J Raptor Res. 28(1):39–42

DIET, BREEDING SUCCESS, AND NEST-SITE SELECTION OF THE SHORT-TOED EAGLE (*Circaetus gallicus*) IN NORTHEASTERN GREECE

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ABSTRACT.—Forty-eight pellets of short-toed eagles (*Circaetus gallicus*) collected during 1988–90 in northeastern Greece were examined to determine the eagle's food habits. The main prey were reptiles (87.2% by frequency of occurrence) followed by birds (6.9%) and rodents (5.9%). The most common prey species were Montpellier snake (*Malpopolon monspessulanus,* 29.4%), grass snake (*Natrix natrix,* 20.6%), lizards (*Lacerta* spp., 18.7%), and European glass lizard (*Ophisaurus apodus,* 11.8%). Short-toed eagles preferred to nest in old pines (*Pinus brutia,* 80% and *P. nigra,* 20%). Nest trees had a mean height of 12.7 ± 2.9 m, d.b.h. of 43.5 ± 10.9 cm, and age of 85 ± 21.4 yr. The average distance between neighboring active nests was 2200 m (range 640–3250 m). Short-toed eagles' mean breeding success was 0.86 fledged young/nest.

KEY WORDS: *breeding*; Circaetus gallicus; *food habits*; *Greece*; *short-toed eagle.*

Dieta, éxito reproductivo y selección de sitios de nidificación de *Circaetus gallicus* en el noreste de Grecia

RESUMEN.—A través de cuarenta y ocho egagrópilas, colectadas entre 1988 y 1990 en el noreste de Grecia, se determinaron los hábitos alimentarios de *Circaetus gallicus.* Los reptiles constituyeron la presa principal (87.2%), sequidos de las aves (6.9%) y de roedores (5.9%). Las presas más comunes fueron las serpientes *Malpopolon monspessulanus* (29.4%) y *Natrix natrix* (20.6%), los lagartos *Lacerta* spp. (18.7%) y *Ophisaurus apodus* (11.8%). *C. gallicus,* prefirió nidificar en *Pinus brutia* (80%) y *P. nigra* (20%). Los nidos se encontraban a una altura media de 12.7 m (DS = 2.9 m), en árboles con un diámetro a la altura del pecho de 43.5 cm (DS = 10.9 cm) y de una edad de 85 años (DS = 21.4 años). La distancia promedio entre nidos vecinos activos fué de 2200 m (rango 640–3250 m). La media del éxito reproductivo fué de 0.86 juveniles volantones por nido.

[Traducción de Ivan Lazo]

Short-toed eagle (*Circaetus gallicus*) food habits and nesting habitat characteristics have been reported by Brown and Amadon (1968), Ali and Ripley (1968), Glutz von Blotzheim et al. (1971), and Massimo (1989). However, such data are not available for Greece.

The objectives of our study were to examine the: (1) diet, (2) nest site selection, and (3) breeding success of short-toed eagle in northeastern Greece.

STUDY AREA

The study was conducted from March 1988 to September 1990 in Dadia Forest, northeastern Greece, which is considered one of the most important breeding areas of short-toed eagles in the country (Hallman unpubl. data). Dadia Forest is located between 40°59′–41°15′N and 2°19′–2°36′E. It lies from 50–800 m above sea level.

The study area has been declared a wildlife reserve since 1980 due to its unique raptor fauna. A total of 20 birds of prey breed in the reserve including cinereous vulture (*Aegypius monachus*), griffon vulture (*Gyps fulvus*), imperial eagle (*Aquila heliaca*), golden eagle (*A. chrysaetos*) and white-tailed eagle (*Haliaeetus albicilla*), making the area not only of national but also of international importance.

The reserve covers an area of about 7000 ha and it is part of a large forest complex of about 40 000 ha. Vegetation includes *Pinus brutia, P. nigra, Quercus conferta,* and *Q. cerris.* Other species occurring with lower frequency are *Erica arborea, Phillyrea media, Arbutus andrachne,* and *Juniperus oxycedrus*

The climate is mediterranean with dry summers and rainy winters. During March to September (breeding season for short-toed eagle) the mean monthly temperature was 19.4°C with minima and maxima of 8.9°C (March) and 27.6°C (July), re-

Table 1. Composition of pellets ($N = 48$) found in short-toed eagle nests in northeastern Greece.

