clustering'), which defines the distance between two groups as the separation between the two closest objects (StatSoft 1997). The final subcolonies were selected by identifying the similarity level which matched physiographic units – mainly valleys separating hillsides – recognizable with the digital terrain models (altitude and slope) of the GIS. To illustrate with an example of the two largest subcolonies – Granadilla II and San Pedro IV – in the first the nearest distance between nests was 0.15 and the furthest 3.47 km, while in the


**Figure 1.** Map of Extremadura (Spain) and Iberian Peninsula showing the location of the studied colonies. Colonies in Extremadura are indicated by circles (closed: colonies included in analyses; open: colonies not included in analyses), and by squares in the rest of the Iberian Peninsula. Cabañeros data (Guzmán & Jiménez 1998); Sierra de Andújar data (Moleón *et al.* 2001); Sierra de Guadarrama data (Grefa 2004).

second the numbers were 0.12 and 3.17 km, respectively. For comparison, the furthest distance between nests of the whole San Pedro colony was greater than 50 km.

## Prey collection and pellet analysis

Pellets were gathered below nesting platforms, except for a small percentage that were obtained at perching sites near nests. All pellets were therefore assigned to a specific pair. Samples were collected throughout the annual cycle of the years 1998–2000.

Ingestion of soft parts without fur may prevent detection in pellets (Rosenberg & Cooper 1990), but our species is noted for its preference of the outer parts of carcasses including hides, which would largely eliminate this source of bias (Hiraldo 1976, König 1983). We think that the approach followed in the present work provides a reliable description of the prey spectrum of the Cinereous Vulture, although it does not estimate the real frequency of ingestion of different prey types as in pellet studies in other large raptors (González 1991). From each pellet, hair samples were extracted and studied under a magnifying glass or microscope. Samples were mounted on supports, and compared with a reference collection, and with identification keys for mammal hair (Faliu *et al.*

**Table 1.** Characteristics of the studied colonies, including mean altitude of the nesting grounds, principal nesting tree, and principal habitats and land use.

| Colonies | Number of pairs | Altitude | Nesting tree | Habitats | Land use |
|---|---|---|---|---|---|
| Sierra De Gata | 42 | 766 m | *Pinus pinaster* | Regeneration pine stands, heath, other Mediterranean scrub, dehesas | Forestry and livestock |
| Granadilla | 12 | 653 m | *Pinus pinaster* | Regeneration pine stands, Mediterranean scrubland, dehesas, cropland | Forestry, livestock, and big game |
| San Pedro | 248 | 475 m | *Quercus* spp. | Cork and Holm Oak stands, scrubland, dehesas, pastureland | Livestock, forestry, and big game |
| Ibores* | 6 | 698 m | *Quercus* spp. | Regeneration pine stands, Cork and Holm Oak stands, scrubland, dehesas, etc. | Forestry and livestock |
| Cíjara* | 11 | 728 m | *Quercus* spp. | Regeneration pine stands, Mediterranean scrubland, Cork and Holm Oak stands, dehesas | Forestry, big game, and livestock |

*Colonies not included in analyses.

1980, Chehébar & Martin 1989, Teerink 1991). The presence of plant remains was not taken into account in the analysis, as the ingestion of plant material is probably to facilitate regurgitation of indigestible elements (Bernis 1966, Hiraldo 1976).

Whenever possible, samples were identified at the species level. Otherwise, samples were classified into higher taxonomic categories, such as swine (Wild Boar *Sus scrofa* and pigs *Sus domesticus*, classified as '*Suidae*') and lagomorphs (Rabbit and Iberian Hare *Lepus granatensis* classified as '*Leporidae*') in the order *Lagomorpha*.

**Data analysis and statistical treatment**

Presence of a prey species in the pellet was interpreted as showing that the vulture had eaten once from one individual of that species (Hiraldo 1976). This frequency of presence in pellets was calculated for each colony. Dietary diversity was calculated with the Shannon-Weaver index (H') for six prey categories: *Suidae, Cervidae, Caprinae, Leporidae*, Other Mammals (see below), and Birds. Similarly, the Berger-Parker index was calculated as a measure of the dominance of any one prey category in the diet (Magurran 1988).

