Terrestrial Ecology and Behaviour
Research Article

ACTA ZOOLOGICA BULGARICA
Acta zool. bulg., 66 (4), 2014: 505-510

Does the Weather Influence the Autumn and Winter Movements of Tits (Passeriformes: Paridae) in Urban Areas?

***Thomas O. Mérő*[1,2], *Antun Žuljević*[2]**

[1]Department of Ecology, Faculty of Science and Technology, University of Debrecen, Egyetem tér 1, H-4032 Debrecen, Hungary; E-mail: thomas.oliver.mero@gmail.com
[2]Nature Protection and Study Society – NATURA, Milana Rakića 20, SRB-25000 Sombor, Serbia; E-mail: antun.zuljevic@gmail.com

Abstract: The migration of tits has been the subject of a number of studies, whereas very little is known as concerns their movements in their wintering areas in urban habitats. This study presents the effects of weather variables (the air temperature, the number of days with a snow cover and the amount of precipitation) on the distances moved by the Great Tit *Parus major* and the Blue Tit *Cyanistes caeruleus* in an urban habitat during autumn and winter. Ringing data from 32 successive years (1981-2013) in Sombor, Serbia, were used. The Great Tits proved to move larger distances, searching the entire town, while the Blue Tits rather moved only within particular areas of the town. The female Great Tits moved significantly larger distances than the males, while such a difference between the sexes was not observed in the Blue Tits. Neither the number of days with a snow cover nor the air temperature affected the distances moved in either species, whereas a higher amount of precipitation led to shorter distances moved in the Great Tits but not in the Blue Tits. The movement activities of the Great Tits were lower in periods when precipitation was frequent.

Keywords: Recaptures, air temperature, amount of precipitation, movement distances, *Parus major, Cyanistes caeruleus*

Introduction

Whereas many papers discuss the migration (long-term movements) and the wintering habits of the Great Tit *Parus major* L. (see Báldi, Csörgő 1991, Sokolov *et al*. 1999, Nowakowski 2001, Nowakowski 2003, Nowakowski, Vähätalo 2003) and the Blue Tit *Cyanistes caeruleus* L. (see Smith, Nilsson 1987, Nowakowski, Chruściel 2004, Nyquist 2006, Nilsson *et al*. 2008, Gyurácz *et al*. 2011, Kokko 2011), little information has been published on the short-range movements of these species in urban areas in autumn and winter. Both species are migrants and the majority of the individuals, which come during the autumn and spend the winter in the Carpathian Basin, arrive from the north-eastern Europe (Török 2009a, 2009b, Mérő, Žuljević 2010, Ćiković 2013a, 2013b). Jokimäki, Kaisanlahti-Jokimäki (2012) and Møller *et al*. (2013) reported that tits prefer urban areas during autumn and winter because of their better survival chances during the cold period. Ringing and recaptures have demonstrated that the majority of Great Tits and Blue Tits found within the town of Sombor from October till March are migrants or winter guests (Mérő, Žuljević 2010). It is well known that the weather conditions are able to influence the migration of birds, *e.g.* the migration intensity, the migration speed, the duration and the food availability (Nowakowski 2001, 2003). Cold weather or rapid cooling can speed up a migration, forcing the birds to move larger distances without stopovers (Sokolov *et al*. 1999). However, there have been no publications as concerns how the movements of tits are affected by weather variables in urban habitats during the autumn and winter period. On the basis of ringing and recovery data related to the Great Tits and Blue Tits

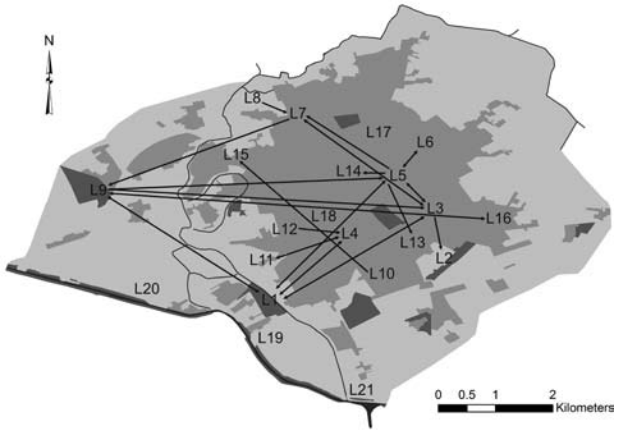

Fig. 1. Movements of the Great Tit between the ringing locations in the town of Sombor during the period 1981-2013 (a single-headed arrow symbol indicates one-way movement, while a double-headed arrow symbol indicates the movements of tits in both directions)

