

# FOOD OF THE BOOTED EAGLE (*HIERAAETUS PENNATUS*) IN CENTRAL SPAIN

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**ABSTRACT.** — The identification of 202 prey remains of the Booted Eagle (*Hieraaetus pennatus*) shows that mammals (41.6% of prey items identified), birds (36.6%) and reptiles (21.8%) are important prey in Central Spain. Most mammals captured were young rabbits, and the majority of the bird prey were fledglings or juveniles. Lizards were adult or subadult individuals. Over 90% of the prey captured weighed between 27 and 243 g.

Little is known about the biology of the Booted Eagle (*Hieraaetus pennatus*), as it occurs in countries with little ornithological activity. Most published accounts of food habits are single enumerations of prey remains recorded mainly during sporadic visits to nests (Valverde 1967; Araújo 1973; Garzón 1973; Iribarren 1975). This procedure provides an inaccurate picture of diet, since prey that are large and leave persistent remains are over-represented in samples (e.g., Valverde 1967; Delibes 1975). In spite of this, several recent papers dealing with the trophic relationships between members of various raptor communities have made use of such data (Jaksić and Soriguer 1981; Jaksić 1983; Jaksić and Braker 1983). In my opinion this has led to erroneous conclusions regarding the ecological position of the Booted Eagle in Mediterranean environments. The present paper presents more accurate information about the diet of this raptor, obtained using a more systematic data collection procedure. I also take into consideration some attributes of prey, such as size and age, that have been overlooked.

## STUDY AREA AND METHODS

This study was carried out in 3 areas, each about 35 km<sup>2</sup> in size, located on the northern slope of the Sierra de Guadarrama mountains (40° 35'–40° 60' N, 0° 5'–0° 60' W). Area 1 is about 60% pasture interspersed with thick scrub. The only arboreal formations present are 3 small pine groves of between 1 and 5 ha. Area 2 is 10 km away and about 40% covered with mature natural pine trees (*Pinus silvestris*) over 15 m tall. The rest of area 2 is made up of a sparse evergreen oak grove (*Quercus rotundifolia*) with extensive clearings in which low scrub mixes with pasture land. Area 3, 15 km from area 2 and 30 km from area 1, is similar to area 1 in that it has only 2 arboreal formations, one of 2 ha and the other of 25 ha.

Area 1 was visited from 1978 to 1981. One pair of Booted Eagles used the same nest year after year. Area 2 was also visited from 1979 to 1981. In 1979 2 pairs of nesting eagles were present, but in 1980 to 1981 no nests were found. Area 3 was also visited from 1979 to 1981. In both 1979 and 1980 1 pair of eagles was located,

but no eagles were seen in 1981. Visits were made approximately every 15 d from shortly before incubation (mid-late April) until after the young left the nest (mid-late August). During the feeding period nests were occasionally visited every 7 d. Pellets and prey remains were sought in and around nests and below perches which were usually within a 200 m radius of the nests.

A total of 110 pellets, containing 130 identifiable prey items, and 72 prey remains were collected. Each species found in any one pellet was counted as 1 individual unless it was possible to show that more than 1 was represented. Therefore, it was necessary to count pieces of remains such as nails, beaks, teeth, etc. Weight and approximate age of the prey were estimated by comparing remains with material from zoological collections and with specimens collected in the study areas. In order to establish a frequency distribution for prey, weight classes were established whose limits followed a geometric progression (Fig. 1). This insured that the resulting distribution would be more or less normal (Schoener 1969; Hespeneheide 1971). Only some prey identified in the pellets could be assigned to one of the established weight categories, particularly in the case of species, like rabbits and ocellated lizards, whose weights vary a great deal.

## RESULTS AND DISCUSSION

Mammals, birds, and reptiles, in decreasing order of capture frequency, comprised the diet of the Booted Eagle in the study area. Percentage differences of these taxa in the diet increased considerably when biomass was taken into account. (Table 1). Among mammal prey, rabbits were the most important prey species. Birds captured were primarily species that forage on the ground. The Ocellated Lizard (*Lacerta lepida*) was the only reptile prey, although other lizards are common in the study area.