The chi-squared test was applied to analyze inter-colony dietary differences. In order to obtain an adequate distribution of expected frequencies, including the appropriate corrections when the degree-of-freedom of the test was equal to unity (Zar 1996), it was necessary to group categories that had the lowest frequencies of presence. In particular, in comparing the diet between different Extremadura colonies, domestic goats *Capra hircus*, having a low frequency of presence of 1.32% ($n$ = 378), were grouped with sheep *Ovis aries* under the subfamily '*Caprinae*', and carnivores were grouped with unidentified mammals in the category 'Other Mammals'. These analyses were also performed for each prey category in order to test whether their frequencies of presence were the same in all colonies. Correspondence analysis was used to study intra-colony dietary variations distinguishing subcolonies. This technique enables plotting of each location and each prey group on the same factorial plane (Pielou 1984). A Hutcheson test was used to analyze the inter-colony differences in prey diversity (Magurran 1988).

## RESULTS

**Diet of Cinereous Vulture in Extremadura**

In the different colonies of Extremadura 238 pellets were collected, from which 378 prey items were extracted (Table 2). The prey category most frequently encountered was *Caprinae* (mainly sheep), followed by *Suidae, Cervidae*, and Birds. *Leporidae* were rarely encountered. Ten percent of the mammals could not be identified by means of fur analysis.

**Inter-colony variation in diet**

The predominant prey category in all three main colonies was *Caprinae*, followed by poultry in Sierra de Gata (22.1%) and *Suidae* in the other two colonies (Table 2). The three colonies showed significant differences in composition of the prey spectrum ($\chi^2_{10}$ = 75.40; $P$ < 0.001). Pairwise comparisons showed the diet in Sierra de Gata to be different from the other two (with Sierra de San Pedro, $\chi^2_5$ = 52.00; $P$ < 0.001; and with Granadilla, $\chi^2_5$ = 32.77; $P$ < 0.001). Instead, the diets of Cinereous Vultures in Granadilla and Sierra de San Pedro were very similar ($\chi^2_4$ = 5.20; $P$ = 0.27).

Comparisons between colonies for each prey category showed statistically significant differences only for Birds and *Cervidae* (Table 2). *Cervidae* were rarely present in the diet of the vultures of Sierra de Gata, while they constituted a considerable part of the diet in Granadilla (12.0%) and Sierra de San Pedro (14.4%). Poultry from intensive farms ('Birds') was a main prey item in Sierra de Gata, but was detected only once or not at all in the other colonies.

Dietary diversity was similar in all three colonies (Table 2), with no significant differences (Hutcheson test, $P$ > 0.05). Prey dominance followed the inverse order of diversity (Table 2), with Sierra de Gata having the lowest dominance and highest diversity, and Sierra de San Pedro the highest dominance and lowest diversity.

**Table 2.** Composition of the diet (percentage of each prey category) of the Cinereous Vulture in colonies in Extremadura (Spain). Diets compared between colonies with largest samples (Sierra de Gata, Granadilla, and Sierra de San Pedro). Nest column gives chi-squared values and statistical significance (ns: not significant; * $P < 0.01$, ** $P < 0.001$). Ibores and Cíjara not included in analysis. Extremadura is total of all five colonies.

| | Sierra de Gata | Granadilla | San Pedro | *Chi-squared test* | Ibores | Cíjara | Extremadura |
|---|---|---|---|---|---|---|---|
| ***Suidae* (swine)** | **10.6** | **21.7** | **15.6** | **4.60 ns** | | | **15.1** |
| ***Cervidae* (deer)** | **1.9** | **12.0** | **14.4** | **11.28 *** | | | **9.8** |
| **Subfam. *Caprinae*** | **46.2** | **47.8** | **58.1** | **5.03 ns** | **66.7** | **83.3** | **52.9** |
| Sheep *Ovis aries* | 43.3 | 47.8 | 58.1 | | 44.4 | 83.3 | 51.6 |
| Goat *Capra hircus* | 2.9 | | | | 22.2 | | 1.3 |
| ***Leporidae* (lagomorphs)** | **2.9** | **5.4** | **3.6** | **0.91 ns** | | **16.7** | **4.0** |
| **Other mammals** | **16.4** | **13.0** | **7.8** | **5.74 ns** | **33.3** | | **11.9** |
| Carnivores | 3.9 | 1.1 | 0.6 | | 11.1 | | 1.9 |
| Unidentified mammals | 12.5 | 12.0 | 7.2 | | 22.2 | | 10.1 |
| **Birds** | **22.1** | | **0.6** | **56.78 **** | | | **6.4** |
| Total food items | 104 | 92 | 167 | | 9 | 6 | 378 |
| Total pellets | 81 | 65 | 125 | | 7 | 5 | 283 |
| Dietary diversity (H') | 1.39 | 1.35 | 1.22 | | 0.64 | 0.44 | 1.41 |
| Dominance | 46.2 | 47.8 | 58.1 | | 66.7 | 83.3 | 52.9 |

