

## Numbers and distribution of Red-footed Falcons (*Falco vespertinus*) breeding in Voivodina (northern Serbia): a comparison between 1990-1991 and 2000-2001

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**ABSTRACT.** The survey of population size and distribution of Red-footed Falcons proceeded in June-July 2000 and 2001 respectively, ten years after the first census (1990 and 1991). Data of only those nests were processed in which there was breeding. Breeding success was calculated from the number of offspring per reproductive female. During the survey in Voivodina in 1990-1991 there were 308 and 124 pairs, respectively, whereas ten years later, in the year 2000 there were 116, and in 2001 only 61 pairs of Red-footed Falcons. Even if the marked fluctuations observed are not considered, the Red-footed Falcon population breeding in Voivodina shows a declining tendency. The south-western margin of the distribution area has moved towards the northeast by about 50-70 kilometres. More than 90% of the nesting sites, including the larger nesting colonies, are found in the Banat region, i.e. east of the Tisa River. More than 90% of the Red-footed Falcons continue to nest in Rook colonies. No significant change has occurred in their breeding success.

**KEY WORDS :** Red-footed Falcon, *Falco vespertinus*, census, fluctuation, nesting strategies, breeding success, Voivodina, Serbia.

### INTRODUCTION

The Palearctic breeding range of the Red-footed Falcon (*Falco vespertinus*) extends across a broad band of steppe, forest-steppe, and cultivated north temperate areas (CADE, 1982). It is estimated that there are 18,000-44,000 pairs nesting in Europe, with the majority (15,000-40,000) found in Russia's European areas (TOMIALOJC, 1994; BIJLSMA, 1997; HEATH et al., 2000). Breeding numbers in the stronghold of the Carpathian basin, Hungary, declined from about 2000-2200 pairs in the early 1990s (TOMIALOJC, 1994; BIJLSMA, 1997; HARASZTHY, 1998; MAGYAR et al., 1998; HEATH et al., 2000) to 1300-1500 pairs in 1997 (TÓTH & MARIK, 1999) and still further to 700-800 pairs in 2000 (BAGYURA et al., 2001). In recent decades, there has been only sporadic nesting west of the Danube (HARASZTHY, 1998). Numbers of Red-footed Falcon breeding in Voivodina, the northern province of Serbia, have been estimated several times over the last 30 years (HAM, 1977; VASIĆ et al., 1985; VASIĆ, 1996; BIJLSMA, 1997; HAM & RAŠAJSKI, 2000). A detailed assessment carried out in 1990-1991 (PURGER, 1996). HAM & RAŠAJSKI (2000) estimated as high as 17.2% increase of the Red-footed Falcon population in Voivodina and an extension of its distribution. Red-footed Falcons use the abandoned nests of various crow species (CRAMP & SIMMONS, 1980) as nest sites and may be solitary, semi-colonial, colonial when nesting. HARASZTHY & BAGYURA (1993) reported that Red-footed Falcons nesting in colonies have significantly higher breeding success. Thus, it is important to know the proportion of pairs that breed in colonies.

The aim of this study was to assess changes in population size, distribution of nesting sites, nesting strategies, and breeding success of Red-footed Falcons nesting in Voivodina, ten years after the first census (PURGER, 1996).

### MATERIALS AND METHODS

#### Study area

The province of Voivodina (44°38'-46°10'N; 18°10'-21°15'E) is predominantly a flat region, occupying the south-eastern part of the Carpathian Basin. It is divided into three regions by the rivers Danube, Tisa and Sava (Fig. 1); Bachka (Bačka) is a wide plain bordered by the Danube, the Tisa and the Hungarian border (8956km<sup>2</sup>); Banat is bordered by the Tisa, the Danube and the Romanian and Hungarian border (8886km<sup>2</sup>); while Srem is the area between the Danube and the Sava and the Serbian and Croatian border (3838km<sup>2</sup>). Within Voivodina there are four loess plateaus (Banatska-, Tamiška-, Titelskalesna zaravan and Telečka), two sandy areas (Deliblatska peščara and Subotičko-Horgoška peščara), and two low mountain ranges (Fruška gora in Srem at 539m, and Vršacke planine in south-eastern Banat at 641m a.s.l.). It is a forest-steppe region with a temperate-continental climate, in which central-European and Mediterranean influences are noticeable (STEVANOVIĆ & STEVANOVIĆ, 1995). The potential natural vegetation of Voivodina consists of climo-zonal vegetation, hydrologically conditioned vegetation, sandy and saline vegetation (PARABUČSKI & JANKOVIĆ, 1978). According to STEVANOVIĆ et al. (1995) natural vegetation includes: steppes (*Festucion rupicolae*), forest-steppes (*Aceri tatarici-Quercion*), mezophytic Slavonian-oak hardwoods (*Quercion roboris*), mezophytic beech and oak-hornbeam forests (*Fagion moesiaca*, *Quercio-Carpinion betuli*), and thermophytic Turkey oak-Italian oak forests (*Quercion frainetto*). More than 75% of the province is used agriculturally; only 6.6% is covered by forests (MARKOVIĆ, 1990). The remnants of steppe and forest-steppe areas are decreasing and being modified by agricultural expansion (MATVEJEV & PUNCER, 1989). The distribution