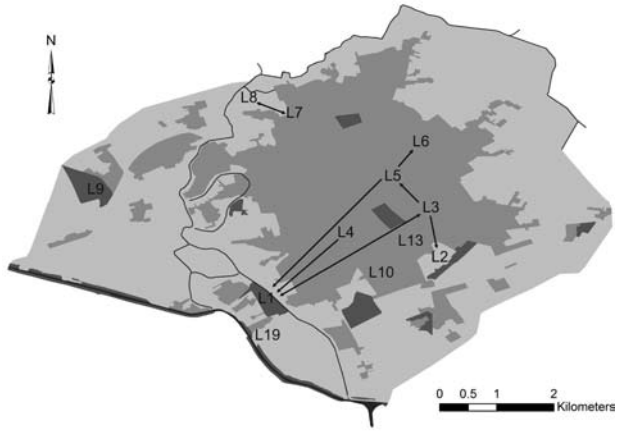

Fig. 2. Movements of the Blue Tit between the ringing locations in the town of Sombor during the period 1981-2013 (a single-headed arrow symbol indicates one-way movement, while a double-headed arrow symbol indicates the movements of tits in both directions)

in the town of Sombor, Serbia, from a period of 32 successive years, this study reports on the effects of the air temperature, the number of days with a snow cover and the amount of precipitation on the distances moved by both tit species in this urban habitat.

Material and Methods

Sombor (UTM CR 57; N 45.79˚, E 19.09˚; NW Serbia) is a typical lowland town (89 m a.s.l.) that covers an area of ca. 3000 ha. It has a population of around 50 000. The climate is temperate continental, with an average annual precipitation ca. 590 mm; the average annual temperature is 10.7˚C (Tomić 1996). The presence of a large number of trees plays an important role in the vegetation structure of the town. Trees are planted along avenues (total length 121 km, ca. 18 000 trees) and in parks (Table 1). The parks cover 0.4% of the area, while the greenery and grass adjacent to the streets and in the housing areas, such as hedges and other vegetation, account for 9.2% (Vojnović 2001). The gardens of the houses contain many coniferous trees, fruit-trees and walnuts *Juglans regia*. Shrubs include native species, *e.g*. black lace elderberry *Sambucus nigra*, blackthorn *Prunus spinosa,* and dog-rose *Rosa canina*. The reed *Phragmites australis* in the Bager Pond (Table 2, L8), located on the northern edge of the town, is a highly suitable habitat for the Blue Tit during migration and in the winter period. The pond was formed by the excavation of clay for the local brickyard. The total pond area, including the surrounding pits and low-lying meadows, is about 3 ha. Another reedy area in the town, the Veliki Bački canal (Table 2, L19 and L21), where the reeds grow on the banks, is also highly favoured by the Blue Tits.

Table 1. Tree composition in the town of Sombor according to the land registry "Zelenilo" from 2009

Tree species		**Proportion (%)**
Common Hackberry	*Celtis occidentalis*	60
Linden	*Tilia* sp.	14
Maples	*Acer* sp.	8
Black Locust	*Robinia pseudoacacia*	7
Poplar	*Populus* sp.	5
Horse Chestnut	*Aesculus hippocastanum*	3
Japanese Pagoda-Tree	*Sophora japonica*	1
Others		2

Table 2. A brief description of the ringing locations in the town of Sombor

Location	**Habitat**	**Location**	**Habitat**
L1	park	L12	avenue
L2	shrubbery	L13	garden
L3	garden	L14	avenue
L4	garden	L15	garden
L5	garden	L16	garden
L6	garden	L17	garden
L7	garden	L18	garden
L8	reed bed	L19	reed bed
L9	park	L20	shrubbery
L10	garden	L21	reed bed
L11	shrubbery		

