Belg. J. Zool., 135 (2) : 261-269 July 2005

The avifauna of the western Rodopi forests (N. Greece)

Stavros Xirouchakis

Natural History Museum of Crete, University of Crete, P.O. Box 2208, Heraklion GR-71409, Crete, Greece

e-mail : sxirouch@nhmc.uoc.gr

ABSTRACT. The composition of the avifauna in the upland forests of western Rodopi (North Greece) was investigated during spring and summer of 1997 and 1998. A total of 109 species were detected in the area, while 93 of them (85.3%) are regarded as breeders. Ten-minute counts in 260 points in plots of the most representative forest stands produced 3 418 bird sightings of 42 species (13.14 individuals/ point, $\bar{x}$ = 6.2 species/ point). Bird density in different forest habitats ranged from six to 34 birds/ 10 ha ($\bar{x}$= 19 birds/ 10 ha). The greatest figure was recorded in oak woods and conifer forests dominated by mature Norway spruce (*Picea abies*) and the lowest in pinewoods. Species diversity was also greater in Norway spruce and broadleaf forests. Species richness should be attributed to the geographical position of the area, and the differences in bird density to the vegetation structure in the various forest habitats.

KEY WORDS : Forest birds, species richness, bird density, Rodopi.

INTRODUCTION

In Greece very few studies have looked at forest bird communities (CATSADORAKIS, 1991, 1997 ; SFOUGARIS et al., 1998), and for species inhabiting commercially exploited forests relevant published accounts are even scarcer. In the Rodopi region (North Greece) special climatic and geomorphologic conditions as well as sociopolitical events have produced widespread woodlands with low human pressure and very few settlements (0.01%). Forested areas cover about 1 180 km^2, which represents 68% of the region. The forests of the area are the most productive in the country and one the most intensively commercialized. Logging usually extracts 187 000 m^3 of wood per year, a figure that represents 30% of the annual timber production in Greece and gives the highest annual forestry revenue at the national level (DAFIS & SMIRIS, 1981; GATZOGIANNIS, 1999). The ecological value of the area lies in its homogenous forests, some of them at the edge of their European distribution, and a great variety of habitats that result in a high degree of biodiversity (SMIRIS, 1987 ; BAUER, 1986).

The aim of this study was to increase the knowledge on the distribution of certain bird groups (i.e. birds of prey, grouses) in the vegetation zones of the region and to provide preliminary information on their breeding status. An attempt was also made to evaluate the significance of the different forest habitats for the avifauna by estimating bird species richness and density.

MATERIAL AND METHODS

Study area

The study area is located in the western Rodopi region in the Drama prefecture, North Greece (Fig. 1) and encompasses the southern slopes of the Rodopi mountain chain whose highest peaks are located in Bulgaria. Its altitude ranges from 300 to 1 600 m a.s.l and covers approximately 1 400 km^2. The climate is transitional from the sub-Mediterranean type to central European with a strong continental character. Mean annual temperature is 11.4° C while the mean annual precipitation is about 1 200 mm distributed through out the year in 100-130 days (MAVROMATIS, 1980 ; Sidironero-Drama & Leivaditis-Xanthi Meteorological Stations : 1978-1989). Forests cover 83% of the study area with 65% of them containing dense forest stands (i.e. 50-75% coverage). In the southern part 100,339 ha (61%) of oak woodland cover the hilly country, adjacent to the valley of the Nestos river and comprise the sub-Mediterranean zone (300-600 m a.s.l). Moving up to the north the beech-spruce zone spreads over 34 500 ha (21%) dominated by beech (*Faqus sylvatica*), Macedonian fir (*Abies borisii-regis*), black pines (*Pinus nigra*), and silver birch (*Betula pendula*). Between the two previous zones black pine forests occupy 6700 ha (4%) only in 6.5% of pure stands, but mainly in mixtures with beech, Scots pine and oaks (e.g. *Quercus frainetto, Quercus pubescens* and *Quercus dalechampii*). Further north the conifer-broadleaf zone extends up to the Greek-Bulgarian border (1600 m a.s.l) and covers 23 400 ha (14%) of dense woodland dominated by Scots pine (*Pinus sylvestris*) (78%), Norway spruce (*Picea abies*) and silver birch (ATHANASIADIS et al., 1993 ; TSIAOUSSI, 1996 ; GATZOGIANNIS, 1999). Basic human activities include apiculture, cattle raising, lumbering and agriculture. Grassland and farmland cover 8.9% and 5.8% respectively of the total area. The greater region is almost void of habitations and human density is about three people per square kilometer (GATZOGIANNIS, 1999).

Fig. 1. – Location of the study area in Northern Greece.