of natural woodlands and fast-growing plantations has also decreased recently.

### Methods

Our survey of the population size and distribution of Red-footed Falcons in 2000 and 2001 followed the same routes taken a decade before (PURGER, 1996). With one or two observers the author drove all main roads and a lot of dirt roads, usually ca. 300-400km per day. However, the majority of trees and bushes along roads, railways and canals have been cut down recently (this is particularly striking in Bachka and in the northern and central parts of Banat). Therefore nesting opportunities for Rooks (*Corvus frugilegus*), Hooded Crows (*Corvus cornix*) and Magpies (*Pica pica*) and consequently for the Red-footed Falcons have decreased. Thus carrying out the survey (total counts) took less time than during the first study. The census was done between 21-24 June and 7-12 July 2000, and between 17-20 June and 13-18 July 2001. It took ten days in both years: one day was spent in Srem, where its breeding is probable in some years, two days in Bachka, where nesting sites are mostly isolated, and seven days in Banat, because the main breeding sites are in northern and

central part of Banat (PURGER, 1996; HAM & RAŠAJSKI, 2000). The types of nests occupied by the Red-footed Falcons were recorded: birds nesting in Rook colonies were considered "colony nester" irrespective of the number of pairs, whereas those occupying Magpie or Hooded Crow nests were regarded as "solitary nesters". For raptors POSTUPALSKY (1974) proposed at least two checks of each occupied nest per breeding season. Due to the frequent rains, it was not possible to check all nests several times, thus breeding success was studied only in 2001 at the colony in Mokrin, which was easily accessible. The number of pin-feathered or fledging chicks (mean number  $\pm$  sd) per reproductive female was used as basic unit for calculating breeding success, in order for the results to be comparable with the earlier survey (PURGER, 1995). Checking nests was done using mirrors, by climbing trees and by counting chicks sitting on nest.

In the statistical analysis for comparing proportions (numbers of colony nester and solitary pairs) we used  $2 \times 2$  contingency tables with Yates' correction. For comparing the means of small samples we used two tailed t-test. The probability threshold for rejecting null hypothesis was 5% (FOWLER & COHEN, 1995).