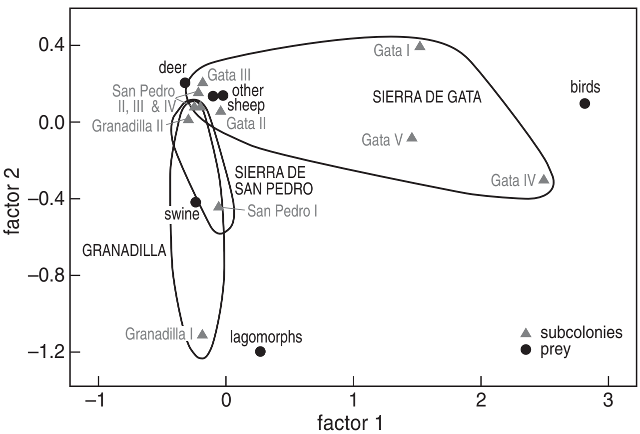


**Figure 2.** Plot of Factors I and II of the correspondence analysis for prey categories and vulture subcolonies, grouped by colony.

## Intra-colony variation in diet

The importance of the different prey items in the diet compared for subcolonies was studied by means of correspondence analysis. For the prey, Factor I was found to account for 59.0% of the variance, and separated the presence of Birds from the rest of the prey (Fig. 2). Factor II accounted for a much smaller percentage of the variance (16.1%), and discriminated *Suidae* and *Leporidae* from the rest (Fig. 2). Lastly, Factor III accounted for 15.2% of the variance, and separated *Suidae, Cervidae*, and Birds.

**Table 3.** Diet of Cinereous Vultures in different subcolonies, shown as frequency of presence (%). $n_t$: total number of prey; H': dietary diversity.

| Subcolonies | $n_t$ | *Suidae* | *Cervidae* | Sheep | Lagomorphs | Others | Birds | H' |
|---|---|---|---|---|---|---|---|---|
| Granadilla I | 18 | 50.0 | 5.6 | 22.2 | 16.7 | 5.6 | 0.0 | 1.30 |
| Granadilla II | 74 | 14.9 | 13.5 | 54.1 | 2.7 | 14.9 | 0.0 | 1.27 |
| San Pedro I | 23 | 8.7 | 0.0 | 56.5 | 17.4 | 17.4 | 0.0 | 1.14 |
| San Pedro II | 34 | 20.6 | 32.4 | 41.2 | 2.9 | 2.9 | 0.0 | 1.26 |
| San Pedro III | 19 | 21.1 | 10.5 | 57.9 | 0.0 | 10.5 | 0.0 | 1.12 |
| San Pedro IV | 61 | 13.1 | 13.1 | 67.2 | 1.6 | 4.9 | 0.0 | 1.02 |
| Gata I | 14 | 0.0 | 7.1 | 35.7 | 0.0 | 21.4 | 35.7 | 1.25 |
| Gata II | 41 | 17.1 | 0.0 | 41.5 | 0.0 | 19.5 | 2.4 | 1.08 |
| Gata III | 23 | 13.0 | 4.4 | 60.9 | 0.0 | 21.7 | 0.0 | 1.04 |
| Gata IV | 9 | 11.1 | 0.0 | 22.2 | 11.1 | 0.0 | 55.6 | 1.15 |
| Gata V | 9 | 0.0 | 0.0 | 55.6 | 11.1 | 0.0 | 33.3 | 0.94 |

For subcolonies, the correspondence analysis yielded similar patterns as to the colonies as a whole. Nevertheless, for each colony separately the relative importance of the different prey species varied between subcolonies (Table 3). The diet was very similar in the different subcolonies, with a clear dominance of *Caprinae* (sheep). Only some Sierra de Gata subcolonies were separated from the rest due to the presence of Birds in the diet (Fig. 2). Likewise, the subcolonies of San Pedro I and Granadilla I (Fig. 2) differed slightly from the rest regarding the importance of *Leporidae* and *Suidae*, respectively. In the remaining subcolonies, the diet was very similar and clustered around positions corresponding to *Caprinae* and *Cervidae*.

