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FEEDING HABITS OF THE LONG-LEGGED BUZZARD (*BUTEO RUFINUS*) DURING BREEDING IN NORTHEASTERN GREECE

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ABSTRACT

The feeding habits of the long-legged buzzard (*Buteo rufinus*) were studied in the Evros area in northeastern Greece during the breeding season. In terms of biomass, the diet consisted of 59% mammals, 27% reptiles, 13% birds, 0.6% insects, and 0.4% centipedes. Prey carried to nests consisted of 58% mammals, 37% reptiles, 1% birds, and 1% amphibians; 3% unidentified. A combined analysis of pellets and prey remains was used to describe the most important prey types. Avian prey were significantly less frequent in pellets in the summer than in the spring; insects were significantly more numerous in the summer. Significantly higher numbers of reptiles were found in pellets from nests in hilly areas than from those in areas on the plains.

INTRODUCTION

The long-legged buzzard (*Buteo rufinus)* is a large Old World raptor that, due to its limited distribution, has been little studied. The species has been included in Annex I of Directive 79/409 of the European Community as a European-conservation-concern-category-3 species (Tucker and Heath, 1994). The breeding population of long-legged buzzards in Greece is estimated at about 150 pairs, of which 20% are found in the Evros Province in northeastern Greece (Adamakopoulos et al., 1995). This area includes rare habitats and hosts unique populations of raptors constituting an Important Bird Area (Grimmet and Jones, 1989). Therefore, there has been an increasing interest in the appropriate management of the area to enhance its populations of raptors. Although diet is one of the most important biotic factors in the life of birds of prey (Smith et al., 1981) no information exists from this part of the region on the long-legged buzzard. Published data on the species diet is generally limited (Petrov, 1964; Dement'ev and Gladkov, 1966; Varshavsky 1973; Cramp and Simmons, 1980; Michev et al., 1984; Frumkin, 1986; Vatev, 1987; Dudas and Sandor, 1993), and there are no studies of feeding ecology. This paper presents information on the diet and foraging ecology of *Buteo rufinus* in Evros.

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STUDY AREA AND METHODS

The long-legged buzzard was studied in the Evros Province, an area between 40°44'–41°15'N and 25°53'–26°08'E in northeastern Greece. The study area is characterized by a relief varying from 10 to 800 m. In the far eastern portion of the area are the lowlands of the Evros River valley, which form the natural border between Greece and Turkey. This part of the area includes extensive cultivated land, woodland, scrub, and uncultivated areas. Hilly country, covered by extensive pine and oak forests and scrub interspersed with openings and many streams, lies in the western-central part of the province. A part of this area, known as "Dadia Forest," includes two core areas totaling 7,291 ha that have been declared a wildlife reserve. In addition to the long-legged buzzard, populations of breeding raptors include black vultures (*Aegypius monachus*), griffon vultures (*Gyps fulvus*), Egyptian vultures (*Neophron percnopterus*), golden eagles (*Aquila chrysaetos*), lesser-spotted eagles (*A. pomarina*), and short-toed eagles (*Circaetus gallicus*).

We studied the diet of the long-legged buzzard by analyzing pellets and prey remains and by visually recording prey carried to nestlings. Pellets and prey remains were collected at regular intervals from eight active nests (a total of 12 nest-years), and occasionally from roosts in the breeding season (March to July of 1989, 1990, 1992, and 1993). A combination of pellets and prey remains has been suggested to adequately describe the diet in a variety of birds of prey species (Collopy, 1983; Simmons et al., 1991; Oro and Tella, 1995). We observed prey carried to nestlings in six nests for a total of 12 nest-years. Prey were identified using binoculars and a telescope. Adult birds were also observed in their territories to record their hunting behavior. Prey biomasses (averages for each taxon) were taken from the literature (Helmer and Scholte, 1985; Perrins, 1987; MacDonald and Barret, 1993).