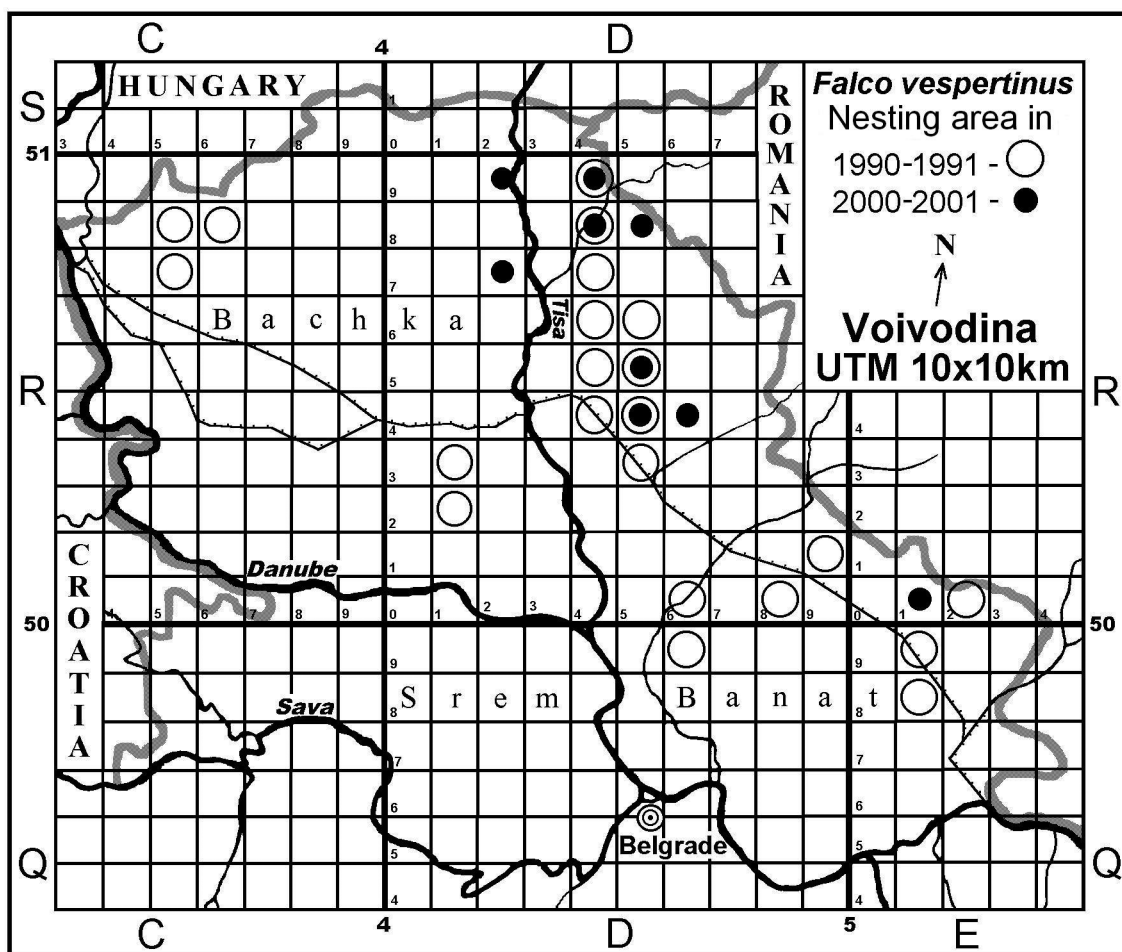


Fig. 1. – Breeding distribution of the Red-footed Falcon in Voivodina in 1990-1991 (according to PURGER, 1996, open circles) and 2000-2001 (original data, black points) based on the bird census data.

## RESULTS AND DISCUSSION

A total of 116 and 61 pairs of Red-footed Falcon nested in Voivodina in 2000 and in 2001, respectively (Table 1). Ten years before there were 308 in 1990 and 124 pairs in 1991 (PURGER, 1996). The survey in 1991 indicated a 60% population decrease since 1990, whereas the number recorded in 2001 was 47% less than in 2000. This suggests that the population size along the south-western margin of European area fluctuates greatly among years. Difference between the surveys in 1991 and 2000 was not big (124, 116 pairs), but whereas a total of 432 pairs of Red-footed Falcon nested in the study area at the time of the first surveys (1990/91), there were only 177 pairs of them breeding during the second surveys (2000/01), which suggest population decline. Also, the number of nesting localities varied from year to year, being 19 in 1990 and 22 in 1991. Only 9 were used in both years (PURGER, 1996). Our survey revealed a further decline in the number of nesting localities used; 17 in 2000, 11 in 2001 and 6 were used in both years (Table 1). Only one nesting location used in the first survey was used again in 2000-2001 (2km south-east of Jazovo). In this colony 147 nesting pairs were counted in 1990 and 29 pairs in 1991 (PURGER, 1996), but only 12 pairs in 2000 and 6 pairs in 2001 (Table 1).

TABLE 1

Number of breeding pairs of Red-footed Falcon found in Voivodina during 2000 and 2001.

UTM	Locality	2000	2001
<b>Bachka</b>			
DR27	1 km south of Sterijino Selo	1	-
	2 km south of Sterijino Selo	2	-
DR29	2.5 km north-west of Zimonjić (Kapetanski rit)	6	2
<b>Banat</b>			
DR48	2 km south-east of Jazovo	12	6
DR49	1 km north-west of Podlokanj	1	-
	1 km south-west of Vrbica	1	-
	1 km west of Banatski Monoštor	1	-
	1 km east of Banatski Monoštor	-	2
	2 km east of Crna Bara	1	-
	3 km east of Crna Bara	1	-
	3.5 km east of Crna Bara	-	1
	5 km south-east of Crna Bara	-	1
DR54	Torda	25	14
	2 km south-west of Torda	4	2
DR55	4 km north of Bašaid	1	-
DR58	Mokrin (Vašarište)	42	26
	1 km north-west of Mokrin	9	5
DR64	1 km south-west of Čestereg	2	-
	Banatsko Karađorđevo	-	1
	1 km north-east of Banatski Dvor	1	-
	1 km north of Banatski Dvor	-	1
ER10	7 km north-west of Vršac	6	-
	<b>Total</b>	<b>116</b>	<b>61</b>