Field techniques and statistics

Bird surveys were carried out in May-July 1997 and 1998. In 1997 most of the fieldwork was spent collecting quantitative data on the species distribution and breeding status. During 11:00 am-15:00 pm observations were made from vantage points and by road surveys with a mean speed of travel of 35 km/h, investigating for birds of prey. All raptors sighted with the unaided eye were identified by the use of binoculars (8x50) and plotted on 1 :50.000 scale maps in an effort to delineate their territories (WOFFINDEN & MURFHY 1977, BILSTEIN 1978, FULLER & MOSHER 1987). The distribution of owl species was surveyed by the playback method by eliciting calls from 20:30h till 23:30h (FALLS 1981). Voice imitations started with the smallest species gradually proceeding to the larger ones (CALL 1978). A search for the abundance of the Capercaillies (*Tetrao urogallus*) was also undertaken by following 35 transects of 42 km total length, all above the 1000-m contour line. As the species is quite cryptic and very reluctant to fly counts were made within a 10m belt walking in a zigzag manner or throwing stones in order to flush any close-sitting individuals.

In 1998 the relative abundance and density of passerines was censused by point counts (BIBBY et al., 1992). Thirteen sample plots were selected from maps of a landscape analysis by the use of a geographic information system in such a manner as to comprise of homogeneous forest stands in terms of age (DBH>30 cm), tree condition and canopy closure (50-75%). Forest stands were selected to be large enough (>60 ha) and dominated by the main tree species of the area. Transient areas among the four vegetation zones were avoided apart from those encompassing oaks with black pines and Scots pines with beech as these tree species intermix a lot in the area. Line transects were firstly followed in order to determine the width of the full-detection strip. Ten transects of about one km each were followed and every bird cue was tallied in five meters strips on either side of the route. The full-detection strip was estimated as the one where the number of birds (regardless of species) dropped below 20% of the average number of the five meters strips closest to the observer (EMLEN 1977). Twenty sample points per plot were established by making stops at 150-m intervals along a straight line by using a prismatic compass. The centre of the sample point was checked by a densiometer for the right percentage of canopy closure. All sample points were situated within the forest away from openings in order to minimize the edge effect. The duration of each count was ten minutes starting about five minutes after arrival, allowing the birds to recover from any disturbance. At each sample point the highest count for each bird species was taken at ranges 0-*r* m and 0 m to infinity. The pre-selected radius *r* was equal to the length of the full-detection strip produced by the transect lines' count. Densities were estimated by assuming that the probability of detecting a bird declines with distance from the observer. The general shape of this decline follows a half normal function, $\exp [-(x/a)^2]$ where *x* is the distance from the observer and *a* is a constant equivalent to the effective radius of the census depending on the circumstances (JARVINEN & VAISANEN 1975). Given that the detectability function has this shape and certain assumptions are met (BUCKLAND 1984), the constant *a* and the bird density D can be calculated directly by the formula : $D= \log_e (n/n_2) \times n/m(pr^2)$ where *n* = total number of birds detected, n_2 = number outside the fixed radius (*r*) and *m*= the number of points. Standard errors of bird density estimates were calculated by using the jackknife method (MILLER 1974, KREBS 1989). Differences in bird abundance between sample plots were evaluated using one-way ANOVA (*F* statistic). The Shannon index of diversity (*H'*) and a heterogeneity index (H'/ H' max) were calculated (MAGURRAN 1988) per sample plot based on the mean number of individuals counted within the fixed detection radius in the point counts. Statistical comparisons were made using the student's t-test with $\alpha= 0.01$ (ZAR, 1984).

RESULTS

Signs of breeding activity and suitable nesting habitat accounted for 93 (85.3%) species out of a total of 109 that belong to 29 families (Appendix 1).

Diurnal raptors were poorly represented with only ten species. The buzzard (*Buteo buteo*) was the commonest raptor distributed equally in all forest habitats and vegetation zones. Twenty eight territories were located over an area of about 300 km^2 producing a density of one pair per 10.7 km^2. Honey buzzards (*Pernis apivorus*) were recorded in oak forests and mixed stands of conifers with deciduous trees up to the conifer-broadleaf zone where no more than five territories were detected. In addition four territories of short-toed eagle (*Gircaetus gallicus*) were delineated at middle and low altitude (<600 m), all in oak forests and marginally in the transient zone between the oaks and the birch-fir forests. The golden eagle (*Aquila chrysaetos*) was located in the Greek-Bulgarian border with one active territory. The breeding distributions of the Levant sparrowhawk (*Accipiter brevipes*), the sparrowhawk (*Accipiter nisus*) and the goshawk (*Accipiter*

gentilis) were sparse and restricted to the upper zone of the conifer-deciduous forests. The hobby (*Falco subbuteo*) occurred in the lowlands (<400 m) in open oak forests and grasslands with scattered shrubs. Two kestrel pairs (*Falco tinnunculus*) were spotted in rocky outcrops within oak stands well below the 800 m contour line. Moreover a flock of Eleonorae's falcon (*Falco eleonorae*) comprising 20-30 individuals was present in the area, roosting in oaks in the sub-mediterranean zone and hunting flying insects in forest openings or along riverside vegetation just before dusk. In the day time the falcons dispersed further north in the Bulgarian part.

