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The Autumnal Diet of Rock Partridge (*Alectoris graeca*) in the Central Apennines

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Abstract - A preliminary study on the autumnal diet of the Rock Partridge (*Alectoris graeca*) in the Central Apennines was carried out through the analysis of 21 gizzard contents. Considering both the number of species present and the variety of parts of plants consumed, the diet was rather diversified. Green parts of plants were always found, especially Cistaceae (*Helianthemum oelandicum)* and Leguminosae. Seeds and fruits were present in 85.5% of the gizzards and the botanical families represented most frequently were Compositae, Fagaceae (*Ostrya carpinifolia* and *Fagus sylvatica*), Cistaceae and Leguminosae. Roots and bulbs appeared less frequently (14%). Coleoptera Chrysomelidae and Orthoptera were found respectively in 43% and 33.3% of the gizzards and constituted 94.5% of the total number of arthropods.
Most of these taxa are linked to rocky slopes, xerophilous and short grass pastures, or abandoned fields. These results stressed the importance of maintaining and managing a mosaic of habitats for the conservation of this bird.

Introduction

The Rock Partridge is a galliform with a restricted distribution area between France and the Balkans (Cramp and Simmons 1980). The Italian peninsula and Sicily support one of the most important populations in the world, with several thousand pairs estimated (Meschini and Frugis 1993). This species has undergone a decline in several areas due to abandonment of farming, tourism pressure, climatic change and, above all, hunting overexploitation (Tucker and Heath 1994). Despite its importance as a vulnerable game species, and, as a consequence, the need for careful management, the Rock Partridge is poorly known. For the Italian population, one of the most numerically relevant, there is little information concerning its diet. Due to the difficulty in recognizing prey remains through faecal analysis (cf. Didillon 1988), Petretti (1985) examined only the pattern of presence of chlorophyll and chitin in faeces during an annual cycle, while Priolo and Bocca (1992) reported some data from gizzards of birds shot. In other countries, several authors examined small samples of gizzards of birds that have been shot, in some cases in different periods of the year (Switzerland, Zbinden 1984; Croatia, Kovacevic and Danon 1952, 1959, Jovetic et al. 1979; Albania, Lamani 1962). Only Bernard-Laurent (1986) studied in detail the autumnal diet for the French Alps from analysis of 114 gizzards. Faecal analysis was used by Didillon (1988) to study the diet of hybrids (*Alectoris graeca saxatilis* X *Alectoris rufa rufa*) during one year. In this case, the author was able to identify prey remains at the genus or species level for plants and at the order level for animals.
However, the analysis of gizzard contents allows for more reliable results without the problems arising from faecal analysis (i.e. bias in estimation of different food categories due to different degree of digestibility). Moreover arthropod prey remains in gizzard can be identified at the species level (Bernard-Laurent 1986). In this note we report the autumnal diet of the Rock Partridge in Central Apennines resulting from the analysis of the gizzard contents of the shot birds.

Study area and methods

We obtained 23 gizzards from individuals shot in October-November 1995, 1996 and 1997 in two

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different areas of the Abruzzo region (Central Italy). Most of them (21) came from the area of the Sagittario Gorge. This is a deep gorge which separates the Genzana massif (2176 m) from the Terratta Mountains (2151 m) for about 12 Kms from North to South. The bottom of the gorge ranges from 1000 to 600 m and the cliffs can exceed a height of 500 m. Beech woods and large areas with herbaceous vegetation cover the steep slopes. Beyond the end and on the bottom of the gorge there are a few zones of traditional cultivation (olive groves, cereals and fodder) which form an environmental mosaic. There are also dry pastures and xerophilous shrubs. The other two gizzards came from the Southern border of the Majella massif, about 20 Km from the gorge. The vegetational characteristics of this area are similar to those of the Sagittario area. Gizzards were extracted from frozen birds and the vegetal and animal parts were separated and preserved in 70% ethyl alcohol before examination.

Vegetal remains were subdivided into the following three categories: green parts, bulbs and roots, seeds and berries.