The authors have possessed valid ringing licences since 1981. Up to 1993, the ringing licences

were issued by the Ringing Centre in Zagreb in the former Yugoslavia, and since 1993 they have been issued by the Ringing Centre in Belgrade (Serbia). Possession of a ringing licence includes a permission for regular catching and handling of birds, whether nestlings or adults. We conducted the ringing of tits from October to March the following year, in the period between 1981 and 2013. At times we ringed tits in the spring and summer period too, but since this was not done every year we excluded these data from the study. We ringed altogether 7558 Great Tits (at 21 locations; Fig. 1) and 1601 Blue Tits (at 12 locations; Fig. 2) within the town of Sombor. Tits were ringed in parks, avenues, gardens, shrubberies and reed beds, where feeders were operating from October to April the following year at all locations (Table 2). In the cases of locations L1, L2, L3, L5, L7, L9 and L10, the feeders were active throughout the entire study period, and ringing was conducted three or four times monthly at these sites. At all other localities the feeders were operating to attract birds only during the ringing activities, which took place at monthly intervals. The birds were fed with common sunflower *Helianthus annuus* seeds. Tits were captured with 3, 6 or 12 m long mist nets near the feeders, and exclusively aluminium rings were used for marking. During the 32 years, we recovered 1518 Great Tits (the total number of recovery cases was 1994), of which 78 individuals showed movements within the town, while in the case of Blue Tits 33 of the 435 recaptured individuals (the total number of recovery cases was 833) showed movements. There were no cases of movements, in which a bird was recaptured at a number of localities, although some of the tits were recaptured several times. We considered the movement distances (linear distance) during the period from October to March the following year, i.e. in autumn and winter.

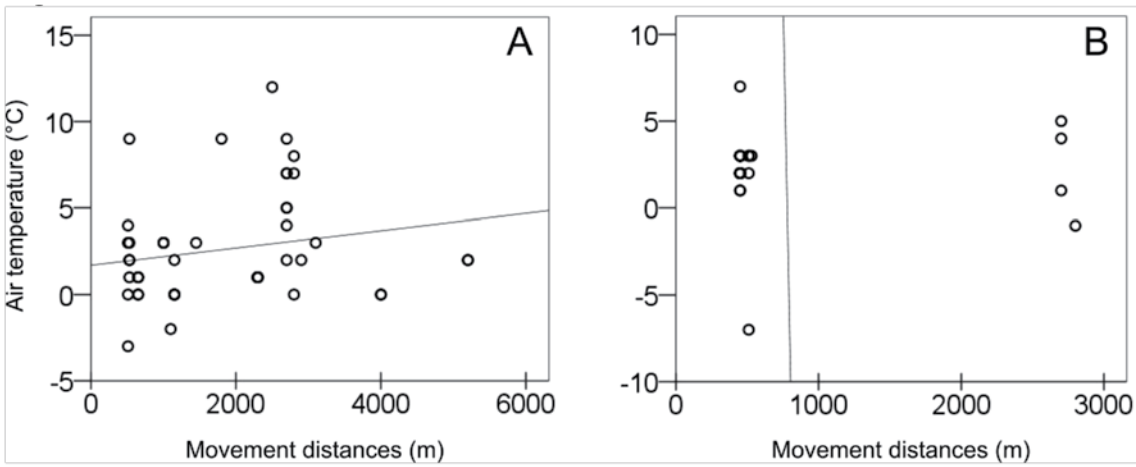

Fig. 3. Linear regression between the movement distances of the Great Tit (A) and the Blue Tit (B) and the air temperature