As far as nocturnal raptors are concerned five species were detected. The tawny owl (*Stix aluco*), was found in all forest habitats and constituted the commonest owl species. It showed strong preference for open stands in mixed beech-spruce forests and exhibited the highest density in mature forests (e.g. five different responses in a single voice imitation). The Tengmalm's owl (*Aegolius funereus*), was restricted in the upper conifer zone (>1400 m a.s.l) showing high densities in mature mixed stands of Norway spruce and fir (e.g. four different responses in a single voice imitation). The long-eared owl (*Asio otus*), exhibited an irregular distribution up to the beech-spruce zone, always heard near small openings within the forests. The little owl (*Athene noctua*) and the scops owl (*Otus scops*) were heard near settlements and cultivation in middle altitude areas (<700 m) or in open shrub land and degraded oak forests that are used as rangelands. The highest altitude at which the little owl was heard was 900 m.

The Rodopi forests constitute the only place in Greece where all tetraonids can be found, namely the Capercaillie (*Tetrao urogallus*) the hazel grouse (*Bonasia bonasia*) and the black grouse (*Tetrao tetrix*) although the breeding status of the latter remains unclear (HANDRINOS & AKRIOTIS 1997). In the present study four individuals of Capercaillie were recorded in the 0.42 km^2 belt giving an estimate of 9.5 individuals/km^2. Moreover, in random walks around the forests the species was recorded 11 times in small groups or individual birds (mostly females). All Capercaillie observations were made in forest stands dominated by Norway spruce and Scots pine or in mixed forests of beech and conifers along the Greek-Bulgarian border. The group size was one male and one female or one male with two females although this figure should be regarded as minimum since the survey did not cover displaying males in leks. The species' population density has been estimated at 10-16 individuals/ km^2 (POIRAZIDIS, 1990). The hazel grouse was common in the area. Most of the sightings took place in pure conifer forests or mixed forests of Norway spruce/ Scots pine with beech as well as forests dominated by silver birch.

A full detection strip in point counts was determined as equal to 30 m, and this figure was appointed as the fixed radius in each sample point, thus bird counts were made at ranges 0-30 m and 0 m to infinity. Excluding raptors and grouses, a total of 3,418 birds belonging to 42 species were detected in 260 point counts ($\bar{x}$= 6.2 species and 13.14 individuals/ point). Twelve species (29%) were recorded within the 30m radius in more than 50% of the plots, and 15 species (36%) at a distance of more than 30 m (Table 1). Thirteen species, robin (*Erithacus rubecola*), coal tit (*Parus ater*), chaffinch (*Fringla coelebs*), marsh tit (*Parus pallustris*), blue tit (*Parus caeruleus*), wren (*Troglodytes troglodytes*), nuthatch (*Sitta europaea*), goldcrest (*Regulus regulus*), great tit (*Parus major*), bullfinch (*Phyrrula phyrrula*), hawfinch (*Coccothraustes coccothraustes*), chiffchaff (*Phylloscopus collybita*) and blackbird (*Turdus merula*) constituted 85% of the bird community in terms of numbers, while the first three species accounted for almost half of the bird numbers (48%) in point counts (Table 1).

By comparing the most common species (those recorded in more than 50% of the sample points) to the most numerous ones (species with densities over 5 individuals/ 10 ha) 11 species were equally distributed in high densities, e.g. chaffinch, robin, great tit, blue tit, marsh tit, coal tit, wren, nuthatch, blackbird, chiffchaff and goldcrest. Four species, cuckoo (*Cunculus canorus*) great spotted woodpecker (*Dendrocopos major*), jay (*Garrulus glandarius*) and blackcap (*Sylvia atricapilla*), were widespread but in low densities, and two species (bullfinch and hawfinch) exhibited dense but localized populations. Species richness ranged from eight to 18 species ($\bar{x}$=14 species) in different forest habitats, and bird density from six to 34 birds/ 10 ha ($\bar{x}$ = 19 birds/ 10 ha) and differed significantly (F_{12}=8.35, P<0.01). Greatest bird density was detected in oak woods and mixed conifers dominated by mature Norway spruce (Table 2). Black pine stands had the lowest bird densities and the least number of species. Beech forests showed an intermediate situation, having relatively low bird densities and species richness (average). Pure conifers and silver birch forests accommodated many bird species but in rather low densities. Species diversity was greater in Norway spruce and broadleaved forests than in pine forests, although these differences were not all statistically significant (Table 2). Considering heterogeneity (H'/max H'), bird species were represented more equally in broad-leaf than in conifer forests especially those encompassing Scots pines (Table 2).

