

## THE PROPORTION OF CROPLAND INFLUENCES NEGATIVELY THE OCCURRENCE OF BREEDING BIRDS IN AN ALKALI GRASSLAND HABITAT IN NW SERBIA

### Delež obdelovalnih zemljišč negativno vpliva na pojavljanje gnezdilk v habitatu z bazičnimi travišči v SZ Srbiji

DEJAN ĐAPIĆ<sup>1</sup>, THOMAS OLIVER MÉRŐ<sup>2</sup>

<sup>1</sup> Nature Protection and Study Society – NATURA, Milana Rakića 20, RS–25000 Sombor, Serbia, e-mail: cbraaa@mts.rs

<sup>2</sup> Department of Tisza Research, Danube Research Institute, Centre for Ecological Research, Hungarian Academy of Sciences, Bem tér 18/c, HU–4026 Debrecen, Hungary

Grasslands have been found to show high plant (e.g. LENGYEL *et al.* 2012) and animal species diversities (e.g. arthropods RÁ CZ *et al.* 2013, DÉRI *et al.* 2011, birds HAMER *et al.* 2006, mammals MÉRŐ *et al.* 2015). Due to increased agricultural use of land, the area of grasslands has decreased considerably, and they have become a focus in conservation biology in Europe (HEDBERG & KOTOWSKI 2010, KIEHL *et al.* 2010) and North America (HERKERT 1994, GERLA *et al.* 2012). To the best of our knowledge, only a few studies describe the relationship between the proportion of cropland within a grassland area and the breeding avifauna (e.g. ROBINSON *et al.* 2001). A North American study reported that besides the heterogeneity of a short-grass prairie habitat, factors such as landscape heterogeneity and prey availability can influence the distribution of nesting grassland bird species (HAMER *et al.* 2006). Furthermore, rapid changes in grasslands (e.g. fragmentation) negatively influence grassland bird communities by increasing predation pressure (BLOUIN-DEMERS & WEATHERHEAD 2006), by brood parasitism (ROBINSON *et al.* 1995) and by limited movement of individuals between habitat units (RICKETTS 2001).

In Serbia, alkaline and salty grasslands are mainly located in the province of Vojvodina. The majority are not subject to conservation and their water regime is therefore disturbed by melioration works. As a consequence of ploughing, grasslands show a fragmented distribution in the Vojvodinian landscape. Despite the presence of habitat fragmentation, the

Vojvodinian alkali and salty grasslands are biologically valuable habitats (ĐAPIĆ *et al.* 2015). Similarly to HAMER *et al.* (2006) we aimed to investigate the relation between the proportion of croplands on the nesting avifauna of salt grasslands. The aim of this study therefore, was to present the nesting avifauna of the alkali grasslands of the upper Mostonga River catchment-basin and then to explore the relation between the proportion of croplands and the species richness and the number of nesting pairs.

The study area lies in the region of Sombor (NW Serbia), between the settlements of Stanišić and Kruševlje (N 45.9329°, E 19.1328°) at the northernmost end of the west Bačka loess terrace. The entire area of the loess terrace is influenced by the semi-dry or dry period of the year which has a remarkable impact on the flora and fauna of the alkali grasslands. The annual mean temperature is 10.7°C – warmest in July with a monthly mean of 21.1°C, and coldest in January with a monthly mean of 0.8°C. The mean precipitation amount is 570 mm (TOMIĆ 1996). Groundwater is located about 150 cm under the ground. However, its level depends strongly on annual climatic conditions (PARABUĆSKI 1980).

The size of the study area is approximately 400 ha with an average elevation above sea level of 90 m. The area is interspersed with melioration canals and croplands where mainly corn and, to a smaller extent wheat, sunflower and soy, grow. These alkaline grasslands are characterised by the *Lepidio-Puccinellietum limosae* vegetation assemblages, containing 31 plant species (PARABUĆSKI 1980). In the northern parts of the study area, the dominant plant is sea aster *Tripolium pannonicum*; the Pannonian vegetation assemblages containing this species are suggested to have desert characteristics (PARABUĆSKI 1980). The banks of the meliorations are overgrown with cattail *Typha* ssp. and common reed *Phragmites australis*. Shrubs such as blackthorn *Prunus spinosa* and European elder *Sambucus nigra* occur accidentally. The southern border of the study area is a driveway with low traffic intensity. At times some parts of the grassland have been mown or grazed by sheep or cattle. The grasslands are interspersed by croplands. In this study cropland is defined as land where crops grow.

