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Local abundance and spatial distribution of some migratory birds during post-breeding period

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Abstract The local abundance and spatial distribution of the short- to medium-distance migratory and daytime stopover passerines (Robin *Erithacus rubecula*, Blackcap *Sylvia atricapilla,* Chiffchaff *Phylloscopus collybita,* Blue tit *Parus caeruleus*, Great tit *P. major*) were studied in a West Hungarian stopover ground during post-breeding season. The dispergation index of all migratory bird species revealed clumped distribution both in „smallest annual capture year" (abb. SACY) and the „largest annual capture year" (abb. LACY). According to the PCA the spatial occurrences of Blackcap, Blue tit and Great tit captured in LACY showed significantly higher concentration than of those migrating in SACY. The studied species appeared in all four habitats (bushy, forest, grassland, marsh) of the study stopover area, but their clumped spatial distribution showed habitat preference. The abundance-dependent shift of habitat selection was found only in Great tit, the most of them captured in SACY concentrated in grassland with bushy, while the ones captured in LACY grouped in forest habitat type. Blackcaps were grouped the grassland with bushes habitat type where many Dwarf elder *(Sambucus ebulus)* bushes were available during autumn migration.

Keywords: stopover birds, annual capture, habitat selection

Összefoglalás Jelen tanulmány öt rövid- és középtávú vonuló, vonulását napközben megszakító énekesmadár faj (vörösbegy *Erithacus rubecula*, barátposzáta *Sylvia atricapilla*, csilpcsalpfüzike *Phylloscopus collybita*, kék cinege *Parus caeruleus*, széncinege *P. major*) egyedszáma (éves fogás) és térbeli eloszlása közötti kapcsolatot vizsgálja az őszi vonulási időszakban, nyugat-magyarországi élőhelyen. A diszpergáltsági index értékei alapján a madarak csoportos eloszlást mutattak a legkisebb (SACY) és a legnagyobb (LACY) fogásszámú évben is. A PCA eredményei alapján a barátposzáták, a kék cinegék és a széncinegék csoportosulásának mértéke lényegesen nagyobb volt a nagy fogásszámú években. A vizsgált fajok megjelentek mind a négy élőhelyen (bokros terület, erdő, gyep, mocsár) a vizsgálati területen, de az egyedek csoportosulása élőhelypreferenciát mutatott. Az élőhelyválasztásban megmutatkozó denzitásfüggő eltolódást csak a széncinegék esetében sikerült kimutatnunk: a legkisebb fogásszámú évben az egyedek többsége a füves-bokros élőhelyeken koncentrálódott, míg a legnagyobb fogásszámú évben az erdei élőhelyen csoportosultak a madarak. A barátposzáták a füves-bokros élőhelyen koncentrálódtak, ahol a táplálékul szolgáló földi bodza nagy mennyiségben állt rendelkezésükre.

Kulcsszavak: vonuló madarak, éves fogás, élőhely-választás

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Introduction

The spatial distribution of migrants is an important population factor in their stopover (Chernetsov 2002). Understanding the distribution and abundance of migratory birds is critical for the effective conservation strategy and comprises the core of bird ecology (Caughley & Sinclair 1994, Krebs 1994, Johnson & Sherry 2001). The distribution of birds among habitat types is particularly important because the conservation of migratory populations is usually realized by management of their habitats (Morrison *et al*. 1998).

Migratory birds move among habitats more than residents and are frequent subjects for stopover studies (Cody 1985). Although most studies of migratory bird habitat selection has focused on breeding populations, a simpler situation exists with birds during migration period, when they are free from bothering factors connected with nesting (Hutto 1985). The spatial distribution of migrants could be determined by vegetation structure (Preiszner & Csörgő 2008), prey availability (Levey & Stiles 1992, Sherry & Holmes 1996), predation risks (Rappole *et al*. 1989), habitat preferences from the breeding period (Morse 1971, Hutto 1980), evolutionary responses to paleoecological circumstances (Johnson & Sherry 2001), competition and population abundance (Greenberg 1986, Leisler 1992, Marra 2000). Density of intra- and interspecific competitors may effect habitat quality and thus the pattern of spatial distribution and habitat selection by stopover birds (Moore & Yong 1991). Most of the passerine migrants use stopover sites in a clearly non-random manner, even if many species have broader habitat preference during migration than during breeding (Chernetsov 2006). For example the stopover Robins establish small home ranges and do not move randomly across a large area during their autumn migration (Titov 1999a).

