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# Genet (*Genetta genetta* L., 1758) diet shift in mountains of central Spain

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## Abstract

This study focuses on the seasonal shift of the main prey and patterns of prey size consumed by a population genet (*Genetta genetta* L.) in central Spain as determined by scat analysis. Four different "middens" (186 scats) were studied. Data were presented as frequency of occurrence and biomass of each prey group considered. Seasonal variation for the occurrence of each prey group in the diet was tested with the Chi-square goodness of fit test. Mean prey size index was used to analyse the distribution pattern of prey weights consumed. The mean prey size obtained was compared with others from different areas.

As in earlier studies, woodmouse (*Apodemus sylvaticus*) was the predominant prey group. However, in winter the diet was based on birds. In addition, this group was the most important throughout the year with respect to frequency of occurrence data. This shift is discussed from an energetic point of view. The role of dung beatles was also significant and their inclusion in mean prey size calculations was recommended. The remaining groups only showed unimportant seasonal fluctuations.

Mean prey size obtained is lower than in other populations. The relative role of woodmouse, arthropods and rabbits (*Oryctolagus cuniculus*) explains these differences.

## Introduction

Studies on the diet of genet (*Genetta genetta* L.) in Spain and other countries are relatively numerous (Delibes 1974; Magalhaes 1974; Alcover 1984; Calviño et al. 1984; Cugnasse and Riols 1984; Lodé et al. 1991; Palomares and Delibes 1991; Hamdine et al. 1993) and have shown the generalist habit of this species. However, the species clearly prefers small mammals, which were always the main prey item in the diet, despite their seasonal or local availability (Lodé et al. 1991; Hamdine et al. 1993). The remaining prey items experienced spatio-temporal variations according to their potential availability (Livet and Roeder 1987). Many studies have pointed out the important intraspecific plasticity of carnivores in their diet selection (see Bekoff et al. 1984) and the functional response to changes in abundance of their main mammalian prey (Anderson and Erlinge 1977; Jaksic 1989). Recently, studies on the generalist or specialist condition in species like the badger, *Meles meles* (Roper 1994; Martín et al. 1995) showed the importance of focusing future research on the population level, according to earlier suggestions (Partridge and Green 1985). With regard to the genet, this species has been noted to have a clear preference for the woodmouse (*Apodemus sylvaticus*) despite some evidence showing changes towards other prey items in certain individuals or populations (Alcover 1982, 1984; Delibes et al. 1989).

On the other hand, the influence of other aspects of trophic ecology such as the size

distribution of the prey consumed have, so far, been largely ignored. Erlinge (1987) and King (1991) demonstrated the importance of these aspects in the ecology of small mustelids. Knowledge of the size pattern could also permit future studies concerned with optimal diets and how these can change, e. g., within and between populations or individuals. These baseline data will aid research into other related ecological subjects.

In this study, the seasonal changes of trophic preferences are described in a local population of genets.

## Material and methods

The field work was conducted in the Alto Manzanares Regional Park, located on the southern slope of the Sierra of Guadarrama (central Spain). All bioclimatic and vegetation stages of central Spain mountains are represented in this area, which varies in altitude from 700–1 200 m (Rivas-Martínez et al. 1987).

To study the genet diet we selected four middens (heaps of scats) located in different but nearby areas. The first one was located in a dehesa (open wood with pastures) where holm oak (*Quercus ilex*) and ash (*Fraxinus angustifolia*) were the dominant tree species. The second and third ones were located in a holm oak closed forest. The fourth midden was located in a *pyrenaica* oak forest (*Quercus pyrenaica*). All middens were located within 850–1 000 m range.

Laboratory analyses were carried out following the procedures described by Corbett (1989) and Reynolds and Aebischer (1991). The remains were determined using diagnostic features (teeth, feathers, flakes, seeds, etc.) supported by keys and reference collections. The prey items considered can be consulted in table 1.

Results were presented as frequency of occurrence (number of scats with prey item presence/total number of scats $\times 100$) and biomass for each prey item, following the methods and recommendations from Corbett (1989). Transformation factors suggested by Palomares and Delibes (1991) were applied to calculate consumed biomass, except for fruits where factors were based on Blanco (1988) from a study on the red fox (*Vulpes vulpes*).