The weight of prey items varied between 10 and 800 g. However, most were in the 27 to 243 g range (Fig. 1). A major part of the diet consisted of prey in the 81 to 243 g weight-class (Fig. 1). Prey-size distributions do not appear to be the same for the 3 taxa present in the diet: most mammal and lizard prey weighed between 81 and 243 g. Avian prey was

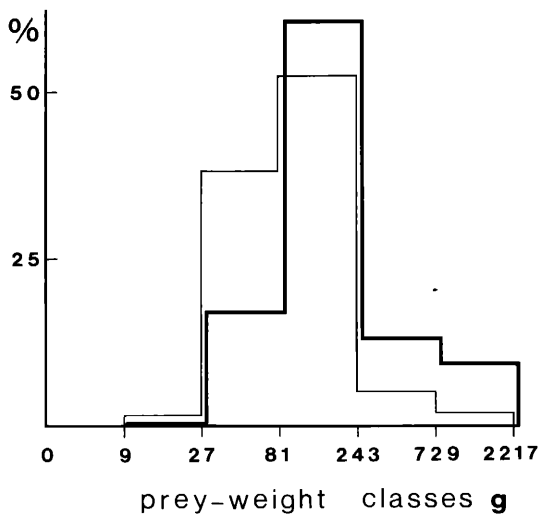


Figure 1. Diet of the Booted Eagle. Thick line histogram: percent of the total biomass supplied by the prey-items; thin line histogram: percent of the total number of prey-items. Sample size = 165.

predominantly between 27 and 81 g (Fig. 2). The majority of birds in this class were the Spotless Starling, (*Sturnus unicolor*) weighing 70 g. Nearly all rabbits captured were very young individuals. Of 27 bird prey items of known age, the number of fledgling and juveniles was greater than the number of adults (22 young vs. 5 adults). All Ocelated Lizards identified were adults or sub-adults.

Prey-size distribution could merely reflect the size distribution of available prey, assuming Booted Eagles on the study area selected prey randomly with respect to size. Nevertheless, the lack of insects, amphibians, and small reptiles in the diet of some other raptors of similar size such as the Common Buzzard (*Buteo buteo*), Black Kite (*Milvus migrans*) and Red Kite (*M. milvus*) in the same study area (Veiga 1982) suggests that prey below a certain weight were avoided. Prey might also be selected according to age and experience. This may be particularly true for avian prey, since the poor flying abilities of young birds make this age class more vulnerable to predation by Booted Eagles.

It has been reported that the analysis of pellets and prey remains for Order Falconiformes tends to underestimate the amount of some prey while overestimating others (Valverde 1967; Delibes 1975; Collopy 1983). The absence of small prey such as insects, amphibians or small reptiles in the Booted Eagles' diet could be due to these

methodological biases. However, using the same methodology, these small prey have been found in the diet of other similar sized raptors in the same areas in which the Booted Eagle was studied. Furthermore, by sampling prey remains regularly and at relatively short intervals the potential bias possibly caused by the greater detectability of certain prey when collected at longer intervals would be diminished. The fact that the material to be analyzed was collected from the nests as well as from the perches of the adults reduces the possibility of obtaining a distorted image of diet if it is assumed that food taken to the nestlings is different from that of the adults. I have not been able to demonstrate this in the Booted Eagle.

Earlier studies of Booted Eagle feeding habits carried out in the Palearctic and in South Africa describe them as a hunter of small birds and, to a lesser degree, lizards (Valverde 1967; Araújo 1973; Garzón 1973; Iribarren 1975; Steyn and Grobler 1981). It is worth noting that although the scarcity of mammals in the South African Booted Eagles' diet could be due to a lack of appropriate sized individuals in the field, the low representation of this taxon in reports from Spain where rabbits abound in a variety of sizes is surprising. My results suggest that the Booted Eagle behaves, in my study