TABLE 1

Frequency of observations, numbers counted and estimated bird species densities (mean number of individuals/ 10 ha) from 260 sample points in western Rodopi forests

Species	Frequency		No. of individuals		Density	S.E.
	0-30	All	0-30	All		
Coal Tit (*Parus ater*)	237	77	238	477	44.86	11.33
Chaffinch (*Fringila coelebs*)	253	139	216	694	35.22	7.76
Robin (*Erithacus rubecula*)	169	148	184	474	31.70	2.73
Marsh Tit (*Parus palustris*)	47	27	87	123	20.57	7.55
Blue Tit (*Parus caeruleus*)	66	54	81	124	17.87	8.83
Wren (*Troglodytes troglodytes*)	66	46	79	194	13.81	2.26
Nuthatch (*Sitta europaea*)	56	29	72	156	13.14	4.24
Goldcrest (*Regulus regulus*)	53	60	57	106	11.13	5.80
Great Tit (*Parus major*)	39	91	53	111	9.81	4.42
Bullfinch (*Pyrrhula pyrrhula*)	10	16	34	44	8.87	6.26
Hawfinch (*Coccothraustes coccothraustes*)	7	8	32	43	7.89	6.26
Chiffchaff (*Phylloscopus collybita*)	31	50	44	259	6.56	2.01
Blackbird (*Turdus merula*)	31	43	33	110	5.34	1.29
Long-tailed Tit (*Aegithalos caudatus*)	5	30	20	30	4.49	1.89
Great Spotted Woodpecker (*Dendrocopos major*)	23	50	24	80	3.88	1.42
Crossbill (*Loxia curvirostra*)	35	7	20	57	3.35	2.45
Blackcap (*Sylvia atricapilla*)	14	37	15	40	2.56	1.02
Mistle Thrush (*Turdus viscivorus*)	8	13	9	19	1.66	0.71
Jay (*Garrulus glandarius*)	8	25	10	31	1.64	0.45
Crested Tit (*Parus cristatus*)	7	6	7	16	1.25	1.35
Water Pipit (*Anthus spinoletta*)	4	4	4	5	1.10	1.21
Rock Bunting (*Emberiza cia*)	2	3	5	8	1.07	0.83
Cuckoo (*Cuculus canorus*)	7	81	7	113	0.98	0.55
Cirl Bunting (*Emberiza cirlus*)	3	7	5	11	0.91	0.57
Red-backed Shrike (*Lanius collurio*)	3	7	3	7	0.53	0.34
Syrian Woodpecker (*Dendrocopos syriacus*)	2	1	2	3	0.45	0.40
Nutcracker (*Nucifraga caryocatactes*)	3	13	3	34	0.43	0.38
Black Woodpecker (*Dryocopus martius*)	2	4	2	7	0.32	0.29
Short-toed Treecreeper (*Certhia brachydactyla*)	1	2	1	2	0.19	0.17
Woodpigeon (*Columba palumbus*)	1	4	1	4	0.16	0.14
Hooded Crow (*Corvus corone cornix*)	1	4	1	4	0.16	0.14
Song Thrush (*Turdus philomelos*)	1	1	1	7	0.15	0.13
Black Redstart (*Phoenicurus ochruros*)	1	8	1	11	0.14	0.13
Green Woodpecker (*Picus viridis*)	0	1	0	1		0
Middle Spotted Woodpecker (*Dendrocopos medius*)	0	1	0	1		0
Tree Pipit (*Anthus trivialis*)	0	2	0	2		0
Black-headed Wagtail (Motacilla flava)	0	17	0	2		0
Firecrest (*Regulus ignicapillus*)	0	1	0	1		0
Sombre Tit (*Parus lugubris*)	0	1	0	2		0
Lesser Spotted Woodpecker (*Dendrocopos minor*)	2	2	2	2		0
Ring Ouzel (*Turdus torquatus*)	0	6	1	1		0
Wood Warbler (*Phylloscopus sibilatrix*)	0	61	2	2		0
Total			1 356	3 418		

TABLE 2

Bird density, number of species, bird species diversity and homogeneity indices in the forest stands of western Rodopi.

Sample plots/ dominant tree species	Ind./ 10 ha	S*	S	H'	H'/ max H'
1. *Picea abies- Picea abies* (2,5,8,9,12,13)*	20.29	17	24	2.26	0.531
2. *Pinus sylvestris- Picea abies* (1)	14.52	9	16	1.68	0.598
3. *Picea abies - Pinus sylvestris* (1,2)	34.40	11	17	4.97	0.624
4. *Fagus sylvatica – Picea abies* (2,3)	13.44	15	19	2.27	0.595
5. *Fagus sylvatica – Pinups sylvestris* (1,3,4)	13.13	10	17	1.68	0.622
6. *Pinus sylvestris - Fagus sylvatica* (2,3,5)	11.58	12	14	2.08	0.657
7. Quercus frainetto - Pinus nigra (2,3,5,6)	32.17	16	18	2.35	0.453
8. *Pinus nigra - Pinus nigra* (1,3,4,6,7)	6.37	8	15	1.75	0.679
9. *Betula pendula - Pinups sylvestris* (1,2,3,5,6,7,8)	17.90	16	26	2.48	0.612
10. *Fagus sylvatica - Fagus sylvatica* (2,3,5,8)	18.88	17	28	2.37	0.495
11. *Quercus frainetto - Quercus frainetto (2,3,5,8)*	32.33	18	24	2.28	0.453
12. *Pinus sylvestris - Pinus sylvestris* (1,3,4,7,9,10,11)	13.28	11	22	1.79	0.559
13. *Betula pendula - Betula pendula* (1,2,3,5,6,8,11,12)	14.04	18	20	2.52	0.470
Average	18.64		20		