Breeding pairs were found only in Bachka and Banat (Table 1, Fig. 1). In the north-western and south-eastern parts of Bachka there were 4 and 5 pairs nesting in 4 and 3 locations in 1990 and 1991, respectively (PURGER, 1996). By 2000 there were 9 pairs in 3 locations and in 2001 only 2 pairs at 1 location in the north-eastern part of

the region (Table 1, Fig. 1). The shift of nesting locations towards the north-east coincided with a contraction of their range that was associated with declining numbers. However, the majority of Red-footed Falcons in Voivodina (1990 – 99%, 1991 – 96%, 2000 – 92%, 2001 – 97%) bred in the northern, central and eastern parts of Banat (Table 1). After a period of ten years, not only the number of nesting locations, but also the number and size of larger colonies (with more than ten pairs of Red-footed Falcons) had declined. In 1990-1991, 88% and 72% of pairs nested in 5 and 4 large colonies respectively, and by 2000-2001 only 3 and 2 larger colonies (Jazovo, Torda, Mokrin) remained (Table 1). Thus, despite the population decline, 73% and 68% of Red-footed Falcons nesting in the areas beyond the Tisa River continued to nest in larger colonies (Table 1). The majority of nesting areas in Banat are about 10-20km from the Tisa, and are aligned parallel with the river (Fig. 1). No nesting Red-footed Falcons were found in the central parts of the region during the survey in 2000-2001. In 2000 there was still a smaller colony near Vršac (ER10), but it had disappeared by 2001 (Table 1). Overall, nesting areas in Voivodina have shifted to the north-east by 50-70 kilometres (Fig. 1).

The 1990-1991 results suggest that there were less birds nesting within Voivodina in 1991; only about a third of the 1990 total. Also, the number of solitary nesting pairs was significantly higher in 1991 ( $\chi^2=17.77$ ,  $df=1$ ,  $P<0.001$ ). In contrast, there was no significant difference ( $\chi^2=0.16$ ,  $df=1$ , ns) in nesting strategies between 2000 and 2001 (Table 2). Red-footed Falcons nesting in Voivodina used Rook nests even if they were situated in human settlements. In 1991, 11.3% of nests were found in the villages Bašaid and Sakule (PURGER, 1996). This association has subsequently increased. In 2000, 59.5% of nests (Mokrin, Torda, Čestereg) and in 2001, 67.2% of nests (Mokrin, Torda, Banatsko Karađorđevo) were located within villages (Table 1).

TABLE 2

Numbers of Rook and Hooded Crow and Magpie nests occupied by Red-footed Falcons in 1990 and 1991 (according to Purger 1996), and in 2000 and 2001 (original data). No significant difference was found between the proportions of the two groups in the two study periods ( $\chi^2=0.26$ ,  $df=1$ , ns).

Years	Rook nests	Hooded Crow and Magpie nests
1990	301 (98%)	7 (2%)
1991	108 (87%)	16 (13%)
Both years	409 (95%)	23 (5%)
2000	107 (92%)	9 (8%)
2001	58 (95%)	3 (5%)
Both years	165 (93%)	12 (7%)

In the Rook colony in Mokrin in 2001 (DR58, Table 1) the mean number of offspring per reproductive female was  $2.46\pm0.76$  ( $n=26$ ) and was not significantly different in either 1990 ( $t=0.95$ ,  $df=48$ , ns) or 1991 ( $t=-0.398$ ,  $df=56$ , ns). There was no significant difference ( $t=1.31$ ,  $df=54$ , ns) between breeding success in 1990 ( $2.66\pm0.76$ ,  $n=24$ ) and 1991 ( $2.34\pm0.87$ ,  $n=32$ ) (PURGER, 1995).