Results were expressed as frequency of occurrence of each taxon and category (F=percentage of gizzards containing a particular taxon or category).

To give an ecological interpretation of the results, according to Pignatti (1982), each plant species or genus was attributed to the following four habitats: calcareous cliffs, xerophilous pastures or sunny calcareous cliffs, woods or bushes, and waste lands.

We referred to Baccetti (1959) and to the personal experience of two of the authors (Massa and Biondi unp. data) for the information about the Orthoptera and Coleoptera Chrysomelidae ecology.

All birds were shot by authorized hunters in accordance with the present laws.

Results

Twenty-one gizzards (including those of the Majella area) contained one or more items; therefore F was calculated only for these gizzards. Green parts of plants were always present while seeds and fruits were found with a high frequency (85.5%, Tab. 1). On the contrary, roots and bulbs represented a small fraction of the diet (F=14%). We did not find flower remains.

Rock partridge consumed both seeds and green parts of *Helianthemum* sp., which was present in almost all the gizzards examined. Green parts of Leguminosae (particularly *Medicago lupulina* and *Trifolium* sp.) occurred with a high frequency (F=52%) and Graminaceae and *Myosotis* sp. were also well represented.

Leguminosae, mainly *Onobrychis alba*, were present as seeds. No taxa clearly dominated the diet as green parts.

Tab. 1. Plants consumed by Rock Partridge

		F
	Seeds or fruits	**85.5**
Compositae		33
	Crupina crupinastrum	19
	Crupina vulgaris	9.5
	Leontodon sp.	5
Fagaceae		28.5
	Fagus sylvatica	9.5
	Ostrya carpinifolia	19
Leguminosae		28.5
	Onobrychis alba	24
	Leguminosae n.i.	9.5
Cistaceae		28.5
	Helianthemum oleandicum	14
	Helianthemum sp.	14
Malvaceae		
	Malvaceae n.i.	14
Ericaceae		
	Arctostaphylos uva-ursi	9.5
Cupressaceae		
	Juniperus communis	9.5
Graminaceae		9.5
	Bromus erectus	5
	Graminaceae n.i.	5
Boraginaceae		
	Cynoglossum sp.	5
Cruciferae		
	Alyssoides utriculata	5
Amaranthaceae		
	Amaranthus sp.	5
Ranunculaceae		
	Nigella sp.	5
	Roots or bulbs	**14**
Compositae		
	Leontodon cichoraceus	9.5
Liliaceae		
	Allium sp.	5
Graminaceae		
	Poa bulbosa	5
	Green parts	**100**
Cistaceae		
	Helianthemum oelandicum	76

Segue: Tab. 1.

Leguminosae	52
Medicago lupulina	19
Trifolium sp.	33
Vicia sp.	5
Graminaceae n.i.	33
Boraginaceae	
Myosotis sp.	24
Compositae	14
Leontodon hispidus	5
Compositae n.i.	9.5
Saxifragaceae	14
Saxifraga lingulata	5
Saxifraga paniculata	5
Saxifraga porophylla	5
Rosaceae	
Sanguisorba minor	9.5
Cruciferae	9.5
Alyssum sp.	5
Draba aizoides	5
Erysimum sp.	5
Aspleniaceae	
Asplenium ruta-muraria	5
Globulariaceae	
Globuraria meridionalis	5
Caryophyllaceae	
Minuartia sp.	5
Ranunculaceae	
Ranunculus millefoliatus	5
Crassulaceae	
Sempervivum tectorum	5
Bryophytes n.i.	5

Compositae (*Crupina* sp.), Cistaceae (*Helianthemum* sp.) and Fagaceae were found with moderately high frequency. It is interesting to observe that the Rock Partridge fed on seeds of this tree wood species; one of the gizzards contained indeed several dozen seeds of *Fagus sylvatica*, indicating a certain importance of this plant in the diet of the bird. On the contrary Graminaceae seeds were rarely found.

Rock Partridge seemed to feed preferentially on the plants of cliffs and xerophilous pasture (Fig. 1). Seeds and berries of plants of woods and bushes were well represented. On the other hand birds consumed only green parts of plants, particularly Saxifragaceae, growing on cliffs.