S* : *Number of species detected within the 30m-fixed radius from the observer*
S : Total number of species detected
H' : Shannon-Wiener diversity index
Max H' : maximum diversity
H'/ max H' : Heterogeneity index
() Forest stands with statistical differences in species diversity*

DISCUSSION

Overall the Rodopi forests seem to host both central European and Mediterranean species and could be classified as a transitional zone between the lowest part of temperate forest and the highest part of the Mediterranean one. The composition and structure of the vegetation in the area is typical of montane forests, dominated by broadleaved species at lower elevations and conifers at higher altitudes (TUCKER & EVANS, 1997). However in the sub alpine coniferous zone, which is dominated by Norway spruce and Scots pine some of the species recorded are typical of boreal forests such as the willow tit, the nutcracker (*Nucifraga caryocatactes*), the ring ouzel (*Turdus torquatus*), the bullfinch, and the Capercaillie which are considered to be rare in Greece. Meanwhile in the temperate forests, dominated by beeches and oaks, the bird community included typical species of broadleaved forests, some of them rather common in many parts of the country (e.g. honey buzzard, short-toed eagle, goshawk, sparrowhawk, tawny owl and a variety of chats, tits and warblers). This pattern is expected in woodland habitats dominated by central European species at the edge of their distribution due to the fact that some of the mountain parts in intermediate zones of the Balkans have been moderately affected by the glacial and interglacial periods. It has also been suggested that mountain regions facing south, east and southeast (such as the mountains of the study area) act as "refugia" for the mediterranean fauna (MATVEJEV, 1976).

Species diversity and density in point counts coincide with and confirm general conclusions in the existing literature. Considering woodland structure it has been shown in many studies that forests with mature trees, standing dead timber, small open areas and many layers of foliage exhibit a higher ecological value in terms of bird species richness and abundance (MACARTHUR & MACARTHUR, 1961; MOSS, 1978, SMART & ANDREWS, 1985; ANDREWS, 1986; AVERY & LESLIE, 1990).

Regarding tree species composition, it is generally accepted that spruce carries more bird species than pine (NEWTON 1986), as spruce woodland provides birds with greater amounts of food (e.g. insects) and better shelter for nests. Birch forests support greater densities of birds than pines (NEWTON & MOSS 1977) while oak woods maintain greater densities than both (FRENCH et al., 1986). Pure conifer forests in the study area are rather dark with closed canopy and for this reason field layers are mostly absent or poorly developed. As a result their avifauna is less diverse but the species are quite characteristic. These forests are heavily exploited for timber production and subsequently the bird communities often follow the man-induced succession of the forest. On the contrary mixed forests dominated by oaks exhibit greater development of understory growth and a higher diversity of vascular plants thus supporting a much richer avifauna. In addition, broadleaves often experience an outbreak of foliage-feeding caterpillars, which leads to the defoliation of the canopy branches. This feature was most pronounced in the pure oak woods of the Sub-Mediterranean zone where the young oak trees, although they had a very low foliage profile, attracted insectivorous passerines from adjacent forest habitats.

Beech and silver birch forests are multi-layered but they are dominated by more homogeneous stands with less horizontal heterogeneity and exhibited an intermediate situation regarding bird abundance and density. Above all, the mixed stands of Norway spruce with Scots pine proved of exceptionally high ornithological value. These forests supported a great structural and floristic diversity

and offer ample feeding and nesting opportunities to a relatively high number of birds. Similarly pure Norway spruce forests where large amounts of dead wood and small openings were present supported forest birds with many different types of food and nesting sites. Breeding and foraging habitat are mostly suitable for these species that are insectivorous and hole nesting. Woodpeckers largely acquired their food in open conifer stands with many snags, and in areas where intense logging takes place they preyed upon insects thriving in the stools. On the contrary, in beech stands they foraged in mature trees with DBH of 30-50 cm. The diverse avifauna detected in silver birch forests should be attributed to the variety of habitats and microhabitats occurring within certain sampling plots (e.g. mature trees, rocky outcrops, freshwater streams and an understory vegetation rich in shrubs).

On the other hand the low density of diurnal birds of prey is the most striking case of low human intervention on the upland forests. The area seems to sustain atypical habitat for many raptors. The lack of suitable breeding sites for cliff nesters and the scarcity of foraging areas must have had a critical impact on many Greek-Mediterranean species. The extensive area was inhabited by an ancient Greek race (Sarakatsani) that practiced traditional stock raising till late '50s (PSYHOGIOS & PAPAPETROU, 1995). However nomadic flocks were eliminated almost completely during the first two decades after World War II. The reduction of extensive grazing has resulted in regeneration of the forest, which was also enhanced by depopulation of the area and abandonment of agricultural land for political and social reasons (e.g. Greek civil war, GIANNATOS, 1997). As a result forest openings became scarce and foraging habitat for hunting raptors has been substantially reduced.Nevertheless forest management may counterbalance some of the differences detected in bird species richness and abundance. Conifer stands are quite intact as they are managed by group felling or selective thinning and are restocked by natural regeneration from shelter wood. On the contrary oak woods are normally under severe forestry operation such as clear cutting or coppicing on a 10-year rotation cycle, and natural regrowth comes mostly from the stumps. The impact has been most severe in the lowlands close to villages where oak woods are used as pastureland and fuelwood production.