SPECIES	NUMBER OF INDIVIDUALS N	FREQUENCY OF OCCURRENCE %
Reptiles		
Malpopolon monspessulanus	30	29.4
Natrix natrix	21	20.6
Natrix tesselata	4	3.9
Elaphe situla	2	1.9
Vipera amodytes	1	0.9
Ophisaurus apodus	12	11.8
Lacerta sp.	19	18.7
Birds	7	6.9
Mammals		
Apodemus sylvaticus	6	5.9
Total	102	100.0

spectively. The mean monthly precipitation during the above period was 40.6 mm with minima and maxima of 0.0 mm (August) and 52.4 mm (June), respectively.

METHODS

The diet of the short-toed eagle was determined by analysis of pellets found in the nests. Active nests were located at the beginning of the breeding season and were visited at irregular intervals to collect regurgitated pellets. Most pellets were collected after the hatching of the chicks to avoid disturbance at the nests.

The identification of reptile prey was accomplished with a scale key (Papageorgiou et al. 1993). Mammals were identified using a hair key (Papageorgiou and Sfougaris 1989). The abundance of reptiles was estimated using transects in different biotopes. In total 18 transects (100 × 5 m each) were used and were counted at 1000 H and 1700 H.

The height, age, and diameter breast height (DBH) of the nest tree, and the height of the nest, the diameter of the branch where the nest was placed, and the distance of the nest from the trunk were recorded for each nest tree The nesting habitat was determined by vegetation analysis within a plot 50 × 20 m centered on the nest.

RESULTS

Diet. A total of 48 pellets were collected during the 3-yr study period. The results of the analysis are presented in Table 1. The data show that short-toed eagles' main food group by frequency of occurrence was reptiles (87.2%) followed by birds (6.9%), and rodents (5.9%). Reptile density varied considerably among the biotopes (Table 2). The main period of reptile abundance in our study area starts from the beginning of April to the end of September.

Nesting Sites. Eighty percent of the short-toed eagle nests found in the study area were in *Pinus brutia* and 20% in *Pinus nigra*. Nest tree height was much less variable than age and DBH. Short-toed eagles preferred old pines with mean height of 12.7 ± 2.9 m, DBH of 43.5 ± 10.9 cm and 85 ± 21.4 yr of age. Nests were located on branches with a mean diameter of 13.5 ± 3.3 cm and a mean distance from the trunk of 1.4 ± 0.3 m.

Vegetation analysis around each nest tree revealed that nest-site habitats selected by short-toed eagles were forest stands with open canopy (40–60%) and

Table 2. Density of reptiles in different biotopes in Dadia Forest (individuals/ha).

SPECIES	NONINTENSIVELY CULTIVATED LAND	SHRUBLAND WITHIN CULTIVATED LAND	RANGELAND	DENSE PINE FOREST	OPEN PINE FOREST	DEGRADED OAK FOREST
Malpopolon monspessulanus	1	3	2	1	2	1
Ophisaurus apodus	1	3	1	—	3	2
Natrix natrix	6	3	1	—	—	2
Vipera amodytes	—	—	1	—	1	1
Coluber najadum	—	1	—	—	—	1
Lacerta viridis	4	13	10	—	4	14
Lacerta trilineata	2	9	4	—	2	8
Lacerta praticola	—	5	2	—	—	6
Podarcis taurica	—	—	—	—	—	3
Total	14	37	21	1	12	38