B-diversity index of Levins (1968) was used for the frequency occurrence data in each season. Association between diversity and occurrence data was analysed by non-parametric Spearman rank correlations (Siegel and Castellan 1988).

To analyse seasonal variation a $2 \times 4$ contingency table with the frequency of occurrence data was used (Reynolds and Aebischer 1991). Prey items that did not satisfy test conditions were excluded from the analysis (Sokal and Rohlf 1981). Bonferroni sequential corrections were applied to avoid type I error (Rice 1989).

In order to analyse the prey sizes consumed, the mean prey-size index suggested by Erlinge (1987) was used and the prey distribution was classified into three categories: $< 15$ g; 16–50 g and $> 50$ g following Clevenger (1994). Delibes (1974) and Rodríguez (1993) mean weight data were used in calculations: *Microtus* (30 g); *Apodemus* (25 g); *Mus* (20 g); *Rattus* (150 g); *Oryctolagus* (150 g); small bird (30 g); medium-size bird (100 g); lacertid (3 g); snake (100 g); amphibian (15 g); arthropod (1 g).

## Results and discussion

Frequency of occurrence and biomass results for each category are shown in table 1. The minimum number of individuals of each taxon according to category is shown in table 2.

The largest group with respect to contributed biomass was small mammals, whereas birds represented the group most frequently found in the scats throughout the year. Genets also consume a large number of insects and in certain seasons amphibians (winter), reptiles (summer), and fruit (autumn).

Significant differences in frequency of occurrence of the five most outstanding prey items (small mammals, birds, reptiles, amphibians and insects) were found (Tab. 3), especially insects and reptiles. The former had very low winter frequencies and the reptiles were consumed more in the summer.

**Table 1.** Frequency of occurrence (f) and biomass (b) of the prey groups considered; scat number analysed (n) and B-index of Levins (1968)

| | Winter (n = 42) | Spring (n = 55) | Summer (n = 56) | Autumn (n = 33) |
|---|---|---|---|---|
| Mammals | b 16.45<br>f 34.88 | b 73.87<br>f 81.48 | b 52.54<br>f 76.66 | b 61.15<br>f 81.81 |
| Birds | b 63.45<br>f 88.37 | b 23.00<br>f 75.92 | b 39.77<br>f 76.66 | b 19.72<br>f 45.45 |
| Reptilies | b 3.74<br>f 11.63 | b 0.63<br>f 11.11 | b 0.48<br>f 45.00 | b 0.00<br>f 0.00 |
| Amphibians | b 10.57<br>f 27.91 | b 1.72<br>f 7.41 | b 0.48<br>f 6.66 | b 0.00<br>f 0.00 |
| Insects | b 0.23<br>f 18.60 | b 0.67<br>f 83.33 | b 2.13<br>f 60.00 | b 3.36<br>f 72.72 |
| Myriapods | b 3.39<br>f 4.65 | b 0.00<br>f 1.85 | b 0.00<br>f 0.00 | b 0.00<br>f 0.00 |
| Eggs | b 0.00<br>f 0.00 | b 0.03<br>f 1.85 | b 0.00<br>f 0.19 | b 0.00<br>f 0.00 |
| Carrion | b 0.02<br>f 2.17 | b 0.00<br>f 0.00 | b 0.00<br>f 0.00 | b 0.00<br>f 0.00 |
| Fruits | b 0.00<br>f 0.00 | b 0.00<br>f 0.00 | b 0.00<br>f 0.00 | b 15.77<br>f 39.39 |
| B-index | 4.58 | 2.94 | 4.04 | 3.04 |

The most important item throughout the year, was the group small-mammals except in winter when birds clearly predominated in the diet, in biomass as well as in frequency of occurrence.

Diversity reached its maximum in winter, and minimum in spring coinciding, respectively, with the highest and the lowest frequencies of occurrence of small mammals in the scats. Frequency of mammals was negatively correlated with trophic diversity (Tab. 3). Insects also correlated negatively with trophic diversity, but this difference was not significant. The remaining groups showed no significant positive correlations with diversity.