The study was performed in the breeding seasons of 2011 and 2012 during April, May and June. Birds were counted at seven transects lying immediately parallel to one another in a south-north orientation (Figure 1). The distance between transects was approximately 250 metres. Such a distance was necessary in order to avoid double counting, i.e. pseudo-replication. The length of each transect was approximately 1500 m.

We mapped the territories of birds when walking slowly through transects, i.e. a combination of the transect and mapping methods (BIBBY *et al.* 2000, GIBBONS & GREGORY 2006, GREGORY *et al.* 2004). We have taken into account all birds showing territorial behaviour and singing males that were within 120 m of either side of the transect. Territories which could not be clearly linked to a transect were excluded from the analysis (e.g. those for Skylarks *Alauda arvensis*) to avoid uncertainties. Transects were visited every 14<sup>th</sup> day, i.e. eight visits per breeding season. We then

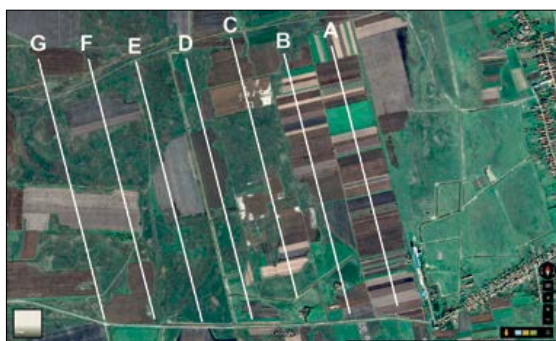
estimated the proportion of croplands in each transect by walking along transects with a hand-held GPS receiver, measuring and recording the length of both grasslands and croplands. The proportion of croplands per transect was calculated by dividing the total lengths of croplands with the total length of transect.

In the statistical analysis we included birds that were recorded at least three times in the same territory during one breeding season, showing territorial behaviour such as singing, defending a nest or defending a female mate. These were considered as

**Tabela 1:** Maksimalno število gnezdečih parov in vrst na posameznem transektu v gnezditvenih sezonah 2011 in 2012

**Table 1:** The maximum number of nesting pairs and species in each transect for the breeding seasons 2011 and 2012

Species / Vrst	Maximum number of nesting pairs per transect/ Maksimalno število gnezdečih parov na transekt							Nesting density per 100 ha/ Gnezditvena gostota na 100 ha
	T <sub>1</sub>	T <sub>2</sub>	T <sub>3</sub>	T <sub>4</sub>	T <sub>5</sub>	T <sub>6</sub>	T <sub>7</sub>	
<i>Falco tinnunculus</i>				1				0.4
<i>Coturnix coturnix</i>				1			1	0.8
<i>Vanellus vanellus</i>	1	1						0.8
<i>Tringa totanus</i>	1							0.4
<i>Alauda arvensis</i>	3	3	7	9	7	8	4	16.3
<i>Galerida cristata</i>	1	1						0.8
<i>Hirundo rustica</i>		1	2					1.2
<i>Motacilla flava</i>	1	4	6	7	6	2	3	11.5
<i>Saxicola rubetra</i>		1	4	2	3	4	3	6.7
<i>Saxicola rubicola</i>		1	2	1		1		2.0
<i>Sylvia communis</i>					2	1		1.2
<i>Acrocephalus schoenobaenus</i>				3	1	3	3	4.0
<i>Acrocephalus scirpaceus</i>					1		1	0.8
<i>Acrocephalus palustris</i>					2			0.8
<i>Acrocephalus arundinaceus</i>			3	2	5		1	4.4
<i>Lanius collurio</i>							1	0.4
<i>Lanius minor</i>			1					0.4
<i>Sturnus vulgaris</i>		1					1	0.8
<i>Passer domesticus</i>		2	5					2.8
<i>Passer montanus</i>		2	3					2.0
<i>Chloris chloris</i>			1					0.4
<i>Emberiza schoeniclus</i>					1			0.4
<i>Emberiza calandra</i>	1	2	3	4	5	4	3	8.7
Total no. of pairs / Skupno št. parov	8	19	37	30	33	23	21	
No. of pairs per 10 ha / Št. parov na 10 ha	2.2	5.3	10.3	8.3	9.2	6.4	5.8	
No. of species / Št. vrst	6	11	11	9	10	7	10	