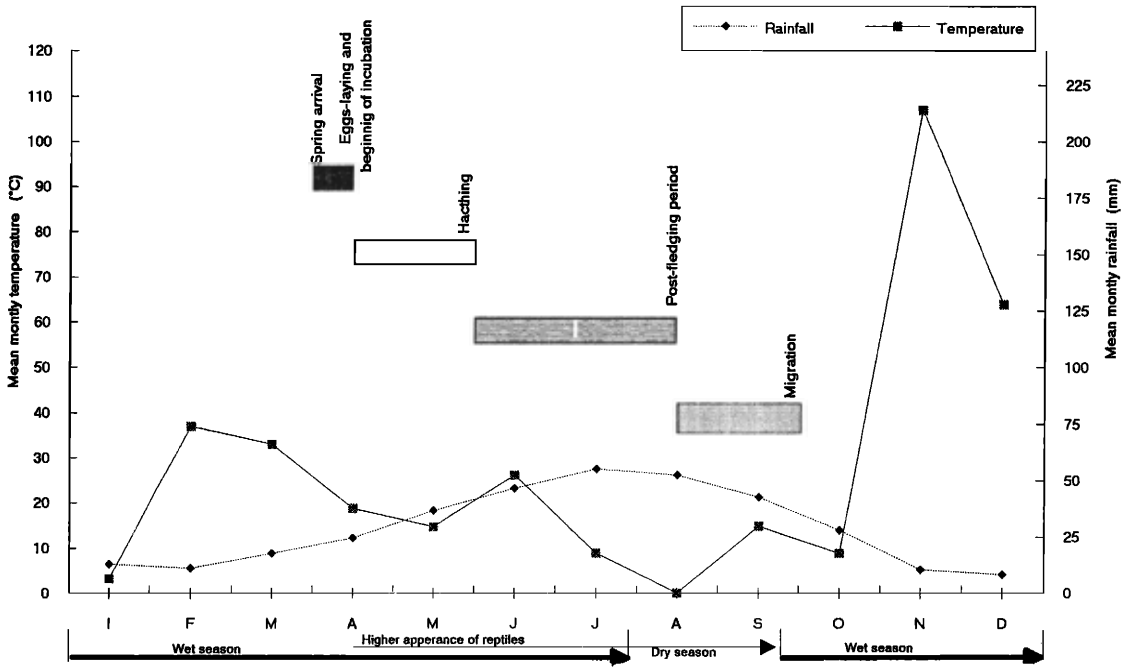

Figure 1. Annual breeding cycle of short-toed eagle in Dadia Forest.

with the nest tree being the dominant one. The nesting sites were located at an elevation ranging from 50–600 m. The average nearest distance between neighboring active nests was 2.2 ± 0.48 km.

Breeding. The breeding cycle of short-toed eagles is given in Fig. 1. The eagles arrived on the study area at the end of March and the laying period began between 10–20 of April. The hatching date, after an average incubation period of 47 d, was estimated to be the beginning of June. The breeding pairs, clutch size and breeding success of short-toed eagles is presented in Table 3. All young that hatched were reared successfully.

DISCUSSION

Our results on the diet of short-toed eagle agree with previous research elsewhere (Boudoint et al. 1953, Brown and Amadon 1968, Glutz von Blotzheim et al. 1971). The staple diet of short-toed eagles consists of reptiles, occasionally supplemented with birds and rodents.

Short-toed eagles prefer breeding areas with dry and warm climate and open discontinuous forest stands and open habitat. The selection of such habitat reflects the short-toed eagle's inability to maneuver through closed stands and the potential of open habitat to support a high density of reptiles.

The high population density of the short-toed eagle in the Dadia Forest (1 pair/1370 ha) and the observed high breeding success indicates that the Dadia Forest's potential for food production and nesting sites is adequate to meet the short-toed eagle's requirements. This conclusion agrees with Helmer and Scolte (unpubl. data) who reported that the northeastern part of Greece supports the highest reptile density in Europe. The main period of reptile abundance in Dadia Forest coincides with the breed-

Table 3. Breeding success of the short-toed eagle in northeastern Greece.

YEAR	NUMBER OF BREEDING PAIRS	NUMBER OF EGGS/NEST	NUMBER OF HATCHLINGS/NEST	NUMBER OF FLEDGLINGS/NEST
1988	10	1	0.8	0.8
1989	12	1	0.92	0.92
1990	11	1	0.91	0.91

ing cycle of short-toed eagles, therefore contributing to successful rearing of young.

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Received 12 July 1993; accepted 2 December 1993