From our results in 2000 and 2001 (116 and 61 pairs, respectively) it appears that HAM & RAŠAJSKI (2000) overestimated the size of the Red-footed Falcon population (250-336 pairs between 1994-1996) breeding in Voivodina. Several authors have presented various distribution maps of nesting areas (PURGER, 1996; PURGER & MUŽINIĆ, 1997; RAŠAJSKI, 1997; HAM & RAŠAJSKI, 2000), but those can not be used for assessing population fluctuations. The spatial distribution of recent data reveals that Red-footed Falcons have traditional breeding locations with larger colonies in Banat where there are more extensive steppe grasslands, but the boundaries of the distribution area do fluctuate. Such fluctuations in range can best be determined if the survey is repeated every year. Our data indicate that the Red-footed Falcon population is declining and its range contracting towards the north-east. Thus, both trends are similar to what has been observed in Hungary (HARASZTHY, 1998; TÓTH & MARIK, 1999; BAGYURA et al., 2001).

Nesting strategy appears not to have changed during the past ten years: the majority of the Red-footed Falcons in Voivodina nest in Rook colonies, even when those are located inside villages. In Hungary only one third of the birds breed in colonies and the rest nest solitarily or in semi-colonies (TÓTH & MARIK, 1999). If solitary nesters have lower breeding success than birds in colonies (TÓTH, 1994; TÓTH & MARIK, 1999; HARASZTHY & BAGYURA, 1993), then the decline of the Hungarian population may be assisted by the lower breeding success. In Voivodina, south from Hungary, Red-footed Falcons continue to nest in colonies, but the population is still declining. Moreover the proportion of birds nesting in Rook colonies was even higher in 2000-2001. Maybe if population size falls under a critical limit, colonial nesting results in growth again through the effect of higher breeding success? This question can be answered only if population size and changes in nesting strategy are monitored for several years. It is likely that the disappearance of nesting sites and feeding grounds greatly influences both nesting strategies and population trends (TÓTH, 1994; TÓTH & MARIK, 1999). The Red-footed Falcon population in Voivodina is threatened by the increase of monoculture plantations and by the use of biotoxins (HAM & RAŠAJSKI, 2000). Changes in agricultural practice are the main factor implied in the population decrease of The Lesser Kestrel (*Falco naumanni*) and other steppary birds of prey (TELLA et al, 1998). This is supported by SNOW & PERRINS (1998), the major causes of Red-footed falcon population decrease being the decline of insect prey because of pesticide use, and habitat changes.