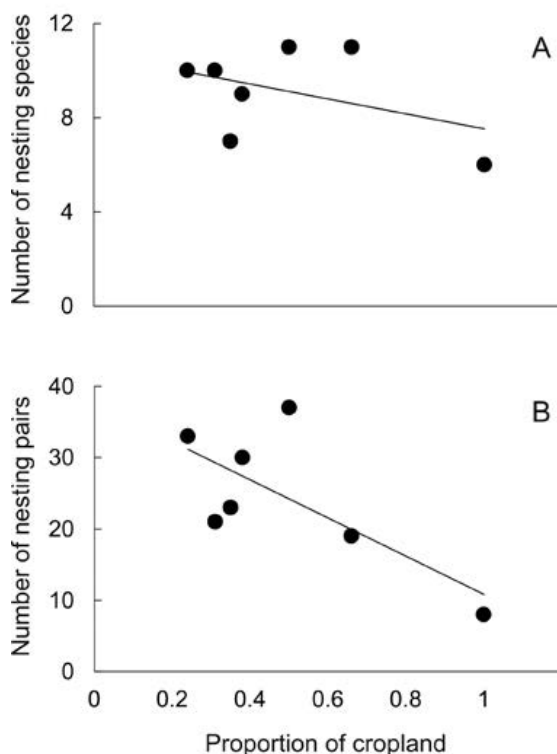
**Figure 1:** The seven transects in the alkali grassland area near Stanišić (NW Serbia)

**Slika 1:** Sedem transektov na območju bazičnih travišč blizu Stanišića (SZ Srbija)

nesting pairs. For every transect we calculated the total number of nesting pairs, the density of nesting pairs per 10 ha and the number of nesting species. For each species we calculated the nesting density for the total area ( $1.5 \text{ km} \times 0.24 \text{ km} \times 7 = 2.52 \text{ km}^2$ , corresponds to 252 ha). We then applied simple linear regression where the relationship between the numbers of nesting pairs and species, and the proportion of cropland were tested. Variables used in the tests displayed normal distribution (Shapiro-Wilk test,  $P = 0.179\text{--}0.898$ ). All tests were performed in the SPSS version 20 statistical software.

A total of 171 breeding pairs belonging to 23 species was recorded in the investigated alkali grassland, with breeding densities ranging from 2.2 to 10.3 pairs per 10 ha (average 6.8 nesting pairs per 10 ha, Table 1). The number of species per transect ranged between 6 and 11. The most abundant breeding species were the Skylark with 41 (16.3/100 ha), the Yellow Wagtail *Motacilla flava* with 29 (11.5/100 ha) and the Corn Bunting *Emberiza calandra* with 22 breeding pairs (8.7/100 ha) per transect. Less abundant breeding species were the Kestrel *Falco tinnunculus*, the Greenfinch *Chloris chloris* and the Reed Bunting *Emberiza schoeniclus* represented by one pair each (0.4/100 ha) (Table 1). Both the number of breeding pairs ( $F_6 = 21.761$ ,  $P < 0.0001$ , Figure 1A) and the number of breeding species ( $F_6 = 13.758$ ,  $P = 0.001$ , Figure 1B) were negatively influenced by the proportion of croplands, i.e. a higher percentage of croplands was associated with smaller numbers of breeding pairs and of breeding species.

Although some species, such as the Skylark and the Crested Lark *Galerida cristata*, adapt well to rapidly changing agricultural landscapes (CRAMP 1988), in



**Figure 2:** The relationship between the proportion of cropland and the numbers of (a) nesting species and of (b) nesting pairs for 2011 and 2012. The maximum numbers of pairs and species are given for each transect for both years together.

**Slika 2:** Odnos med deležem obdelovalnih zemljišč in (a) številom gnezdečih vrst ter (b) gnezdečih parov v letih 2011 in 2012. Za izračun je bilo uporabljeno maksimalno število parov in vrst na posameznem transektu v obeh letih.

our study we found only two nesting pairs of Crested Lark, while the number of nesting Skylarks was 41 pairs, suggesting that grassland fragmentation is less relevant than other factors to the occurrence of these two species (ŠÍMOVÁ *et al.* 2015). A possible explanation in the difference of the number of nesting pairs in both species may lie in their differences in habitat preference (KOVÁCS 1998A, B). The presence of some species in solitary shrubs (e.g. Whitethroat *Sylvia communis*, Red-backed Shrike *Lanius collurio*), trees (e.g. Starling *Sturnus vulgaris*, Lesser Grey Shrike *Lanius minor*) and small reed patches (e.g. Reed Bunting *Emberiza schoeniclus*) or reed beds along the small canals (e.g. *Acrocephalus* warblers) that intersperse the grasslands, suggests that unploughed areas of the study area are favoured by a wide range of bird species. Mean total nesting densities in our study were higher than the 2.5 pairs/10 ha found by MOREIRA (1999), but lower than the 10 pairs/10 ha found by PAVEL (2004).