ACKNOWLEDGEMENTS

I would like to thank the Forestry Department of Drama prefecture for offering me accommodation at the village of Elatia. I am especially thankful to the Forester G. Isaak for assistance in the fieldwork, S. Roberts for improvement of the English text, the Society for the protection of the Brown Bear "Arctouros" for technical support and the Hellenic Ornithological Society for allowing me access to its archives.

REFERENCES

ANDREWS, J.H. (1986). The implications for birds of farm woodland expansion. Farming and Forestry. In : HATFIELD, G.R. (ed.), *Proceedings of Conference,Loughborough University.* Forestry Commission, Occasional Paper 17.

ATHANASIADIS, N., A. GERASIMIDIS, E. ELEFTHERIADOU & K. THEODOROPOULOS (1993). Zur postglazialen Vegetationsentwicklung des Rhopdopi-Gebirges (Elatia Dramas-Grichenland). *Diss. Bot*., 196 : 427-537

AVERY, M. & R LESLIE (1990). *Birds and Forestry.* A & A.D. Poyser, London.

BAUER, W. & H.J. BOHR (1987). Zut Kenntnis der sudlichen Arealgrenzen einiger Vogellarten in den griechischen Rhodopen. *Vogelwelt,* 108 : 1-13

BIBBY, C.J., N.D BURGESS & D. HILL (1992). *Bird Census Techniques*. Academic Press, London.

BILSTEIN, K.L. (1978). *Behavioural ecology of Red-Tailed Hawks, Rough-legged Hawks, Northern Harriers, American Kestrels and other raptorial birds wintering in South central Ohio*. Ph.D. Dissertation, Ohio State University, Columbus.

BUCKLAND, S. (1984). Models for the variable circular plot method of estimating animal density. *Dept. of Stat. Technical. Report* No. 6. University of Aberdeen.

CALL, M.W. (1978). Nesting Habitats and Surveying techniques for the common Western Raptors. *Technical Note,* TN-316. U.S. Department of the Interior-Bureau of Land Management.

CATSADORAKIS, G. (1991). On the avifauna of Samaria gorge (Crete, Greece). *Kartieung mediterraner Brutvoegel*, 6 : 3-12

CATSADORAKIS, G. (1997). Breeding birds from reedbeds to alpine meadows (Lake Prespa, northwestern Greece : a uniquie Balkan wetland). *Hydrobiologia,* 351 : 143-155

DAFIS, S. & P. SMIRIS (1981). Forest and stage research in Fir forests of Greece. *Scientific Yearbook. Dept. of Forestry,* Vol. 104. No. 5 : 145-191. (In Greek).

EMLEN, J.T. (1977). Estimating breeding season bird densities from transect counts. *Auk*, 94 : 455-468.

FALLS, J.B. (1981). Mapping territories with playback : an accurate census method for songbirds. In : RALPH & SCOTT (eds), *Estimating numbers of terrestrial birds*. Studies in Avian Biology 6, Cooper Ornith. Society : 86-91.

FRENCH, D.D., D. JENKINS & J.W.H. CONROY (1986). Guidelines for managing woods in Aberdeenshire for song birds. In : JENKINS, D. (ed) : *Trees and Wildlife in the Scottish Uplands,* ITE Symposium No. 17, pp. 121-128. Huntingdon, Institute of Terrestrial Ecology.

FULLER, M.R. & J.A. MOSHER (1987). Raptor survey techniques. In : PENDLETON, MISSLAP, CLINE & BIRD (eds), *Raptor Management techniques Manual*. Institute for Wildlife Research National Wildlife Federation. Sc. Tech. Series No. 10.

GATZOGIANNIS, S. (1999) : *Special Environmental Study of the Rodopi region. Project LIFE- NATURE, ARCTOS (Phase II)*, Vol. A & B, pp. 439. Thessaloniki.

GIANNATOS, G (1997). *Human-related factors affecting Brown bear conservation in the Rodopi mountains of Northeastern Greece*. M.Sc. Thesis, Missoula, Un. of Montana.

HANDRINOS, G. & T. AKRIOTIS (1997). *The Birds of Greece*. Helm-A&C Black, London.

JARVINEN, O. & R.A. VAISANEN (1975). Estimating relative densities of breeding birds by the line transect method. *Oikos,* 26 : 316-322.

KREBS, C. (1989). *Ecological Methodology.* Harper Collins, New York.

MACARTHUR, R.H. & J.W. MACARTHUR (1961). On bird species diversity. *Ecology,* 42 : 594-598

MAGURRAN, A. (1988). *Ecological Diversity and Its Measurements*. Croom Helm, London.