We studied the local abundance and spatial distribution of the short- to medium-distance migratory and daytime stopover passerines (Robin *Erithacus rubecula* abb. ERIRUB, Blackcap *Sylvia atricapilla* abb. SYLATR, Chiffchaff *Phylloscopus collybita* abb. PHYCOL, Blue tit *Parus caeruleus* abb. PARCAE, Great tit *P. major* abb. PARMAJ) in a stopover ground during post-breeding season. Our expectation was that the pattern of spatial distribution of bird species would differ between years when bird abundance was different.

Material and methods

Study site

The study was carried out at Tömörd Bird Ringing Station in West Hungary (47°21’23”N 16°40’04”E), located 15 kilometres from Szombathely. There were four natural habitat types around the station *(Figure 1)*. These habitats were characterized according to the SE European Bird Migration Network (Busse 2000) (see below) as follows.

Bushes: Bushes and herbs were made up a compact, dense vegetation, which were dissected by small grass patches. Its characteristic plants were: Blackthorn *(Prunus spinosa)*, Common hawthorn *(Crataegus monogyna)*, Wild pear *(Pyrus pyraster)*, Wild rose *(Rosa canina)*. There were great variety of crops but there was not management in the bushes. The height of vegetation was 2-3 meters.

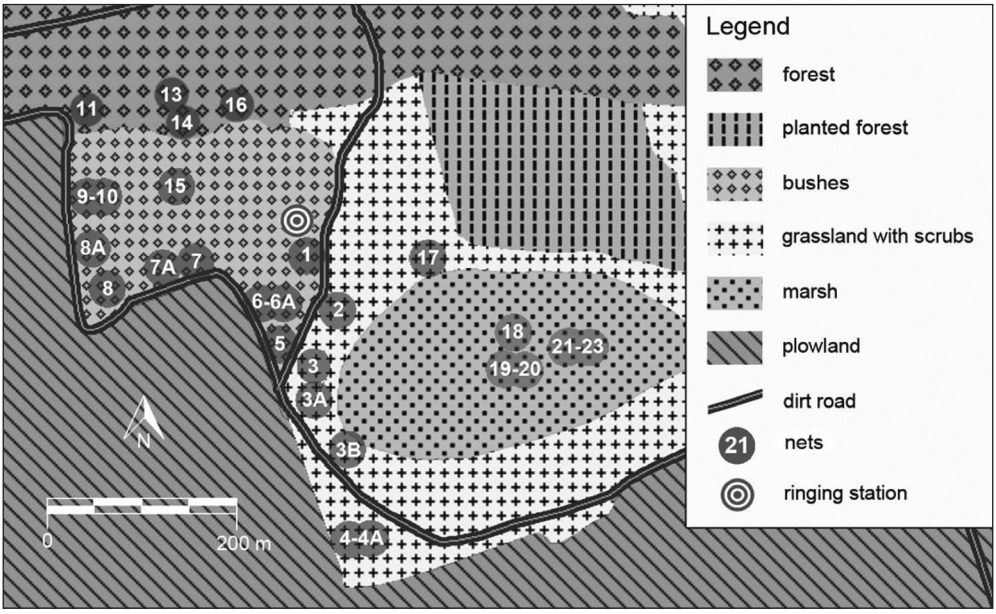

Figure 1. Habitat map of the study area with the locations of nets
1. ábra A vizsgálati terület élőhely-térképe hálóhelyekkel

Forest: Broadleaf trees and bushes show a compact, dense edge vegetation, forming an ecoton community with Turkey oak *(Quercus cerris)*, Blackthorn, Common hawthorn, Wild pear as characteristic plants. There were plenty of crops and normal forestry management in the forest. The height of vegetation was 6-7 meters.

Grassland with scrubs: This habitat type made a transition between the wet habitats of the swamp and the steppe communities that used to cover the croplands around the marsh. There were a few bushes in the grassland, with two small patches of Dwarf elder *(Sambucus ebulus)*. There grassland was not managed.