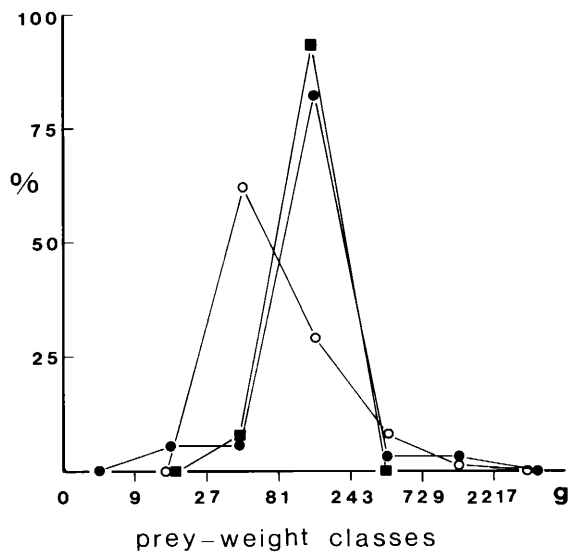


Figure 2. Distribution of the prey remains in the prey-weight classes in each taxonomic group. Black circles = mammals; open circles = birds; squares = reptiles. Sample sizes: mammals = 61; birds = 64; reptiles = 40.

Table 1. Prey of the Booted Eagle in central Spain.

SPECIES	NUMBER OF ITEMS	OCCURRENCE PERCENT	BIOMASS PERCENT
<b>REPTILES</b>			
Ocellated Lizard ( <i>Lacerta lepida</i> )	44	21.8	14.3
Total	44	21.8	14.3
<b>BIRDS</b>			
Common Kestrel ( <i>Falco tinnunculus</i> )	2	0.99	1.0
Quail ( <i>Coturnix coturnix</i> )	2	0.99	0.46
Unidentified Phasianidae	1	0.49	0.46
Little Bustard ( <i>Otis tetrax</i> )	1	0.49	1.76
Stone Curlew ( <i>Burhinus oedipnemus</i> )	1	0.49	1.05
Wood Pigeon ( <i>Columbia palumbus</i> )	1	0.49	1.08
Unidentified Columbidae	3	1.48	2.54
Swift ( <i>Apus apus</i> )	1	0.49	0.09
Hoopoe ( <i>Upupa epops</i> )	7	3.46	1.03
Green Woodpecker ( <i>Picus viridis</i> )	1	0.49	0.39
Unidentified Alaudidae	1	0.49	0.08
Mistle Thrush ( <i>Turdus viscivorus</i> )	1	0.49	0.27
Spotless Starling ( <i>Sturnus unicolor</i> )	28	13.86	5.13
Magpie ( <i>Pica pica</i> )	9	4.45	4.33
Jackdaw ( <i>Corvus monedula</i> )	4	1.98	2.1
Carrion Crow ( <i>Corvus corone</i> )	1	0.49	1.18
Unidentified	10	4.95	1.83
Total	74	36.6	24.8
<b>MAMMALS</b>			
Common White-toothed Shrew ( <i>Crocidura russula</i> )	1	0.49	0.03
Blind Mole ( <i>Talpa caeca</i> )	2	0.99	0.19
Rabbit ( <i>Oryctolagus cuniculus</i> )	65	32.18	48.71
Hare ( <i>Lepus granatensis</i> )	2	0.99	5.0
Unidentified Lagomorpha	1	0.49	0.75
Water Vole ( <i>Arvicola sapidus</i> )	8	3.96	5.0
Weasel ( <i>Mustela nivalis</i> )	3	1.48	0.94
Unidentified	2	0.99	0.19
Total	84	41.6	60.8
<b>TOTAL ITEMS</b>	<b>202</b>		

area, like a taxa-generalist that concentrates on terrestrial prey weighing between 70 and 240 g. It is probable that the general decrease of the rabbit in Iberian ecosystems in the last decades, resulting from the effect of mixomatosis, has influenced the composition of the Booted Eagle's diet. However, there are no detailed studies of the population dynamics of the rabbit and other prey species, which would be necessary before this could be seriously discussed.

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