MATVEJEV, S.D. (1976). Survey of the avifauna of the Balkan peninsula. *The Serbian Academy of Sciences and Arts Monog*., Vol. CDX-CI, pp. 321. Beograd.

MAVROMATIS, G. (1980). The bioclimatic zones of Greece. Relation of the climate and vegetation. Bioclimatic zones of Greece. *Forest Research*, Athens, 63 pp. (In Greek).

MILLER, R.G. (1974). The Jackknife-a review. *Biometrika* 61 : 1-15.

MOSS, D. (1978). Diversity of woodland song-bird populations. *Journal of Animal Ecology,* 47 : 521-527.

NEWTON, I. (1986). Principles underlying bird numbers in Scottish woodlands. In : JENKINS, D. (ed) : *Trees and Wildlife in the Scottish Uplands,* ITE Symposium No. 17, pp. 121-128. Huntingdon, Institute of Terrestrial Ecology.

NEWTON, I. & D. MOSS (1977). Breeding birds of the Scottish pinewoods. In : BUNCE & JEFFERS. (eds), *Native Pinewoods of Scotland,* pp. 26-34. Institute of Terrestrial Ecology, Cambridge.

POIRAZIDIS, C. (1990). The Capercaillie (*Tetrao urogallus,* L.) in the Greek forests. *Physis,* 48 : 3-7 (In Greek).

PSYHOGIOS, D. & G. PAPAPETROU (1995). The movements of pastoralism in Sarakaqtsani : A Hellenic pastoralist population. *Proceedings of Congress in Serres*, pp. 27-46. Athens (In Greek).

SFOUGARIS, A., P. BIRTSAS & A. NASTIS (1998). Bird diversity and density in relation to different habitats and land uses in Portaicos-Pertouli area, Greece. In : WATERHOUSE &. MCEWAN (eds) *Landscape, Livestock and Livelihoods in European less favoured areas*, Proceedings of EU EQULFA Project : 57-62

SMART, N. & J. ANDREWS (1985). *Birds and broadleaves handbook*. RSPB.

SMIRIS, P. (1987). The dynamic evolution of vegetation stucture of the "Virgin Forest" in Paranesti. Sci. *Ann. Fac. Forest*., Vol. A, No. 13. Aristotle University of Thessaloniki, Thessaloniki.

TSIAOUSSI, V. (1996). *Specific Management Plan for the site Periochi Elatia (GR1140003*). The Goulandris Natural History Museum-Greek Biotope/ Wetland Centre, pp. 197. Thermi, Salonika.

TUCKER, G.M. & M.I., EVANS (1997). *Habitats for birds in Europe : a conservation strategy for the wider environment,* BirdLife Conservation Series no. 6, pp. 464. BirdLife International, Cambridge.

WOFFINDEN N. & J. MURFHY (1977). A roadside reptor census in the eastern Great Basin 1973-1974. *Raptor Research,* 11 : 62-66.

ZAR, J. (1984). *Biostatistical analysis*. Prentice Hall, New Jersey.

APPENDIX 1

Breeding status of bird species detected in the western Rodopi forests

1 : Suitable nesting habitat
2 : Territorial defense/ Aerial display/ Courtship behaviour
3 : Nest with chicks found
4 : Adult feeding chicks/ carrying food to the nest
5 : Fledglings observed
6 : Data insufficient