Marsh: It was a small (6 ha) permanent and an isolated wetland. Characteristic plants were Reedmace *(Typha latifolia)* and Rush *(Schoenoplactus lacustris)* in the marsh. The height of vegetation was 1-2 meters. Water was supplied to the marsh only by precipitation. The marsh dried out and marsh vegetation was degraded because of scarce rainfall in 2000 and 2001.

Field work

The birds were captured and ringed at the Tömörd Bird Ringing Station between 1998 and 2011. Bird ringing took place during the post-breeding period (dispersion and autumn migration), from the third decade of July to the first decade of November, 95-100 ringing days each year. For catching the birds we used 28 numbered mist-nets (12 meter long and 2.5 meter high with 5 shelves and a mesh size of 16 mm). There was a line of six nets in the deepest part of the marsh. Four nets were in the forest, eleven in the bushes and seven in the grassland. Birds had been captured from dawn to dusk, except on rainy and stormy days. All birds were ringed and aged according to Svensson (1992). The birds

	ERIRUB		SYLATR		PHYCOL		PARCAE		PARMAJ	
Year	2003	2007	2002	2009	2002	2004	2003	2004	2006	2010
AC	565	911	393	1132	237	558	119	1040	141	958
D	19.48	31.41	13.55	39.03	8.17	19.24	4.10	35.86	4.86	33.03
V	312.62	402.25	136.54	1753.53	59.08	235.90	29.81	5477.91	26.55	2055.82
SD	17.68	20.06	11.69	41.88	7.69	15.36	5.46	74.01	5.15	45.34
DI	16.05	12.81	10.08	44.92	7.23	12.26	7.26	152.75	5.46	62.23
X^2-test	205.09	230.26	26.32	712.26	59.71	81.09	25.37	1344.00	43.97	306.62
P	<0.001									

Table 1. Annual captures (AC), density (D), variance (V), standard deviation (SD) and dispergation index (DI) of bird species. (See the introduction for species abbreviations.) The results of X^2-test and significance level (P) relate to the dispergation index (DI)

1. táblázat A madárfajok évi fogása (AC), denzitása (D), varianciája (V), szórása (SD), és diszpergáltsági indexe (DI). (A fajnevek rövidítését ld. a bevezetésben.) A X^2-teszt és a szignifikanciaszint (P) értékei a diszpergáltsági indexre vonatkoznak

were weighed to the nearest 0.1 g (using a spring balance) and the fat reserves (fat index, condition) were estimated visually according to SE European Bird Migration Network protocol (Busse 2000) – ranging from 0 (no fat) to 8 (bulging fat).

Data processing and statistical analysis

From the 13 study years we selected the „smallest annual capture year" (abb. SACY) and the „largest annual capture year" (abb. LACY) for all the five selected bird species. Table 1 shows the annual captures of the selected years. We used the number of caught birds (only birds with net number) per year and per net of five bird species. The first-year and adult birds were not separated in the statistical analysis. To determine the spatial distribution of bird population in SACY and LACY we used the dispergation index. It was calculated as $DI = s^2/d$, where s^2 is variance of number of caught/net/year, d is density, average number of caught/net/year. We tested the spatial distribution *(DI)* of birds caught by nets were standing in different habitat types with X^2-*test*. Chi square supplies us with a method for determining if a sample variance is significantly greater than or less than the average (Fowler & Cohen 1991, Moskát *et al*. 1992). We compared the mean body mass and condition of birds in SACY and LACY by *Student t-test* (Fowler & Cohen 1991).

We used *principal component analysis (PCA)* on number of caught birds in the four habitat types in SACY and LACY, to examine correlations among spatial distribution of birds and habitat types (Podani 1997). Statistical analyses were carried out by the PAST software version 1.38 (Hammer *et al*. 2006).