These data reveal a shift in the main prey-item from one group to another, in accordance with earlier studies on the diet of genet (Alcover 1982, 1984; Delibes et al. 1989). Birds composed the bulk of prey consumed in winter and they were the most significant prey-item in frequency of occurrence for the whole year, although the woodmouse remained the main prey item in biomass and correlated negatively with diversity. Contrary to investigations of Alcover (1982, 1984) and Delibes et al. (1989), the main prey is replaced by an equivalent group from an energetic point of view. The high winter predation suggests a specialization in roost of small passerines. They constitute abundant (Tellería 1987) and predictable resources in this area, both characteristics that determine high encounter rates and make them easy to capture (high success rate). High encounter and success rate determine high prey vulnerability to predation (Greene 1986). Moreover, they make an important contribution to biomass. As a result, the high profitability of this prey item could cause the shift in preferences. However, because of the lack of availability estimates we cannot assess whether this shift is a consequence of selective choice or an indication of changes in main prey availability (e. g. decline).

**Table 2.** Prey species in each prey group considered and minimun number of individuals (N) found.

| Prey-items | N |
|---|---|
| Mammals | |
| *Oryctolagus cuniculus* | 1 |
| *Crocidura russula* | 6 |
| *Talpa* spec. | 1 |
| *Pitymys duodecimcostatus* | 18 |
| *Apodemus sylvaticus* | 69 |
| *Mus* spec. | 2 |
| Muridae | 14 |
| Small-mammals | 38 |
| Birds | |
| *Turdus merula* | 6 |
| *Fringilla coelebs* | 30 |
| Passerines | 17 |
| Birds undetermined | 107 |
| Reptiles | |
| *Psammodromus algirus* | 29 |
| Ophidia | 2 |
| Reptiles undetermined | 9 |
| Amphibians | |
| Anura | 20 |
| Insects | |
| *Typhaeus typhoeus* | 17 |
| Geotrupidae | 2 |
| Escarabeidae | 95 |
| Carabidae | 6 |
| Cetonidae | 3 |
| Melolonthidae | 8 |
| Elateridae | 2 |
| *Blaps* spec. | 1 |
| Coleoptera | 17 |
| Orthoptera | 11 |
| *Gryllotalpa* spec. | 4 |
| Formicidae | 17 |
| Insects undetermined | 11 |
| Eggs | |
| *Turdus merula* | 2 |
| Undetermined | 3 |
| Fruits | |
| *Juniperus oxycedrus* | 1 |
| *Rubus* spec. | 650* |
| *Ficus carica* | 430* |
| Others | |
| *Julus terrestris* | 3 |
| *Buthus occitanus* | 1 |

*: seed number found

**Table 3.** Chi-square test for 2×4 contingency tables on seasonal variation in presence/absence data and Spearman correlation coefficient ($r_s$) between trophic diversity (B-index) and frequency of occurrence data.

| | $X^2$ | $r_s$ |
|---|---|---|
| Mammals | 34.32*** | –1.00*** |
| Birds | 22.41*** | 0.80 |
| Reptiles | 40.01*** | 0.60 |
| Amphibians | 19.32*** | 0.40 |
| Insects | 43.15*** | –0.40 |

***: $P < 0.001$.

Insects also play an important role with respect to frequency of occurrence. Other studies have already indicated the significance that this group can acquire in certain periods of the year (Delibes 1974; Delibes et al. 1989). The explanation for this high consumption in a not particularly thermic area can be found in the nature of the insects captured and their ecology. Most of them are dung beetles with nocturnal activity, very abundant in the habitat studied due to high availability of cow faeces (Palmer et al. 1989).

In the case of reptiles the *Psammodromus algirus* stands out, a plentiful species in these habitats (Diaz and Carrascal 1991). Amphibians were well represented in winter. Coinciding with the last few days of this season, some species were concentrated in reproductive pools (Rodríguez-Jiménez 1983; López-Jurado 1988) becoming an easy and predictable food resource. Fruits were eaten exclusively in autumn, when their availability reached a maximum. Only two species were significantly consumed, blackberries (*Rubus* spp.) and figs (*Ficus carica*). However, these are not very important in the overall diet, especially compared to other Mediterranean generalist carnivores (Ciampalini and Lovari 1985; Blanco 1988; Alegre et al. 1991).

The prey size found (17 g) is very small compared with that recorded for other genet populations: 27 g (Galicia, Calviño et al.