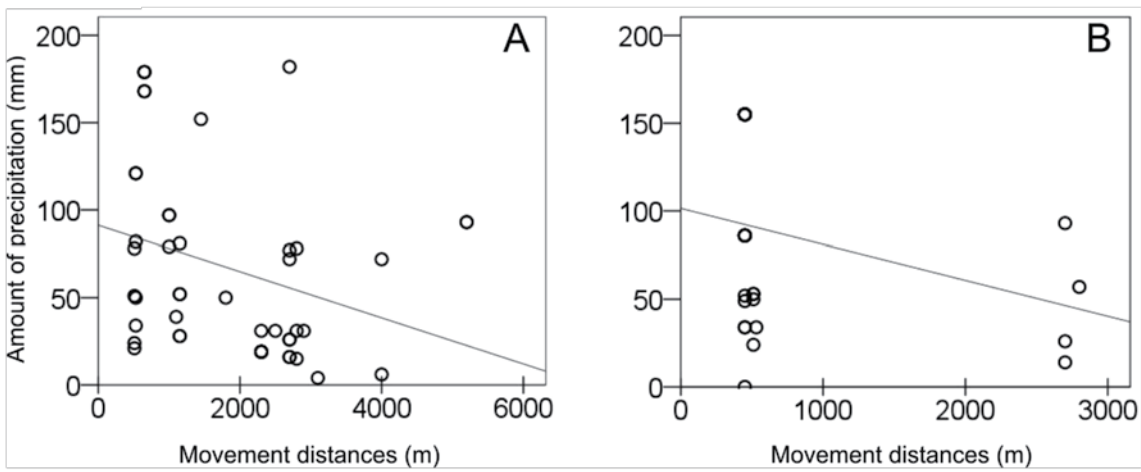

Fig. 4. Linear regression between the movement distances of the Great Tit (A) and the Blue Tit (B) and the amount of precipitation

The Kruskal-Wallis test was used to check the differences in movement distances between the two species. The difference in movement distances between the sexes within species was tested with one-way ANOVA (Great Tit) and Student's t-test (Blue Tit). Further tests involved the daily air temperature, the number of days with a snow cover and the amount of precipitation (measured by the meteorological station at Sombor for the period 1981-2013). For each individual where movement was recorded we calculated the mean air temperature, the total number of days with a snow cover and the total amount of precipitation for the period between the ringing date and the last recovery date. Backward elimination multiple linear regression (BEMLR) was applied to check which factor as an independent variable (the air temperature, the number of days with a snow cover and the amount of precipitation) mostly affected the movement distance (as dependent variable). In the BEMLR method, calculations are firstly made on the full model containing all three independent variables. This is followed by reduced models, using the backward elimination function. The method excludes the independent variable which has the least effect on the movement distance of both tit species. Statistical analyses were calculated with the R statistical environment software package (version 2.13.0, Oksanen *et al*. 2011) and SPSS statistical software.

Results and Discussion

The movement distances of the Great Tits ranged between 510 and 5,200 m, with a mean distance of 1,847 m SE ± 174.8 (Fig. 1), i.e. significantly larger than the movement distances of the Blue Tits, which ranged between 450 and 2,800 m, with a mean distance of 775 m SE ± 147.5 (Fig. 2) (Kruskal-Wallis test, $H_4 = 8.741$, $p = 0.033$). Furthermore, within the Great Tits, we found differences in the movement distances between the sexes, the females moving larger distances (one-way ANOVA, $F_{25} = 5.588$, $p = 0.003$). Dingemanse *et al*. (2003) and Andreu, Barba (2006) likewise reported that female Great Tit individuals move larger distances than males. However, the data of Dingemanse *et al*. (2003) related to the natal dispersion period, while Andreu, Barba (2006) studied the breeding dispersal of Great Tits. Our data indicated that there was no difference between the Blue Tits sexes in the movement distances (Student's t-test, $t_{10} = 0.248$, $p = 0.809$).

The BEMLR removed first the total number of days with a snow cover from the model, as this had the least and non-significant effect on the movement distances of both species (Great Tit: BEMLR, $B = 2.41 \pm 18.888$, $F_{3.44} = 1.859$, $p = 0.151$; Blue Tit: $B = 9.88 \pm 15.158$, $F_{2.26} = 0.434$, $p = 0.653$). The lack of a significant effect of the duration of a snow cover on the movement distances of the tits was probably due to the low number of days with snow in the study area. Furthermore, an air temperature decrease did not induce a larger movement distance in either tit species (Great Tit: $B = 54.84 \pm 56.682$, $F_{2,45} = 2.842$, $p = 0.069$, Fig 3A; Blue Tit: $B = 16.98 \pm 69.708$, $F_{3,25} = 0.298$, $p = 0.826$, Fig. 3B). However, in the case of the Great Tit, a higher amount of precipitation resulted in the individuals moving shorter distances; larger movements were more frequent in the drier periods ($B = -7.10 \pm 3.255$, $F_{1,46} = 4.755$, $p = 0.034$; Fig. 4A). In rainy weather, the wetting of the feathers can cause difficulties in flight, and consequently reduces the survival probability (Caslick, Stowers 1967, Kessler *et al*. 1967, Jogi 1968, Stickley *et al*. 1971, Lustick 1976). We assume that local movement within a town depends strongly on the sources of food supply. It seems that Great Tits favour trustworthy food supply sources in rainy weather, e.g. our bird feeders situated at the ringing sites, whereas no such movement pattern was found for the Blue Tits as regards to precipitation ($B = -2.10 \pm 3.124$, $F_{1,27} = 0.452$, $p = 0.507$; Fig. 4B). The Blue Tits basically move smaller distances than the Great Tits (Figs. 1, 2), which leads to the assumption that unfavourable weather conditions do not significantly shorten the already small distances. Furthermore, the Blue Tits moved significantly fewer large distances than shorter movements in the town ($t_6 = 10.190$, $p < 0.0001$), indicating that they rather move within particular areas of the town, concentrating on the feeders or the reed beds, irrespective of the weather conditions. The relationship between the movements and the food supply in the Great Tit was investigated earlier by Perrins (1966) in a beech *Fagus sylvatica* forest, where the food (beech crop) availability was observed to be an important promoter of the movements in tits. The food supply in winter is richer in human settlements, which leads to increased numbers of individuals in urban areas during cold periods (Bańbura, Bańbura 2012). The more dependable food supply in settlements during winter may result in the movements of tits only within a given urban area, as presented in this study.