The diet of the long-legged buzzard in spring (mid-April to late May) was compared with its diet in summer (early June to early July). The spring and summer periods reflect two important stages in the biology of the long-legged buzzard in Evros: egg-laying and incubation, and nestling growth respectively. The diet in the plains was compared with that in the hilly areas. To avoid overestimating the prevalence of larger prey in the remains (Gilmer and Stewart 1984; Simmons et al., 1991; Oro and Tella, 1995) these comparisons were based on pellet analysis only.

Numerical proportions of prey items were compared by χ^2. Prey diversity, H, was estimated at the class level (Chilopoda, Insecta, Reptilia, Aves, Mammalia) by the Shannon–Wiener function $H = -\sum_{i=1}^{k} p_i \log_2 p_i$, where p_i is the proportion of i-th prey class and k is the number of classes. Evenness or equitability was estimated by the formula $E = H/H_{max}$, where $H_{max} = \log_2 k$.

RESULTS

The buzzards' foraging habitat was mainly open uncultivated land, including openings among scrub, riverine areas, abandoned fields, and pastures. They also foraged on the margins of cultivated fields covered with wild grasses and herbaceous plants, but rarely on cultivated land. They foraged in areas ranging from about 50 m to 4,000 m from the nest. The main hunting technique used was soaring while circling at a variable height and occasionally hovering. After detecting prey, the buzzard dived to the ground at variable speeds and angles. On some occasions, when the attack was launched from a fairly great height, the bird dived at moderate speeds and then stopped and hovered briefly, before diving again. The birds were also observed to launch attacks from perches on at least ten occasions, and also, on at least five occasions, to sit for a long time on the ground, waiting for prey. In all cases prey was caught on the ground, but frogs were occasionally caught in shallow water. Large prey was captured and carried in the talons. Small prey was carried in the bill.

In total, 268 prey items were recorded from the analysis of pellets and prey remains (Table 1). Pellets ($n = 89$) averaged 46 ± 12 mm in length (range 30–78 mm) and 19 ± 5 mm in breadth (10–28 mm). Pellets contained on average 2.7 ± 2.0 prey items (1–11). Small mammals dominated the diet both in terms of numbers and biomass, followed by reptiles, birds, insects, and centipedes. The European suslik (*Spermophilus citellus*) was by far the most important mammalian prey. Reptiles included mainly snakes and lizards. The most common bird prey was the starling (*Sturnus vulgaris*). Insect prey included Orthoptera and Coleoptera. One species of centipede was taken.

A total of 116 prey items were recorded by direct observations. Reptiles were the most numerous, but mammals dominated in terms of biomass (Table 1). Birds constituted a minor fraction, and amphibians, a prey not detected in pellets and prey remains, were identified by observations. A considerable proportion of small-sized prey was unidentified.

Numerical proportions of the diet differed significantly between spring and summer ($\chi^2 = 32.29$, $p < 0.001$) due to a drop in birds and an increase in arthropods (Fig.1). Proportions of mammal and reptile prey remained relatively constant. Bird biomass declined by 14% in summer, whereas in the remaining prey categories differences were less than 10%. Despite the considerable numerical increase of insects in the summer, their biomass remained similar to that in spring, probably because larger prey were taken in spring. Mammals, mainly European susliks (58% and 50% of the total biomass in spring and summer, respectively), were the dominant prey by biomass. Of reptiles, snakes (11% and 28%) were the most important. In spring the most important avian species was the starling (14%), while in summer, passerines, though important numerically, comprised only 1% of the total biomass.