Dietary diversity was similar in all subcolonies. Those with the highest values were Granadilla I and II (1.30 and 1.27, respectively), as approached by subcolonies San Pedro II and Gata I (Table 3).

## DISCUSSION

### Diet variation in Extremadura and Iberian Peninsula

The Cinereous Vulture is known to feed on a great variety of prey worldwide and in the Iberian Peninsula in particular (Valverde 1966, Garzón 1973, Hiraldo 1976, Cramp & Simmons 1980, Del Hoyo *et al.* 1994). In this sense, the diet of the Cinereous Vulture in Extremadura was found to be very different from that of other Iberian colonies (Fig. 3). In Cabañeros (Guzmán & Jimenez 1998) and in the Sierra de Andujar (Moleón *et al.* 2001), the diet is composed of lagomorphs and deer. On the contrary, in the Sierra de Guadarrama, the presence of lagomorphs is low, and a great part of the diet consists of domestic pigs (23%) and sheep and goats (25%) (Grefa 2004). In line with general trends in raptors, the diet of Cinereous Vulture in different parts of the Iberian Peninsula changes in response to prey availability (Costillo 2005). In the different colonies of Extremadura sheep carcasses formed the staple food. Nevertheless, there were major differences between colonies in supplementary prey as *Suidae, Cervidae* and Birds, with the result that the diet found in Sierra de Gata was different from that of Sierra de San Pedro and Granadilla (Fig. 2).

The Cinereous Vulture is able to make use of carcasses of small animals such as Rabbit, which used to be its main prey when Rabbit populations still thrived (Garzón 1973, Hiraldo 1976). The Rabbit is currently an important prey in Cabañeros and in the Sierra de Andújar (Guzmán & Jiménez 1998, Moleón *et al.* 2001), where densities are still high (Guzmán & Jiménez 1998, Angulo 2003). In

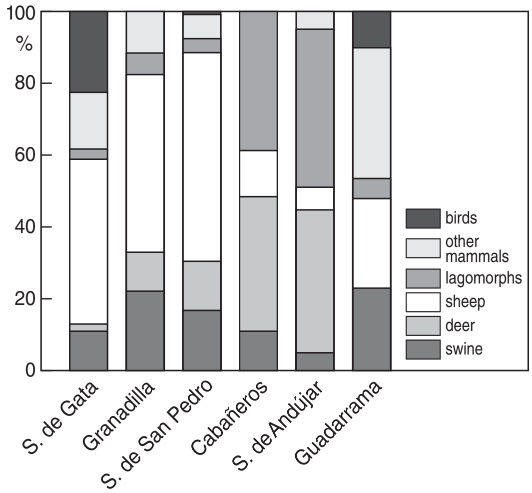


**Figure 3.** Frequency of presence (in pellets) of main prey categories in several colonies of Cinereous Vulture in the Iberian Peninsula. Sources: S. de Gata, Granadilla and S. de San Pedro ($n$ = 283 pellets, this study); Cabañeros ($n$ = 129; Guzmán & Jiménez 1998); Sierra de Andujar ($n$ = 199; Moleón *et al.* 2001); Guadarrama ($n$ = 60; Grefa 2004).

areas with abundant lagomorphs, Cinereous Vultures predation centred on Rabbit carcasses (Garzón 1973, Hiraldo 1976, Costillo 2005), a situation that complies with theories in avian ecology that predict that abundant resources lead to specialization (MacArthur & Levins 1967). Epidemics such as myxomatosis result in seasonal variations in the availability of carcasses for Cinereous Vultures (Soriguer 1981, Guzmán & Jiménez 1998), and hence in similar variations of Rabbits in the diet (Hiraldo 1976, Guzmán & Jiménez 1998, Moleón *et al.* 2001). In such colonies, ungulates – being a relatively stable resource throughout the year – become an important albeit secondary prey: during the past century sheep and goats supplemented the lagomorph-based diet (Hiraldo 1976); today it is deer (Guzmán & Jiménez 1998, Moleón *et al.* 2001).