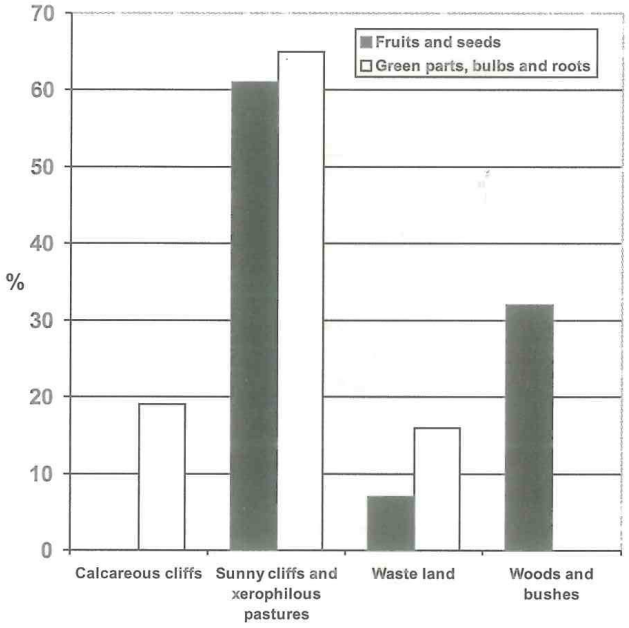

Fig. 1. Percentage of plants belonging to each habitat following Pignatti (1982). For each species or genus we assigned a score equal to the number of gizzards in which it appeared as Fruits/Seeds or Green parts/Bulbs/Roots. Then we calculated the sum of the scores of the plants belonging to each category (Fruits and Seeds, n=31; Green parts, n=37), thereafter subdividing for each habitat to calculate the percentage.

About 47% of the gizzards examined contained remains of insects (Tab.2). In these gizzards, the mean number of arthropods was 11.4±12.11 (range 1-39, n=10). Coleoptera Chrysomelidae (F=43) were fund more frequently than Orthoptera (F=33.3), but the latter category represented more than 50% of the total number of arthropods. All these arthropod species were associated with open areas such as pasture land, clearings of beech woods and cultivated fields. Nine out of the fourteen species of Orthoptera preyed on by the Rock Partridge live preferentially in xerophilous pastures. Seven of these are usually associated with *Brachypodium rupestre*. Only two species live in cool habitats. All Coleoptera species preyed on are usually found in grazed pasture land with a very short herbaceous layer (Tab. 1).

The mean number of Chrysomelidae in each gizzard was 5.11±5.27 (range 1-16, n=9), that of Orthoptera were 10.14±10.97 (range 1-29, n=7). This difference was not statistically significant (Mann-Whitney U test, Z=-0.92, P=0.35). For this last insect group, the females were preyed upon more than five times more frequently than males (χ^2=31.1, df=1, P<0.001). Heteroptera were also present, in 14% of the gizzard, but only with a few individual (2.4% of the total number of prey). Finally, *Mantis religiosa* was observed in two of the gizzards that were examined.

Tab. 2. Arthropods captured by the Rock Partridge. M=male, F=female, n.i.=non identified