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## REFERENCES

- BAGYURA J, HORVÁTH Z & KALOCSA B (2001). A Magyar Madártani és Természetvédelmi Egyesület Ragadozómadár-  
védelmi Szakosztálya 2000. évben elért eredményeinek  
összefoglalója. Tűzok, 6: 25-29 (in Hungarian).
- BILLSMA RG (1997). Red-footed falcon *Falco vespertinus*. In:  
HAGEMEIJER EJM & BLAIR MJ (eds), The EBCC Atlas of  
European Breeding Birds: Their Distribution and Abun-  
dance. T. & A.D. Poyser, London: 182-183.
- CADE TJ (1982). The falcons of the world. Collins, London.
- CRAMP S & SIMMONS KEL (eds) (1980). Handbook of the birds  
of Europe, the Middle East and North Africa, Vol. 2. Oxford  
University Press, Oxford.
- FOWLER J & COHEN L (1995). Statistics for Ornithologists. Brit-  
ish Trust for Ornithology, Thetford.
- HAM I (1977). Stanje i mere zaštite ptica grabljivica Vojvodine  
sa posebnim osvrtom na Deliblatsku peščaru. Priroda Vojvo-  
dine, 3: 49-52 (in Serbian).
- HAM I & RAŠAJSKI J (2000). Siva vetruška *Falco vespertinus*  
(Linnaeus, 1758). In: PUZOVIĆ S (ed), Atlas ptica grabljivica  
Srbije, mape rasprostranjenosti i procene populacija 1977-  
1996. [Atlas of birds of prey of Serbia: their breeding distri-  
bution and abundance 1977-1996] Zavod za zaštitu prirode  
Srbije, Beograd: 153-155 (in Serbian with English sum-  
mary).
- HARASZTHY L (1998). Kék vércse *Falco vespertinus*. In: HAR-  
ASZTHY L (ed), Magyarország madarai. Mezőgazda Kiadó,  
Budapest: 99-100 (in Hungarian).
- HARASZTHY L & BAGYURA J (1993). A comparison of the nest-  
ing habits of the Red-footed Falcon (*Falco vespertinus*) in  
colonies and solitary pairs. In: NICHOLLS MK & CLARKE R  
(eds), Biology and conservation of small falcons. The Hawk  
and Owl Trust, London: 80-85.
- HEATH M, BORGGREVE C, PEET N & HAGEMEIJER W (eds)  
(2000). European bird populations: estimates and trends.  
BirdLife Conservation Series No. 10. BirdLife International,  
Cambridge.
- MAGYAR G, HADARICS T, WALICZKY Z, SCHMIDT A, NAGY T &  
BANKOVICS A (1998). Nomenclator avium Hungariae.  
Madártani Intézet – MME – Winter Fair, Budapest Szeged.
- MARKOVIĆ JĐ (1990). Enciklopedijski geografski leksikon  
Jugoslavije. Svjetlost, Sarajevo. (In Serbian and Croatian).
- MATVEJEV SD & PUNCER IJ (1989). Map of Biomes – Land-  
scapes of Yugoslavia. Natural History Museum, Belgrade.
- PARABUĆSKI S & JANKOVIĆ M (1978). An attempted determina-  
tion of the potential vegetation of Voivodina. Proceedings  
for Natural Sciences, Matica Srpska Novi Sad, 54: 5-20.
- POSTUPALSKY S (1974). Raptor reproductive success: Some  
problems with methods, criteria, and terminology. Raptor  
Research Report, 2: 21-31.
- PURGER JJ (1995). Breeding success of the Red-footed Falcon  
(*Falco vespertinus*) in Banat (Voivodina, Yugoslavia) based  
on ringing data. Ornis Hungarica, 5: 67-68.
- PURGER JJ (1996). Numbers and distribution of red-footed fal-  
con (*Falco vespertinus*) nests in Voivodina (northern Ser-  
bia). Journal of Raptor Research, 30: 165-168.
- PURGER JJ & MUŽINIĆ J (1997). The breeding distribution and  
migratory movements of the Red-footed Falcon (*Falco ves-  
pertinus*) in Province Voivodina (southern part of Carpathian  
basin). Ring, 19: 65-73.
- RAŠAJSKI J (1997). Ptice Srbije: sa kartama distribucija. [Birds  
of Serbia: with distribution maps]. Prometej, Novi Sad (in  
Serbian).
- SNOW DW & PERRINS CM (1998). The Birds of the Western Pal-  
earctic, Non-Passerines. Vol. 1. Oxford University Press,  
Oxford.
- STEVANOVIĆ V & STEVANOVIĆ B (1995). Osnovni klimatski,  
geološki i pedološki činioci biodiverziteta kopnenih ekosis-

- tema Jugoslavije. In: STEVANOVIĆ V & VASIĆ V (eds), Biodiverzitet Jugoslavije: sa pregledom vrsta od međunarodnog značaja. Biološki Fakultet i Ecolibri, Beograd: 75-95 (in Serbian).
- STEVANOVIĆ V, JOVANOVIĆ B & LAKUŠIĆ D (1995). Diverzitet vegetacije Jugoslavije. In STEVANOVIĆ V & VASIĆ V (eds), Biodiverzitet Jugoslavije: sa pregledom vrsta od međunarodnog značaja. Biološki Fakultet i Ecolibri, Beograd: 219-241 (in Serbian).
- TELLA JL, FORERO MG, HIRALDO F & DONÁZAR JA (1998). Conflicts between Lesser Kestrel Conservation and European Agricultural Policies as Identified by Habitat Use Analyses. *Conservation Biology*, 12: 593-604.
- TOMIALOJC L (1994). Red-footed falcon *Falco vespertinus*. In: TUCKER GM & HEATH MF (eds), *Birds in Europe: their conservation status*. BirdLife Conservation Series No 3. BirdLife International, Cambridge: 192-193.
- TÓTH I (1994). Kék vércse (*Falco vespertinus*) állományfelmérés és -védelem Békés-megyében. *Calandrella*, 8: 115-119 (in Hungarian).
- TÓTH I & MARIK P (1999). Kék vércse felmérés. *Madártávlat*, 6: 4-5 (in Hungarian).
- VASIĆ V, GRUBAČ B, SUŠIĆ G & MARINKOVIĆ S (1985). The status of birds of prey in Yugoslavia, with particular reference to Macedonia. In: NEWTON I & CHANCELLOR RD (eds), *Conservation studies on raptors*. Cambridge, ICBP Tech. Publ. No. 5: 45-53.
- VASIĆ VF (1996). European news: Red-footed Falcon *Falco vespertinus*. *British Birds*, 89: 253.

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