In general, breeding densities of species found in our study were relatively small. For example, in some Hungarian grassland the nesting density of Skylarks varied between 8.3 and 22.7 pairs per 100 ha (TRASER 1983, KOVÁCS 1984). The breeding densities of the Lapwing *Vanellus vanellus* were greater than 13 and, of the Redshank *Tringa totanus*, more than 68 times larger than in our study (MARIÁN 1976, KOVÁCS 1984). For passerines, such as the Sedge Warbler *Acrocephalus schoenobaenus* and the Reed Bunting, the breeding densities in our study were considerably lower than in the study of TRASER (1983). In contrast with most of the species, the Yellow Wagtail and Corn Bunting showed much higher nesting densities in our study than in the grasslands near the Fertő Lake (TRASER 1983). These large differences between grasslands in various geographical regions suggest that there may be various factors that can locally influence the occurrence and nesting density of a species. For example, the higher nesting density of the Redshank in Hungary was probably due to the availability of larger areas covered by water in spring than at our study site.

Similarly to HAMER *et al.* (2006), we found a significant negative relationship between the proportion of cropland and the number of nesting species and nesting pairs, indicating that both were lower when the proportion of cropland was greater. The proportion and area of the grassland habitat have been found to influence the richness and nesting density of grassland bird species (MØLLER & JENNIONS 2002), which was linked to the availability of edges (HAMER *et al.* 2006). The more aggregated grassland patches contained more bird species (HAMER *et al.* 2006). The frequent edges between grassland and croplands may function as ecological traps due to increased predator density (FLASPOHLER *et al.* 2001), since that predators were suggested to use these edges as foraging corridors (SMALL & HUNTER 1988). We assume that the similar pattern in the number of nesting species and density found in our study may also be explained by frequent edges between cropland and grassland and associated with predation pressure.

In conclusion, general nesting densities of grassland birds may vary geographically. The nesting densities of each species were generally much lower at our study site, except for very few species, suggesting that various local factors can influence the presence and density of a species. Similarly to previous findings, the proportion of cropland influenced negatively bird species richness and abundance. Since these alkali grasslands of the upper Mostonga River belong to the national ecological net, we suggest that studies like ours should also be conducted for other groups of animals and plants. These

grasslands are planned to be protected areas until 2019 and are recommended for inclusion in the UNESCO biosphere reserve "Mura-Drava-Danube" (ĐAPIĆ *et al.* 2015). The biodiversity of the upper Mostonga River grasslands would greatly benefit from such protection.

## Acknowledgements

We thank Tibor Szép and Marko Tucakov for providing valuable references.

## Povzetek

Na travišćih je raznovrstnost rastlinskih in živalskih vrst velika. Največ bazičnih travišć v Srbiji je v Vojvodini, većina jih ni zavarovanih. Cilj naše raziskave je bil ugotoviti odnos med deležem obdelovalnih površin in (1) številom gnezdećih vrst ter (2) številom gnezdećih parov na bazićnih travišćih v zgornjem toku reke Mostonge (SZ Srbija). Obravnavano obmoćje je bilo veliko 400 ha. Ptice smo popisovali vzdolž sedmih vzporednih transektov osemkrat na gnezditveno sezono. Vzdolž transeкта smo merili dolžino travišć in obdelovalnih zemljišč. Delež obdelovalnih zemljišč smo izračunali tako, da smo dolžino obdelovalnih zemljišč vzdolž transeкта delili s celotno dolžino transeкта. Odnos med deležem obdelovalnih zemljišč, številom gnezdećih vrst in številom gnezdećih parov smo ocenili z linearno regresijo. Skupno smo na obravnavanem obmoćju popisali 171 gnezdećih parov 23 vrst z gnezditvenimi gostotami med 2,2 in 10,3 para na 10 ha. Število vrst na posameznem transektu je bilo med 6 in 11. Najpogostejše vrste so bile poljski škrjanec *Alauda arvensis*, rumena pastirica *Motacilla flava* in veliki strnad *Emberiza calandra*. Delež obdelovalnih zemljišč je negativno vplival tako na število gnezdećih parov ( $P < 0,0001$ ) kot število gnezdećih vrst ( $P = 0,001$ ). Te ugotovitve poudarjajo pomen usklajenih varstvenih ukrepov na bazićnih travišćih v Vojvodini.