Myxomatosis and viral haemorrhagic pneumonia have caused Rabbit populations to crash over extensive areas in the Iberian Peninsula (Sumption & Flowerdew 1985, Villafuerte *et al.* 1995). Rabbit densities are presently low in those parts of Extremadura where Cinereous Vultures breed (Junta de Extremadura 1992). For this reason, Cinereous Vultures in Extremadura mainly fed on carcasses of domestic ungulates, in particular Sheep. Sheep has been known as food of Cinereous Vultures in the Iberian Peninsula (Garzón 1966, Hiraldo 1976) and other areas of its distribution (Cramp & Simmons 1980), although never before to the extent found in Extremadura. This situation may have arisen from the fact that sheep density in Extremadura is much higher (on average 10 808/100 $km^2$) than in the rest of Spain (4037/100 $km^2$) (MAPA 2002). Additionally, the European Community subsidizes sheep farming by head of livestock, hence fostering the ageing of stock (as calculated by Álvarez 2002) with consequent higher natural mortality.

In the colonies of Granadilla and Sierra de San Pedro (Fig. 4), the vultures supplemented their diet with swine and deer. The importance of Red Deer *Cervus elaphus* as food of Cinereous Vultures has also been established elsewhere in the Iberian Peninsula, such as Cabañeros and Sierra de Andujar (Guzmán & Jiménez 1998, Moleón *et al.* 2001) (Fig. 3). Red Deer have undergone a major population boost in the Iberian Peninsula (Braza *et al.* 1989, Soriguer *et al.* 1994). Many estates have been fenced to allow intensive management of deer populations, and this has led to a considerable increase (Carranza 1999). High densities and fencing caused a decline in health and genetic quality of deer, resulting in higher mortality rates (Ballou & Ralls 1982, León 1991, Carranza 1999). Combined with increased hunting these estates offer now many more deer remains for Cinereous Vulture than in the recent past.

Cinereous Vultures in the Sierra de Guadarrama take advantage of intensive pig farming; carcasses are dumped in what are known as 'muladares' (dumps for dead livestock) (Grefa 2004). The greatest number of livestock near this vulture colony is found in the Province of Segovia, with pigs predominating; in 2000 out of 1.8 million head of livestock, pigs totalled 950 000 (data:

**Figure 4.** Typical habitat of Cinereous Vulture in Sierra de San Pedro with the nesting area (at the right) and feeding area (at the left) (photo E. Costillo).

Junta de Castilla y León, Regional Authorities of Castilla y León). In the Extremadura, domestic pigs and Wild Boar are abundant but their relative importance in the vulture's diet is difficult to assess because of problems of differentiating them in pellets. The pig-farming sector in Extremadura is represented by 1.3 million animals, mostly in a free-range regime in the proximities of vulture colonies (MAPA 2002). The situation of Wild Boar is similar to that described above for Red Deer (Saez-Royuela & Telleria 1986, León 1991).

In the colony of Sierra de Gata, Cinereous Vultures showed a different feeding strategy by complementing their diet with Birds, in particular chickens *Gallus domesticus* from intensive poultry farms. Presence of birds, both wild and domestic species, in the diet of the Cinereous Vulture has been noted before (Valverde 1966, Hiraldo 1976). Also in Guadarrama, it is recorded frequently, accounting for 10% of prey presence (Grefa 2004). However, the high proportion of Birds as found in the diet of the vultures from the Gata colony has never been reported before. Indeed, birds constituted the principal prey in two subcolonies (Table 3). García *et al.* (1998) noted the importance of poultry from intensive farms in the diet of Red Kite *Milvus milvus* overwintering in the Iberian Peninsula. The Cinereous Vulture's current use of remains from intensive poultry farms is probably a response to the high availability of this resource. This livestock sector has undergone explosive growth in recent years in Spain in general, and in Extremadura in particular (MAPA 2002).

**Intra-colony variation in diet**

In addition to variability between colonies, we also found variability in diet between subcolonies in a given colony. This may reflect individual feeding differences of pairs constituting a colony, as described by Hiraldo (1976). Vultures may use different home ranges, and hence exploit different carrion types, as show by radio-tracking (Costillo 2005). It is also possible that individuals specialize, as observed in other bird species (Götmark 1984).

**Food habits and conservation biology**

In agreement with other authors (Anderson & Erlinge 1977, Recher 1990) our data suggest that the Cinereous Vulture in the Iberian Peninsula can be regarded as a generalist. Likewise, its use of new food sources, its adaptive responses to drastic changes in prey availability, and the breadth of its prey spectrum, indicate that the Cinereous Vulture presents great trophic plasticity (sensu Morse 1980). Its use of new resources is not only illustrated by the exploitation of remains and carrion from intensive poultry farms, but also by the feeding on dead fish in a reservoir of Extremadura (own observations). For the Doñana marshes, Valverde (1966) furthermore cites Eel *Anguilla Anguilla* and waterbird carrion as prey.