The weather conditions are able to play an important role in the migration and long-range movements of birds (Alerstam 1993, Sokolov *et al*. 1999, Nowakowski 2003). However, our study concerned the effects of weather variables on the

movement distances of tits in an urban habitat, where we found that the air temperature and the number of days with a snow cover did not exert a significant influence, whereas the amount of precipitation induced shorter movements, but only in Great Tits.

Acknowledgements: The study was supported by the Nature Protection and Study Society – NATURA, Sombor. We express our thanks to several citizens of Sombor who facilitated ringing activities in some parts of the town. The map of the town of Sombor was drawn by Katalin Varga. We are also grateful to the anonymous reviewers for their useful and constructive comments, which have significantly improved the paper.

References

Alerstam T. 1993. Bird Migration. Cambridge University Press, Cambridge.

Andreu J., E. Barba 2006. Breeding dispersal of Great Tits *Parus major* in a homogeneous habitat: effect of sex, age and mating status. – *Ardea*, **94** (1): 45-58.

Bańbura J., M. Bańbura 2012. Blue Tits *Cyanistes caeruleus* and Great Tits *Parus major* as urban habitat breeders. – *International Studies on Sparrows*, **36**: 66-72.

Báldi A., T. Csörgő 1991. Effect of environmental factors on tits wintering in a Hungarian marshland. – *Ornis Hungarica*, **1**: 29-36.

Caslick J., J. Stowers 1967. Studies of wetting agents. Progress report to U.S. Department of Interior, Division of Wildlife Research, Patuxent Wildlife Research Center, 1-25 pp.

Ćiković D. 2013a. Great Tit *Parus major*. – In: Kralj J., S. Barišić, V. Tutiš and D. Ćiković (eds.): Croatian Bird Migration Atlas. Hrvatska akademija znanosti i umjetnosti, Zavod za ornitologiju, Zagreb, 196-197 pp.

Ćiković D. 2013b. Common Blue Tit *Cyanistes caeruleus*. – In: Kralj J., S. Barišić, V. Tutiš and D. Ćiković (eds.): Croatian Bird Migration Atlas. Hrvatska akademija znanosti i umjetnosti, Zavod za ornitologiju, Zagreb, 197-198 pp.

Dingemanse N. J., C. Both, A. J. van Noordwijk, A. L. Rutten, P. J. Drent 2003. Natal dispersal and personalities in great tits (*Parus major*). – *Proceedings of the Royal Society London B*, **270** (1516): 741-747.

Gyurácz J., P. Bánhidi, A. Kóródi 2011. Post-breeding movements of Blue Tits (*Parus caeruleus*) in a West Hungarian stopover site. – *Ornis Hungarica*, **19**: 21-29.

Jogi A. I. 1968. Mass death of swallows in Estonia at the end of August 1959. In: Spurin Z. O. (ed.): Birds of the Baltic Region: Ecology and Migration. Riga, 154-159 pp.

Jokimäki J., M-L. Kaisanlahti-Jokimäki 2012. Residential areas support overwintering possibilities of most bird species. – *Annales Zoologici Fennici*, **49** (4): 240-256.