## Abstract

Grasslands host a high diversity of plant and animal species. In Serbia, most alkali grasslands are located in the province of Vojvodina. The majority are not subject to conservation. The aim of the study was to investigate the relationship between the proportion of croplands and (1) the number of breeding species and (2) the number of breeding pairs in the alkali grasslands of the upper Mostonga River catchment basin (NW Serbia). The size of the study area was 400 ha. Birds were surveyed along seven parallel transects eight times

per breeding season. Lengths of the cross sections of both grasslands and croplands were measured. The proportion of croplands per transect was calculated by dividing the total length of cross sections of croplands by the total length of transect. The relationship between the proportion of croplands and the number of breeding pairs and the number of breeding species, respectively, was studied using simple linear regression. We recorded a total of 171 nesting pairs belonging to 23 species in the alkali grassland investigated, with breeding densities between 2.2 and 10.3 pairs per 10 ha. The number of species per transect ranged between 6 and 11. The most abundant species were Skylark *Alauda arvensis*, Yellow Wagtail *Motacilla flava* and Corn Bunting *Emberiza calandra*. The numbers of breeding pairs ( $F_6 = 21.761$ ,  $P < 0.0001$ ) and of breeding species ( $F_6 = 13.758$ ,  $P = 0.001$ ) were both influenced negatively by the proportion of croplands. These findings highlight the need for coordinated conservation measures on the alkali grasslands of Vojvodina.