Numerical proportions of the main prey types differed significantly between the two habitats ($\chi^2 = 10.47$, $p = 0.015$) due to significantly higher numbers of reptiles in pellets from hilly areas (Fig. 2). Other prey types had similar proportions in both habitats. Reptile biomass increased to 23.5% in summer, while mammal biomass decreased by 18% over the same period. In the plains, the dominant mammal prey was the European suslik (67% of the total biomass). In the hilly areas, the biomass of the eastern hedgehog (*Erinaceus concolor*) was larger than that of the suslik (25% vs. 20%), although the latter were more numerous (5% vs. 9%). Eastern hedgehogs were not detected in pellets

Table 1
Diet of long-legged buzzards as recorded from analysis of 89 pellets, prey remains, and direct observations

Prey	Pellets and prey remains			Observations		
	No. of prey items	% of prey items	% biomass	No. of prey items	% of prey items	% biomass
CHILOPODA	29	11	<1	–	–	–
Scolopendra spp.	29	11	<1	–	–	–
INSECTA	49	18	1	–	–	–
Orthoptera	29	11	1	–	–	–
Gryllotalpa gryllotalpa	1	<1	<1	–	–	–
Callimenus macrogaster	17	6	<1	–	–	–
Tettigoniidae	10	4	<1	–	–	–
Acrididae	1	<1	<1	–	–	–
COLEOPTERA	20	8	<1	–	–	–
Hister quadrimaculatus	1	<1	<1	–	–	–
Buprestidae	1	<1	<1	–	–	–
Meloe sp.	1	<1	<1	–	–	–
Tenebrionidae	6	2	<1	–	–	–
Scarabaeidae	1	<1	<1	–	–	–
Coleoptera unident.	10	4	<1	–	–	–
AMPHIBIA	–	–	–	3	3	1
Rana ridibunda	–	–	–	3	3	1
REPTILIA	57	21	27	47	41	37
Testudo spp.	2	1	1	–	–	–
Lacerta spp.	21	8	2	34	29	10
Ophisaurus apodus	4	2	6	2	2	8
Natrix spp.	4	2	1	–	–	–
Coluber caspius	2	1	2	–	–	–
Vipera spp.	2	1	1	–	–	–
Serpentes unident	22	8	14	11	10	19
AVES	43	16	13	3	3	1
Alectoris chukar	1	<1	2	–	–	–
Upupa epops	3	1	1	–	–	–
Galerida cristata	3	1	1	–	–	–
Motacilla flava	1	<1	<1	–	–	–
Turdus merula	2	1	1	–	–	–
Sturnus vulgaris	16	6	6	–	–	–
Passer sp.	1	<1	<1	–	–	–

Table 1 *continued*

Prey	Pellets and prey remains			Observations		
	No. of prey items	% of prey items	% biomass	No. of prey items	% of prey items	% biomass
Emberiza melanocephala	3	1	<1	–	–	–
Passeriformes unidentified	10	4	1	3	3	1
Aves unident.	3	1	1	–	–	–
MAMMALIA	90	34	59	36	31	58
Erinaceus concolor	3	1	6	–	–	–
Soricidae	1	<1	<1	–	–	–
Mustela nivalis	2	1	1	–	–	–
Spermophilus citellus	57	21	49	22	19	50
Microtus arvalis	20	8	2	–	–	–
Apodemus sylvaticus	6	2	1	–	–	–
Rattus norvegius	1	<1	1	–	–	–
Rodentia unidentified	–	–	–	14	12	8
Unidentified prey	–	–	–	27	23	3
Total	268	100	100	116	100	100

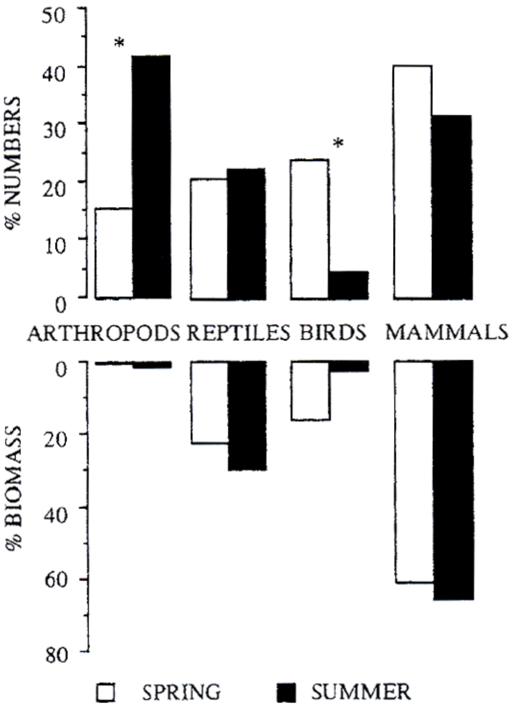

Fig. 1. Comparison of numerical and biomass proportions of prey categories of long-legged buzzards between spring and summer. An asterisk indicates a significant difference *($p<0.001$)*.