Results

The dispergation index of all migratory bird species revealed clumped distribution *(DI>1)* in both SACY and LACY *(Table 1),* but according to the PCA the spatial occurrences of Blackcap, Blue tit and Great tit captured in LACY showed significantly higher concentration than of those migrating in SACY *(Figure 2)*. The most Blackcaps

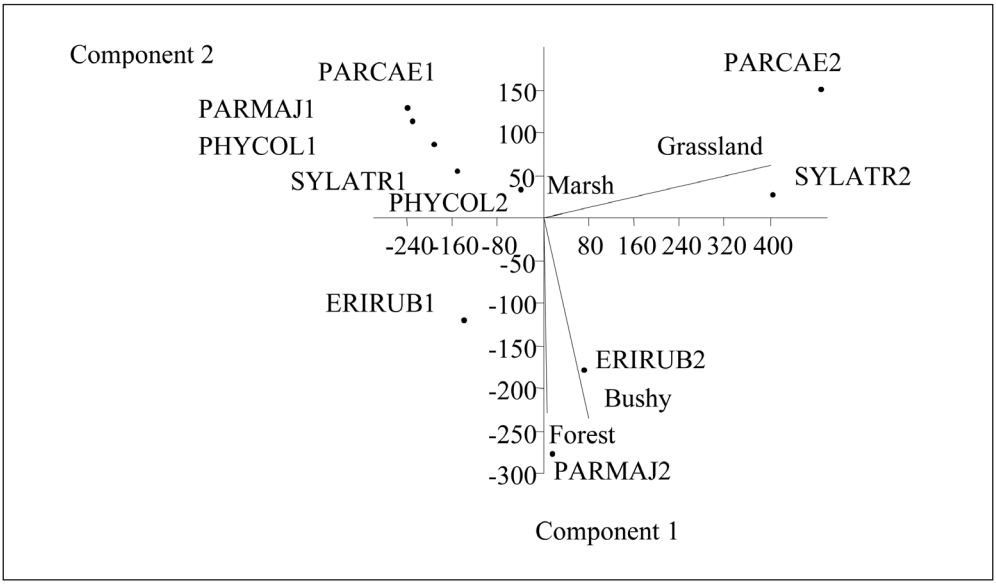

Figure 2. Principal component analysis ordination of bird distribution pattern in SACY (1) and LACY (2) over four habitat types: forest, bushy, grassland with scrubs, marsh. The first component explains 72.33% of the data variability, the second component 22.47%, the third component 4.58 % and the fourth component only 0.61%

2. ábra A madárfajok főkomponens-analízis ordinációja a kis (SACY=1) és nagy fogású (LACY=2) évek és élőhely-típusok (erdő, bokros, bokros-gyep, mocsár) alapján. Az első főkomponens az adatok varianciájának 72,33, a második 22,47, a harmadik 4,58, a negyedik mindössze 0,61 százalékára ad magyarázatot

and Blue tits clumped in grassland habitat type both in SACY and LACY, but the most Great tits were captured in grassland during SACY and most of them were captured in forest during LACY *(Figure 3)*.

The average fat index and body mass of Robins caught in LACY was significantly smaller than of those migrating in SACY. The average fat index of Blackcaps, Blue tits and Great tits caught in LACY were significantly larger than of those migrating in SACY. The mean condition and body mass of Chiffchaffs, as well as mean body mass of Blue tits migrating in SACY and LACY did not differ significantly. The average body mass of Blackcaps and Great tits caught in LACY were significantly larger than of those migrating in SACY *(t-test, Table 2)*.

Discussion

The spatial distribution of all five species showed clumped distribution at the study stopover site during post-breeding period. The spatial concentration of individuals could be explained by unequal food resource and refuge site distribution because the habitat selection during stopovers should be aimed achieving the two of the most important goals: to maximize the fuel deposition rate and to minimize the risk of predation (Alerstam & Lindström 1990). Another factor that can strongly effect spatial distribution and habitat selection of stopover birds is prey-based intraspecific competition (Moor & Yong 1991), which depends on the abundance of birds. Our results sup-