## References

- BIBBY C. J., BURGESS N. D., HILL D. A., MUSTOE S. H. (2000): Bird Census Techniques, 2<sup>nd</sup> edition. – Academic Press, London.
- BLOUIN-DEMERS G., WEATHERHEAD P. J. (2006): Habitat use by black rat snakes (*Elaphe obsoleta obsoleta*) in fragmented forests. – *Ecology* 82: 2882–2896.
- CRAMP S. (1988) The Birds of the Western Palearctic (Vol. V). – Oxford University Press, Oxford, New York.
- DÉRI E., MAGURA T., HORVÁTH R., KISFALI M., RUFF G., LENGYEL S., TÓTHMÉRÉSZ B. (2011): Measuring the short-term success of grassland restoration: the use of habitat affinity indices in ecological restoration. – *Restoration Ecology* 19: 520–528.
- ĐAPIĆ D., STUMBERGER B., TUCAKOV M., RAJKOVIĆ D., ŠEAT J. (2015): Upper Mostonga alkaline meadows. – Društvo za zaštitu i proučavanje ptica Srbije, Novi Sad. (In Serbian)
- GERLA P. J., CORNETT M. W., AHLERING M. A., EKSTEIN J. D. (2012): Talking big: lessons learned from a 9,000 acre restoration in the Northern Tallgrass Prairie. – *Sustainability* 4: 3066–3087.
- GIBBONS D. W., GREGORY R. D. (2006): Birds. pp. 308–344. In: SUTHERLAND W. J. (ed.): *Ecological Census Techniques* (second edition). – Cambridge University Press, Cambridge.
- GREGORY R. D., GIBBONS D. W., DONALD P. F. (2004): Bird census and survey techniques. pp. 35–40. In: SUTHERLAND W. J., NEWTON I., GREEN R. E. (eds.): *Bird Ecology and Conservation*. – Oxford University Press, Oxford.
- FLASPOHLE D. J., TEMPLER S. A., ROSENFELD R. N. (2001): Species-specific edge effects on nest success and breeding bird density in a forested landscape. – *Ecological Applications* 11: 32–46.
- HAMER T. L., FLATHER C. H., NOON B. R. (2006): Factors associated with grassland bird species richness: the relative roles of grassland area, landscape structure, and prey. – *Landscape Ecology* 21: 569–583.
- HEDBERG P., KOTOWSKI W. (2010): New nature by sowing? The current state of species introduction in grassland restoration, and the road ahead. – *Journal for Nature Conservation* 18: 304–308.
- HERKERT, J. R. (1994): The effect of habitat fragmentation on mid-western grassland bird communities. – *Ecological Applications* 4: 461–471.
- KIEHL K., KIRMER A., DONATH T. W., RASRAN L., HÖLZEL N. (2010): Species introduction in restoration projects - Evaluation of different techniques for the establishment of semi-natural grasslands in Central and Northwestern Europe. – *Basic and Applied Ecology* 11: 285–299.
- KOVÁCS G. (1984): A balmazújvárosi Nagyszik madárvilága. – A Hajdúsági Múzeum Évkönyve 5: 5–18.
- KOVÁCS, G. (1998A): Mezei pacsirta *Alauda arvensis*. pp. 250–251. In: HARASZTHY, L. (ed.): *Magyarország madarai*. – Mezőgazda Kiadó, Budapest.
- KOVÁCS, G. (1998B): Bubos pacsirta *Galerida cristata*. pp. 248–249. In: HARASZTHY L. (ed.): *Magyarország madarai*. – Mezőgazda Kiadó, Budapest.
- LENGYEL S., VARGA K., KOSZTYI B., LONTAY L., DÉRI E., TÖRÖK P., TÓTHMÉRÉSZ B. (2012). Grassland restoration to conserve landscape-level biodiversity: a synthesis of early results from a large-scale project. – *Applied Vegetation Science* 15: 264–276.
- MARIÁN M. (1976): A Pusztaszeri Természetvédelmi Terület madárvilága. – *Aquila* 82: 81–98.
- MÉRŐ T. O., BOCZ R., POLYÁK L., HORVÁTH G., LENGYEL S. (2015): Local habitat management and landscape-scale restoration influence small-mammal communities in grasslands. – *Animal Conservation* 18: 442–450.
- MOREIRA F. (1999): Relationships between vegetation structure and breeding bird densities in fallow cereal steppes in Castro Verde, Portugal. – *Bird Study* 46: 309–318.
- MØLLER A. P., JENNIONS M. D. (2002): How much variance can be explained by ecologists and evolutionary biologists? – *Oecologia* 132: 492–500.
- PARABUČSKI S. (1980): Characteristics of some halophyte phytocenoses in Bačka. – *Zbornik Matice srpske za prirodne nauke* 58: 91–98. (In Serbian)
- PAVEL V. (2004): The impact of grazing animals on nesting success of grassland passerines in farmland and natural habitats: a field experiment. – *Folia Zoologica* 53: 171–178.
- RÁCZ I. A., DÉRI E., KISFALI M., BATIZ Z., VARGA K., SZABÓ G., LENGYEL S. (2013): Early changes of orthopteran assemblages after grassland restoration: a comparison of space-for-time substitution versus repeated measures monitoring. – *Biodiversity and Conservation* 22: 2321–2335.
- RICKETTS T. H. (2001): The matrix matters: effective isolation in fragmented landscapes. – *American Naturalist* 158: 87–99.
- ROBINSON S. K., THOMPSON F. R. III, DONOVAN T. M., WHITEHEAD T., FAABORG J. (1995): Regional forest fragmentation and the nesting success of migratory birds. – *Science* 267: 1987–1990.

- ROBINSON R. A., WILSON J. D., CRICK H. Q. (2001): The importance of arable habitat for farmland birds in grassland landscapes. – *Journal of Applied Ecology* 38: 1059–1069.
- SMALL M. F., HUNTER M. L. (1988): Forest fragmentation and avian nest predation in forested landscapes. – *Oecologia* 76: 62–64.
- ŠÍMOVÁ P., ŠŤASTNÝ K., ŠÁLEK M. (2015): Refugial role of urbanized areas and colonization potential for declining Crested Lark (*Galerida cristata*) populations in the Czech Republic, Central Europe. – *Journal of Ornithology* 156: 915–921.
- TOMIĆ P. (1996): Klima. pp: 16–21. In: ĐURIČIĆ J. (ed.): Opština Sombor. – Prirodno - matematički fakultet, Institut za geografiju & Prosveta, Novi Sad.
- TRASER GY. (1983): Egy félintenzíven legeltetett tehénlegelő madárvilága a Fertő DK-i partján. – *Erdészeti és Faipari Tudományos Közlemények* 2: 175–189.

Prispelo / Arrived: 14. 1. 2016

Sprejeto / Accepted: 31. 5. 2016