Species	Breeding status
***FAMILY*: Accipitridae**	
Pernis apivorus (Linnaeus)	2, 4
Circaetus gallicus (Gmelin)	3, 4
Accipiter brevipes (Severtzov)	1, 2
Accipiter nisus (Linnaeus)	1, 2
Accipiter gentiles (Linnaeus)	1, 2
Buteo buteo (Linnaeus)	2, 4
Aquila chrysaetos (Linnaeus)	1, 2
***FAMILY*: Falconidae**	
Falco tinnunculus (Linnaeus)	2, 2
Falco subbuteo (Linnaeus)	1, 2, 4
Falco eleonorae (Cene)	6
***FAMILY*: Tetraonidae**	
Bonasia bonasia (Linnaeus)	1, 5
Tetrao urogallus (Linnaeus)	1, 5
***FAMILY*: Columbidae**	
Columba palumbus (Linnaeus)	1, 4
Streptopelia turtur (Linnaeus)	1, 2, 5
***FAMILY*: Cuculidae**	
Cunculus canorus (Linnaeus)	1, 2
***FAMILY*: Strigidae**	
Otus scops (Linnaeus)	1
Athene noctua (Scopoli)	1
Asio otus (Linnaeus)	1, 2
Stix aluco (Linnaeus)	1, 2
Aegolius funereus (Linnaeus)	1, 2
***FAMILY*: Caprimulgidae**	
Captimulgus europeus (Linnaeus)	1
***FAMILY*: Apodidae**	
Apus apus (Linnaeus)	6
Apus melba (Linnaeus)	6
***FAMILY*: Meropidae**	
Merops apiaster (Linnaeus)	1
***FAMILY*: Coracidae**	
Coracias garrulous (Linnaeus)	1
***FAMILY*: Upupidae**	
Upupa epops (Linnaeus)	1, 4
***FAMILY*: Picidae**	
Picus canus (Gmelin)	1, 2
Picus viridis (Linnaeus)	1, 2
Dryocopus martius (Linnaeus)	1, 5
Dendrocopos major (Linnaeus)	1, 3
Dendrocopos syriacus (Hemprich-Ehrenberg)	1, 2
Dendrocopos medius (Linnaeus)	1, 3
Dendrocopos leucotos (Bechstein)	1
Dendrocopos minor (Linnaeus)	1, 3
Picoides tridactylus (Linnaeus)	1
***FAMILY*: Alaudidae**	
Melanocorypha calandra (Linnaeus)	1
Caladrella brachydactyla (Leisler)	1
Galerida cristata (Linnaeus)	1
***FAMILY*: Hirundidae**	
Pryonopogne rupestris (Scopoli)	6
Hirundo rustica (Linnaeus)	6
Delichon urbica (Linnaeus)	6
***FAMILY*: Motacillidae**	
Anthus trivialis (Linnaeus)	1
Anthus spinoletta(Linnaeus)	1, 2
Motacilla flava (Linnaeus)	6
Motacilla cinerea (Tunstall)	6
Motacilla alba (Linnaeus)	6
***FAMILY*: Cinclidae**	
Cinclus cinclus (Linnaeus)	1
***FAMILY*: Troglodytidae**	
Troglodytes troglodytes (Linnaeus)	5
***FAMILY*: Turdidae**	
Erithacus rubecola (Linnaeus)	1, 5
Luscinia megarhynchos (Brehm)	1, 2
Phoenicurus ochruros (Gmelin)	5
Phoenicurus phoenicurus (Linnaeus)	1
Saxicola rubetra (Linnaeus)	5
Saxicola torquata (Linnaeus)	6
Oenanthe isabellina (Temminck)	6
Oenanthe oenanthe (Linnaeus)	1
Turdus torquatus (Temminck)	3, 5
Turdus merula (Linnaeus)	5
Turdus philomelos (Brehm)	5
Turdus viscivorus (Linnaeus)	5
***FAMILY*: Sylvidae**	
Hippolais pallida (Hemprich-Ehrenberg)	1
Sylvia cantillans (Pallas)	1
Sylvia melanocephala (Gmelin)	2
Sylvia communis (Latham)	1,1
Sylvia atricapilla (Linnaeus)	3, 5, 4
Phylloscopus bonelli (Vieillot)	1, 2
Phylloscopus sibilatrix (Bechstein)	1, 2
Phylloscopus collybita (Veillot)	1, 2
Regulus regulus (Linnaeus)	1, 2
Regulus ignicapillus (Temminck)	1
***FAMILY*: Muscicapidae**	
Muscicapa striata (Pallaas)	1
Ficedula parva (Bechstein)	1
***FAMILY*: Aegithalidae**	
Aegithalos caudatus (Linnaeus)	5
***FAMILY*: Paridae**	
Parus lugubris (Temminck)	2
Parus palustris (Linnaeus)	1, 5
Parus montanus (Conrad)	1
Parus cristatus (Linnaeus)	5
Parus ater (Linnaeus)	5, 4
Parus caeruleus (Linnaeus)	5
Parus major (Linnaeus)	5

Species	Breeding status
***FAMILY*: Sittidae**	
Sitta europaea (Linnaeus)	5
Sitta neumayer (Michahelles)	1
***FAMILY*: Certhiidae**	
Certhia familiaris (Linnaeus)	1
Certhia brachydactyla (Brehm)	1
***FAMILY*: Oriolidae**	
Oriolus oriolus (Linnaeus)	1
***FAMILY*: Laniidae**	
Lanius collurio (Linnaeus)	5
Lanius minor (Gmelin)	1
Lanius senator (Linnaeus)	2
***FAMILY*: Corvidae**	
Garrulus glandarius (Linnaeus)	1, 2, 5
Nucifraga caryocatactes (Linnaeus)	1, 5
Corvus corone (Linnaeus)	1
Corvus corax (Linnaeus)	6
***FAMILY*: Passeridae**	
Passer domesticus (Linnaeus)	4
Passer montanus (Linnaeus)	1
***FAMILY*: Fringilidae**	
Fringila coelebs (Linnaeus)	5
Serinus serinus (Linnaeus)	5
Carduelis chloris (Linnaeus)	5
Carduelis carduelis (Linnaeus)	5
Carduelis spinus (Linnaeus)	1
Carduelis cannabina (Linnaeus)	5
Loxia curvirostra (Linnaeus)	5, 4
Pyrrhula pyrrhula (Linnaeus)	5, 4
Coccothraustes coccothraustes (Linnaeus)	5
***FAMILY*: Emberizidae**	
Emberiza citrinella (Linnaeus)	6
Emberiza cirlus (Linnaeus)	1, 2
Emberiza cia (Linnaeus)	5
Emberiza hortulana (Linnaeus)	6
Emberiza melanocephala (Linnaeus)	6
Milaria calandra (Linnaeus)	6