In this aspect the Cinereous Vulture contrasts with the Griffon Vulture *Gyps fulvus*, which is highly specialized in consumption of medium-sized or large ungulates (Donázar 1993). Pennycuick (1976) describes a similar situation in Africa with Lappet-faced Vulture *Torgos tracheliotus*, an ecological counterpart of the Cinereous Vulture, and other species of the genus *Gyps* which are specialized on large African herbivores (Houston 1974). Similarly, the California Condor *Gymnogyps californianus*, another large carrion-feeder, exhibits a highly varied diet (Snyder & Snyder 2000) with a similar range of prey as found in Cinereous Vulture. This wider range of carrion is probably related to a wide range of foraging strategies (Donázar 1993), which makes them efficient in finding carrion of smaller size.

The feeding habits of the Cinereous Vulture could play an important role in the conservation of its populations. Regarding diet two types of colonies occur in the Iberian Peninsula: one is linked to wild prey (lagomorphs and deer) and another to livestock (sheep and pigs). In areas where Rabbits are scarce, the diet of the Cinereous Vulture is closely linked to human resources such as livestock farming. This implies that the species is sensitive not only to environmental change, but especially to human activities as extensive livestock farming that affect these resources (De Juana & De Juana 1984, Arroyo *et al.* 1990). The social and health alarms caused by livestock diseases (BSE, Rift Valley fever, and bluetongue disease) have led to legislation and other measures aimed at a stricter control of livestock carcasses (Camiña & Montelío 2006). Also, the forthcoming reform of the CAP will affect the livestock sector as a whole, and may well result in a reduction in the present and future availability of food for carrion-feeders. Given the trophic plasticity of the Cinereous Vulture, and the fact that the impact of these new circumstances (CAP reforms and stricter control of livestock carcasses) will presumably vary from colony to colony, studies of the availability of other prey, both domestic and wild, would be required to foresee how this new situation would affect the Cinereous Vulture.

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## SAMENVATTING

Er is weinig bekend over de huidige voedselkeuze van Monniksgieren *Aegypius monachus*, want het meeste werk op dit gebied is tientallen jaren oud. Het onderhavige onderzoek richtte zich op het menu van deze gieren in een aantal kolonies in Extremadura in het zuidwesten van Spanje. Kolonie is hierbij een rekbaar begrip, want de maximale afstand tussen nesten binnen een kolonie bedroeg 50 km. Binnen kolonies lagen de nesten meestal in clusters ('subkolonies') bijeen, op een afstand van 100 m tot ruim 3 km van elkaar. Er werden 283 braakballen bij de nesten verzameld, waarin 378 prooien werden geïdentificeerd. Schapen vormden in alle kolonies de hoofdmoot van het voedsel. In Sierra de Gata werd dit aangevuld met kippen en varkens uit de intensieve veehouderij – gedumpt op zogenoemde 'muladares' – en in Sierra de San Pedro en Granadilla brachten herten, varkens en wilde zwijnen variatie in het menu. Uit literatuuronderzoek bleek ook het gierenbestand elders in Spanje sterk afhankelijk van landbouwdieren met overwegend schapen en varkens op het menu (Sierra de Guadarrama). In gebieden met een rijk aanbod aan konijnen en herten (bijvoorbeeld Cabañeros en Sierra de Andujar) vormden wilde dieren (na hun dood) een belangrijke bron van voedsel. De grote variatie in voedselkeuze die de gieren over heel Spanje lieten zien, bleek ook op kleinere schaal uit verschillen tussen subkolonies. Het grote aandeel van landbouwhuisdieren in het menu van de Monniksgier laat zien hoe goed de soort zich in het moderne landschap weet aan te passen. Aan de andere kant maakt het de soort kwetsbaar, omdat de beschikbaarheid van dergelijke prooien sterk kan fluctueren. In de nabije toekomst kan daarbij gedacht worden aan de consequenties van recente uitbraken van BSE, mond- en klauwzeer en blauwtong en aan veranderingen in de Europese landbouwpolitiek. (RGB)

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