1984); 24 g (Mallorca, Alcover 1984); 40 g (Doñana, Palomares and Delibes 1991); 12 g (Algerie, Hamdine et al. 1993), and is primarily influenced by the high rate of insects and other arthropods in the diet. In Algerian genets the prey size value was lower still and they also ingested a high proportion of insects (Hamdine et al. 1993). Data from Mallorca and Galician populations show values within the range of woodmouse weights, in accordance with a higher and lower ingestion of woodmouse and arthropods, respectively, in these areas (Alcover 1984; Calviño et al. 1984). The value obtained from Doñana (Palomares and Delibes 1991) revealed the importance of rabbits (*Oryctolagus cuniculus*) and rats (*Rattus* spp.) in the diet of this population. Nevertheless, it is impossible to determine whether these large differences indicate a higher level of trophic stress (Heggebert and Moseid 1994) in populations with an important arthropod contribution in their diet without data on the physical condition of individuals. On the other hand, smaller prey size could be an optimal adaptation on many occasions (Juanes 1994) despite early predictions from classical optimal foraging theory (Stephens and Krebs 1986). Gittleman (1985) and Fisher and Dickman (1993) pointed out a tendency for smaller prey sizes in insectivorous carnivores. This interspecific pattern could be extrapolated to the intraspecific level.

Moreover, King (1991) discusses whether arthropods should be included when applying to the index proposed by Erlinge (1987) and considers that this should depend on whether this group is incidentally predated. Regarding the ecological characteristics of the majority of insects found in the diet, we consider that their location in predictable and abundant patches (cow faeces) render them especially rewarding prey items (high prey vulnerability). In addition, their rapid and easy ingestion results in a minimum of time lost before they can begin searching for more profitable prey (see Fisher and Dickman 1993). Likewise, it is uncertain whether other prey groups (amphibians and reptiles) should be included in calculation of the index in view of their probable incidental predation. However, their seasonal and local importance preclude their exclusion. In any case a greater consensus is required about which groups to include in the application of these indices for generalist carnivores. Extrapolation of the criteria used for small specialist mustelids (Erlinge 1987; King 1991) is not reasonable.

The absence of larger prey is noteworthy and is probably due to the scarcity of rabbits and rats in the study area. As in other subjects related to trophic ecology, it would be necessary to know the range of available sizes in the environment in order to determine whether observed patterns reflect selective prey choice by genets.

All the above data manifest the generalist character of genets in this area (despite quantitative estimates of food availability). The shift of the main prey item towards birds verifies the plastic behaviour of this species.

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## Zusammenfassung

***Nahrungswechsel bei Ginsterkatzen (Genetta genetta L., 1758) in den Gebirgen von Zentralspanien***

Diese Arbeit beschäftigt sich mit dem aus Kotproben ermittelten jahreszeitlichen Wechsel der Nahrungsbestandteile und der Verteilung der Größe der Beute in einer Ginsterkatzen-Population in Zen-

tralspanien. 186 Kotproben von vier Absetzstellen wurden untersucht und die Ergebnisse als Frequenzen der Häufigkeit und als Biomasse pro Beutegruppe dargestellt. Die jahreszeitliche Variabilität in der Verteilung auf Beutegruppen wurde mit dem Chi-Quadrat-Test ermittelt. Der mittlere Index der Beutegröße wurde zur Analyse der Verteilung der Gewichte der Beute benutzt. Die mittlere Beutegröße wurde mit solchen aus anderen Regionen verglichen.

Wie aus früheren Untersuchungen bekannt stellte die Waldmaus (*Apodemus sylvaticus*) die wichtigste Beute dar. Im Winter bestand die Beute jedoch weitgehend aus Vögeln. In bezug auf die Häufigkeit im Auftreten in der Nahrung stellten Vögel durch das ganze Jahr hindurch den bedeutendsten Futterbestandteil dar. Dieser Wechsel wird vom energetischen Standpunkt her besprochen. Auch war der Anteil an Mistkäfern bemerkenswert. Es wird empfohlen, Mistkäfer bei der Ermittlung der mittleren Beutemengen zu berücksichtigen. Die übrigen Nahrungsgruppen weisen nur geringe jahreszeitliche Schwankungen auf.

Die mittlere Beutegröße ist geringer als bei anderen Populationen. Die relative Bedeutung von Waldmäusen, Arthropoden und Kaninchen (*Oryctolagus cuniculus*) erklärt diese Unterschiede.

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