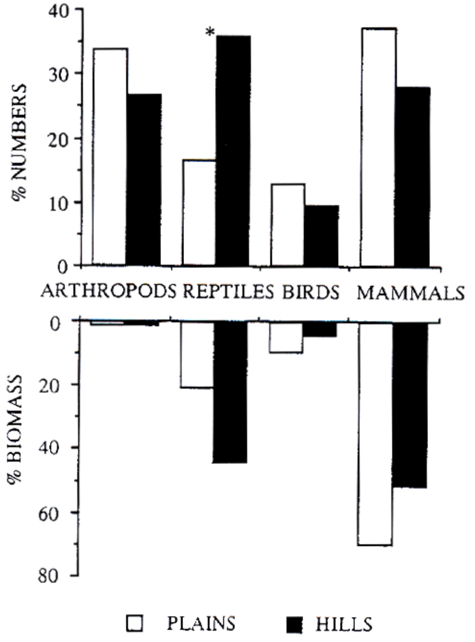

Fig. 2. Comparison of numerical and biomass proportions of prey categories of long-legged buzzards between plain and hilly habitats in Evros. An asterisk indicates a significant difference (p<0.015).

from the plains. In the plains, 13.5% of the total biomass was snakes and 7% lizards, while in the hilly areas we found 29% snakes and 15% lizards. In the plains, starlings were the most important avian prey (8%), whereas in the samples from hilly areas they were missing entirely. In the hills, birds other than starlings constituted 4% of the prey. Arthropods were a minor constituent (1% in both habitats).

DISCUSSION

Our results suggest that for mammals, considerable agreement exists between the results from all methods of study. The most important prey types (European susliks and reptiles) can be adequately described by the examination of pellets and prey remains, but this does not seem to be the case for the rest of the prey types. Reptiles showed similar results in both sample types. These animals were easy to identify visually, so it was expected that a negligible proportion would be relegated to the unidentified prey category. The somewhat lower representation of reptiles in pellets and prey remains (6% by number and 4% by biomass) could be due to the fact that a number of reptile species, most probably snakes, may not leave identifiable remains. On the other hand, birds were over-represented in the pellets and prey remains. It is possible that a portion of the unidentified prey in the direct observation sample may have been composed of birds, probably small passerines, since most other birds found in pellets and prey remains were of the size of a starling or bigger (Table 1) and therefore easily identifiable. The results of the pellets and prey remains may overestimate larger birds probably because such birds are not generally brought to the nest but are mainly consumed at roosts.

Undoubtedly, arthropods were underrepresented in observations due to their small size. As in other studies (Vlachos, 1989; Simmons et al., 1991), amphibians were not found in pellets, possibly because they are fully digested.

The long-legged buzzard has been reported to take a variety of prey, with various species of diurnal rodents forming the most important part of its diet (Petrov, 1964; Varshavsky, 1973). Some of the prey taxa we report here are not mentioned by other authors. These include centipedes, starlings, crested larks (*Galerida cristata*), hoopoes (*Upupa epops*), and wood mice (*Apodemus sylvaticus*). On the other hand, we did not find any arachnids, nor evidence of scavenging, as has been recorded by Varshavsky (1973). With the exception of Frumkin (1986), in other studies based on the analysis of pellets and prey remains (Table 2), mammals, followed by reptiles, were found to be the dominant prey. Diversity and evenness were highest in Evros, suggesting that prey was taken from a more diverse habitat spectrum.