	N	% gizzards (*F*)	% total arthropods	Habitat preference*
Coleoptera	48	43	37.8	
Coleoptera n.i.	1	5	0.8	
Chrysomelidae	47	43	37	
Galeruca tanaceti	23	28.5	18	P
Galeruca pomonae	20	24	15.8	P
Galeruca circumdata	1	5	0.8	P
Galeruca n.i.	1	5	0.8	
Chrysolina reitteri	2	9.5	1.6	P
Mantoidea	4	9.5	3	
Mantis religiosa	4	9.5	3	W, C
Heteroptera	3	14	2.4	
Codophila varia	1	5	0.8	P, W, C
Lygaeus saxatilis	2	9.5	1.6	W, C
Orthoptera	72	33.3	56.7	
Platycleis grisea	8 (1M, 7F)	14	6.3	P, O (b)
Chorthippus brunneus	20 (4M, 16F)	14	15.7	P (h), C, O
Chorthippus dorsatus	4 (4F)	14	3	P (h), O
Chorthippus monticola	4 (2M, 2F)	14	3	O (b)
Euchortippus declivus	3 (1M, 2F)	9.5	2.3	P, C, W (b)
Calliptamus italicus	15 (15F)	9.5	11.8	O (t)
Oepipoda coerulescens	4 (4F)	9.5	3	C, O
Stenobothrus apenninus	7 (1F, 6N.I.)	9.5	5.5	P (b)
Stenobothrus lineatus	1 (1F)	5	0.8	O
Tylopsis lilifolia	1 (1F)	5	0.8	P (t)
Pholidoptera fallax	1 (1F)	5	0.8	O (b)
Ephippiger ruffoi	1 (1F)	5	0.8	P, O (b)
Omocestus haemorrhoidalis	1 (1M)	5	0.8	P, O (t)
Tessellana tessellata	1 (1M)	5	0.8	C, O
Acrididae n.i.	1	5	0.8	
Total insecta	**127**	**47.5**	**100**	

*Legend: P= pasture land, O=clearings of beech woods, W=waste land, C=cultivated fields, (h)=preference for fresh sites, (b)=preference for *Brachipodium rupestre*, (t)= preference for warm sites.

Discussion

Our results indicate that the autumnal diet of the Rock Partridge in our study area was fairly varied with a particular dominance of vegetables, as was also reported in the French Alps (Bernard-Laurent 1986, Didillon 1988). The frequency of occurrence of the different vegetal and animal categories match those observed by Bernard-Laurent (1986) in the Alps. Namely, green parts were the most frequent category (100% in this study vs 95% in the French Alps) and the presence of fruits and seeds (85% vs 68+5%) was considerable. Roots and bulbs were less frequent in both areas (14% vs 11%). Moreover, the animal portion was important in both sites (47.5% vs 64%), and similarly the most frequent taxa are Coleoptera Chrysomelidae and Orthoptera. These insect groups constituted an important part of the Rock Partridge diet in several sites (cf. Kovacevic and Danon 1952, 1959, Zbinden 1982, Priolo and Bocca 1993). Coleoptera were consumed with a higher frequency in our area than in the Alps, but the Orthoptera were the most abundantly preyed. This

fact indicates a possible tendency to prey upon Orthoptera when they are available in the environment. Particularly, females were preyed on preferentially, but we do not know if this could be due to a different rate of predaction by the Rock Partridge or to other causes. Females of Orthoptera are usually bigger than males and this might reduce their manoeuvrability during flight when facing a predator. Moreover, the Rock Partridge might preferentially feed on females due to their higher energy content.

The species of Coleoptera Chrysomelidae found in the gizzards live preferentially in short grazed grass pasture, while a large part of the Orthoptera species live in beech wood clearings, pasture or waste land with *Brachypodium rupestre* (e.g. *Pholidoptera fallax*, *Platycleis grisea*, *Stenobothrus apenninus*, *Chorthippus monticola*). *Brachypodium rupestre* usually forms monospecific and tall pasture, especially in abandoned fields. A fairly component of Orthoptera live in xerophilous pastures (particularly *Omocestus haemorrhoidalis* and *Calliptamus italicus*). The presence of other animal taxa was negligibile; no Aracnida, Dermaptera and Hymenoptera were found in this study, while they were found in the Alps (Bernard-Laurent 1986).