Kessler F. W., M. L. Giltz, H. E. Burtt 1967. High mortality of a population of cowbirds wintering at Columbus, Ohio. – *The Ohio Journal of Science*, **67** (1): 46-50.

Kokko H. 2011. Directions in modelling partial migration: how adaptation can cause a population decline and why the rules of territory acquisition matter. – *Oikos*, **120** (12): 1826-1837.

Lustick S. 1976. Wetting as a means of bird control. Bird Control Seminars Proceedings, **50:** 41-53.

Mérő T. O., A. Žuljević 2010. Birds of Sombor. Nature Protection and Study Society - NATURA, Sombor. 133 p.

Møller A. P., T. Grim, J. D. Ibáñez-Álamo, G. Markó, P. Tryjanowski 2013. Change in flight initiation distance between urban and rural habitats following a cold winter. – *Behavioral Ecology*, **24** (5): 1211-1217.

Nilsson A. L. K., T. Alerstam, J-Å. Nilsson 2008. Diffuse, short and slow migration among Blue Tits. – *Journal of Ornithology*, **149** (3): 365-373.

Nowakowski J. K. 2001. Speed and synchronisation of autumn migration of the Great Tit (*Parus major*) along the eastern and the southern Baltic coast. – *Ring*, **23** (1-2): 55-71.

Nowakowski J. K. 2003. Catch numbers at ringing stations is a reflection of bird migration intensity, as exemplified by autumn movements of the Great Tit (*Parus major*). – *Ring*, **25** (1-2): 3-15.

Nowakowski J. K., A. Y. Vähätalo 2003. Is the Great Tit *Parus major* an irruptive migrant in north-east Europe? – *Ardea*, **91** (2): 231-244.

Nowakowski J. K., J. Chruściel 2004. Speed of autumn migration of the Blue Tit (*Parus caeruleus*) along the eastern and southern Baltic coast. – *Ring*, **26** (1): 3-12.

Nyquist L. 2006. Migration patterns of blue tits (*Parus caeruleus*) at Hammaro Bird Observatory. Degree Project, Karlstad University, Sweden. 11 p.

Oksanen J., F. G. Blanchet, R. Kindt, P. Legendre, S. B. O'Hara, G. L. Simpson, P. Sólymos, M. Henry, H. Stevens. H. Wagner 2011. vegan: Community Ecology Package. R package version 1.17-11. http://CRAN.R-project.org/package=vegan.

Perrins C. M. 1996. The effect of beech crops on Great Tit populations and movement. – *British Birds*, **59**: 419-432.

Smith H. G., J-Å. Nilsson 1987. Intraspecific variation in migratory pattern of a partial migrant, the Blue Tit (*Parus caeruleus*): an evaluation of different hypotheses. – *The Auk*, **104** (1):109-115.

Sokolov L. V., Yu. Markovets M., Yu. G. Morozov 1999. Long-term dynamics of the mean date of autumn migration in passerines on the Courish Spit of the Baltic Sea. – *Avian Ecology and Behaviour*, **2** (1): 1-18.

Stickley A., R. Matteson, D. Harker, J. Stowers 1971. Studies of wetting agents. Progress Report to U.S. Department of Interior, Division of Wildlife Research. Patuxent Wildlife Research Center, 1-16 pp.

Tomić P. 1996. Klima. – In: Đuričić J. (ed.): Opština Sombor. Prirodno-matematički fakultet, Institut za geografiju, Prosveta, Novi Sad, 16-21 pp.

Török J. 2009a. Blue Tit *Parus caeruleus* Linnaeus, 1758. – In: Csörgő T., Z. Karcza, G. Halmos, G. Magyar, J. Gyurácz, T. Szép, A. Bankovics, A. Schmidt and E. Schmidt (eds.): Magyar madárvonulási atlasz. Kossuth Kiadó, Budapest, 549-551 pp.

Török J. 2009b. Great Tit *Parus major* Linnaeus, 1758. – In:

Csörgő T., Z. Karcza, G. Halmos, G. Magyar, J. Gyurácz, T. Szép, A. Bankovics, A. Schmidt, E. Schmidt (eds.): Magyar madárvonulási atlasz. Kossuth Kiadó, Budapest, 554-556 pp.

Vojnović M. 2001. Sombor. Publikum, Sombor. 85 p.

Received: 05.02.2014
Accepted: 12.07.2014