The European suslik and other squirrels, seem to be the favored mammalian preys of the long-legged buzzard in areas where they are available (Petrov, 1964; Sushkin in Dement'ev and Gladkov, 1966; Michev et al., 1984; Dudas and Sandor, 1993). The European suslik has a very limited distribution, confined to only some sun-exposed habitats in Evros, such as dikes and fields with sandy dry substrates covered by sparse and low vegetation. Its population has declined mainly due to habitat changes induced by humans. In the Evros sanctuary for birds of prey, only a colony of susliks has survived (Vlachos, 1989; Adamakopoulos et al., 1995). Of the 16 territories of long-legged buzzards found in Evros, colonies of European susliks occurred in 10 of these at an average distance of 1.03 ± 0.40 km from one another (range 0.40–1.55 km). Considering the large contribution of this small mammal to the diet the of long-legged buzzard,

Table 2

Diet of long-legged buzzards in different parts of its breeding area

Area	Kuma Delta, Russia[a]	Northern Aral, Kazakhstan[b]	Negev desert, Israel[c]	This study
No. of prey items %	471	1106	81	268
Arthopods %	18	19	–	29
Amphibians %	7	–	–	–
Reptiles %	22	17	34	21
Birds %	6	1	62	16
Mammals %	47	63	4	34
Prey Diversity (H)	1.34	0.99	0.79	1.54
Evenness (E)	0.83	0.61	0.72	0.96

[a] Petrov, 1964; [b] Varshavsky, 1973; [c] Frumkin, 1986.

it is probable that its occurrence and distribution has partly affected the distribution of the birds' territories. Squirrels constitute the dominant prey of other buzzards such as the ferruginous hawk (*Buteo regalis*), red-tailed hawk (*B.jamaicensis*), and Swainson's hawk (*B. swainsoni*) (Schmutz et al., 1980; Gilmer and Stewart, 1984). Extensive use of reptile prey in our study area is related to the fact that they are diverse, readily available, and occur at densities that are unique in Europe (Helmer and Scholte, 1985).

Seasonal differences in the prey spectrum have also been observed in other raptors (Phelan and Robertson, 1978; Mearns, 1983; Parr, 1985; Underhill-Day, 1985; Simmons et al., 1991). Such differences are usually attributable to different prey availability or to variable use throughout the seasons. In long-legged buzzards, seasonal differences were due to a shift in its avian diet; in spring, the diet mainly included starlings that are found in large flocks during spring migration. The most important prey categories (mammals and reptiles) were similarly represented in the diet in both periods. Nevertheless, we cannot conclude whether or not this was due to prey availability.

Differences in prey composition related to foraging habitat have been documented in various studies on raptors (i.e., Parr, 1985; Smallwood, 1988). In this study the greatest difference in the diet between plains and hills was that reptiles were more abundant in the latter. This is partly attributable to a greater than average availability of reptiles in hilly areas (Helmer and Scholte, 1985; Vlachos, 1989; see also Papageorgiou et al., 1993).

An important factor responsible for the selection of hunting habitats (resulting in differences in prey composition) is vegetation, which determines perch availability (Preston, 1990), prey accessibility (Bechard, 1982), and hunting-substrate visibility (Smallwood, 1987). Thus, heterogeneity and differences between the two habitats could account for the differences observed in prey composition. Reptiles may, therefore, be caught more easily in the hills than in the plains, where perches are scarcer due to tree cutting and where cultivated land supports relatively few reptiles. In lowlands, reptiles are frequently caught on road verges. Such habitat differences may also account for differences in utilization of other types of prey between two habitats.

Further studies should examine in detail the availability and seasonal dynamics of each prey type (especially susliks and reptiles). However, in view of the importance of the European suslik as prey, and because of its limited distribution, experimental introduction should be carried out in selected areas to clarify its importance for the breeding success and survival of the local breeding population of the long-legged buzzard.

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