The Rock Partridge fed preferentially on plants living on cliffs and secondary pasture, particularly xerophilous ones. *Helianthemum oelandicum*, *Onobrychis alba* and *Crupina* sp. are representative of these habitats. It must be pointed out that the diet of the Rock Partridge includes plants of woods, such as *Fagus sylvatica* and *Ostrya carpinifolia.* However in our study area small patches of shrubs and woods are interspersed with open habitat and the surface of the border zone between large woods and pastures is relevant. So in these areas the Rock Partridge could feed on seeds of these wood plant species without necessarily moving to areas with continuous arboreal cover. It is important to emphasize the considerable presence of green parts of newly grown Graminaceae. This could be related to summer grazing, which favours leaves to grow again in Autumn. Bernard-Laurent (1986) suggested that this species avoids ligneous part of plants due to their inability to digest them. It is reasonable to assume that soft shoots of plant are most easily assimilated, and these could be selected by the Rock Partridge. However in the Autumn, the species could meet most of its energy demand through ingestion of insect and berries which have a higher energy content than the green parts of plants (Rolando and Laiolo 1997). Moreover, insects are of particular relevance for protein assimilation, and Petretti (1985) considers that in the Autumn the Rock Partidge may exploit these high energy items to prevent starvation in winter, when food is partly inaccessible due to the snow-cover.

The large part of the prey was collected directly from the ground through surface pecking. Digging was used only to extract some roots and bulbs, probably because in this period the costs associated with this feeding technique (i.e. prolonged handling time and increased risk of predation due to the necessity to look continuously at the ground) outweights the benefits. Indeed, these costs are relatively higher in periods when more energetical-valuable prey such as insects and berries are widely available.

Even if we do not have quantitative data regarding the availability of food resources in the environment, our results provide some evidence that this species feeds opportunistically upon some items, such as Orthoptera, seeds and berries, which are particularly availaible in Autumn in our study area (Petretti 1985). Our data suggest that in the Central Apennines the Rock Partridge is associated with a mosaic of open habitats, especially short xerophilous pastures and vegetation of sunny calcareous cliffs. However, we emphasize the importance in these habitats of the presence of small patches of woods and shrubs, as suggested previously by Petretti (1985). For the conservation of the Rock Partridge, several authors recommended the preservation of open landscape through the maintainance of traditional forms of arable and pastoral farming (Sarà 1989, Priolo and Bocca 1993, Tucker and Heath 1994). In the Apennines, the abandonment of farming in large areas is causing natural wood recruitment at a very fast rate (Corbetta et al. 1996). So the expensive and widely developed afforestation practices on the remnant areas of pastures and mountainous slopes should be avoided or restricted only to small areas, using only local plants as suggested by the E.U. Reg. 2080. Economic resources should be used for the naturalistic management of the abandoned patches of woods and of the newly forested areas. This in turn make seeds and berries available to the Rock Partridge through the opening of the forest structure. Cultivated plants were not represented in our samples, but this could be associated with the scarcity of cultivated fields in the pastures neighbouring our study area, due to abandonment. However species such as *Nigella* sp. and *Amaranthus* sp. are typical of cultivated fields or recently-abandoned fields. So this habitat could have a certain importance for this species in Autumn. Thos suggests the importance of keeping cultivated fields near pastures, which could be periodically abandoned for short periods of time.

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Riassunto - Uno studio preliminare sulla dieta autunnale della Coturnice (*Alectoris graeca*) è stato realizzato attraverso l'esame del contenuto di 21 gozzi provenienti da individui dell'Appennino centrale. La dieta è risultata essere piuttosto diversificata, considerando sia il numero di specie consumato sia la varietà delle parti di vegetali utilizzate. In tutti i gozzi sono stati rinvenute parti verdi di diverse specie di piante, soprattutto di Cistacee (*Helianthemum oelandicum)* e Leguminose. Semi e frutti, soprattutto di Composite, Fagacee (*Ostrya carpinifolia* e *Fagus sylvatica*), Cistacee e Leguminose, sono stati rinvenuti nell'85.5% dei gozzi. Parti di radici e di bulbi erano presenti meno frequentemente (14%). Tra gli insetti, i coleotteri Crisomelidi e gli Ortotteri sono i taxa più rappresentati, rispettivamente nel 43% e nel 33.3% dei gozzi. Questi due gruppi rappresentano complessivamente il 94.5% del numero totale di artropodi predati.
Gran parte di questi taxa sono legati a versanti rocciosi, pascoli xerofili e coltivi abbandonati. I risultati ottenuti indicano la necessità di preservare gli habitat a mosaico per la conservazione della Coturnice.

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