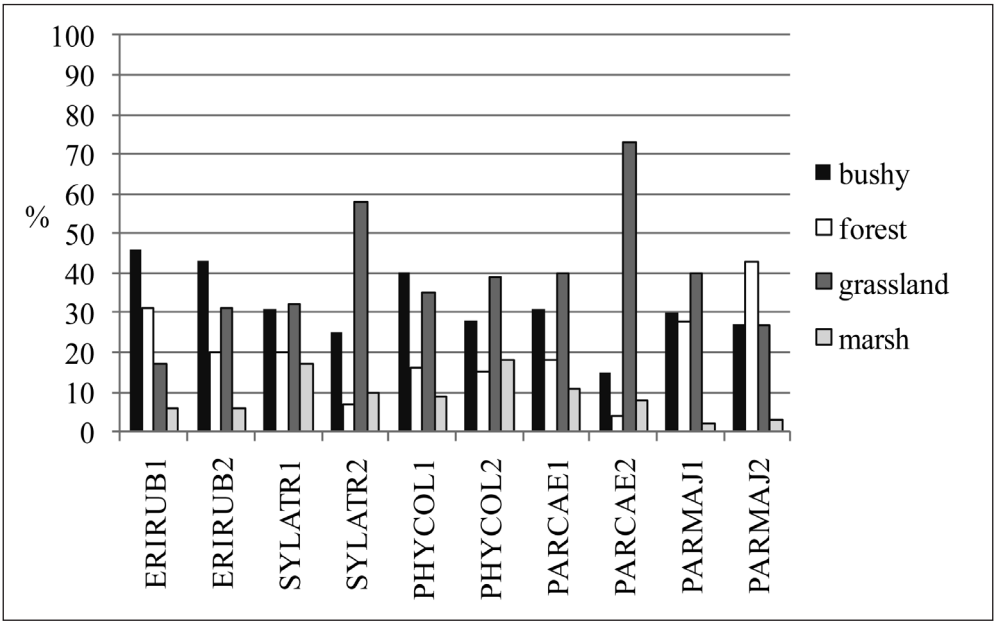

Figure 3. Distribution of the percentages (%) of annual captures in SACY and LACY according to habitat types

3. ábra A befogott madarak százalékos aránya élőhely-típusok szerint a legkisebb (SACY) és legnagyobb (LACY) fogásszámú években

	Mean±S.D.		t-test	df	P
fat	**SACY**	**LACY**			
ERIRUB	1.80±1.41	1.40±1.23	5.61	1476	<0.01
SYLATR	1.44±0.50	1.50±0.75	–2.1	1326	<0.05
PHYCOL	1.32±1.39	1.51±1.21	–1.84	790	NS
PARCAE	0.93±0.79	1.45±1.25	–6.25	1154	<0.01
PARMAJ	1.16±0.72	2.83±1.19	–23.10	1097	<0.001
body mass					
ERIRUB	16.47±1.39	16.19±1.25	3.99	1466	<0.01
SYLATR	18.00±1.38	18.26±1.48	–3.12	1499	<0.01
PHYCOL	7.45±0.67	7.40±0.76	0.83	770	NS
PARCAE	10.82±0.66	10.88±0.67	–0.92	1065	NS
PARMAJ	17.40±1.12	18.03±1.24	–6.07	1082	<0.01

Table 2. Mean fat index (condition) and body mass of bird species in SACY and LACY

2. táblázat A madárfajok átlagos vonulási zsírtartaléka (kondíció) és testtömege a legkisebb (SACY) és legnagyobb fogásszámú (LACY) években

port the strong influence of local abundance on the spatial distribution of Blackcap, Blue tit and Great tit migratory populations, which stopovered at the study site during post-breeding period. Higher proportion of stopover Blackcaps, Blue tits and Great tits were captured in LACY by nets in grassland as well as forest habitat type than of those captured in SACY. The recapture rates showed that most migratory Blackcaps, Blue tits and Great tits captured stopover only 1-2 days at the study area in September and October (Gyurácz & Bánhidi 2008). The most migratory individuals with larger fat reserve and body mass in LACY could continue their autumn migration after short stopover. The Robin, Chiffchaff and Blackcap were dominant and regular migrant and stopover species during autumn at the study area. By contrast, the Blue tit and Great tit had intensive migration in 2004 or 2010. The bulk migration of the tits could be in relation with less beech crop and the number of tits breeding in Alps and Carpathians as well as areas north from Hungary (Smith & Nilsson 1987, Nowakowski & Vähätalo 2003, Nyquist 2007*)*. Flocking behaviour of the wintering birds was expected to relate inversely to food supply of habitat (Grubb 1987, Székely & Juhász 1993). Although the most Blue tits were captured in grassland with scrub, the forest and the bushy habitat types were better habitats in terms of feeding and fat accumulation, than the grassland with scrub and the marsh (Gyurácz *et al*. 2011). Some migrant species were known to establish defined home range or temporary territory within the suitable habitat during stopover (Chernetsov 2005). We suggest the territorial spacing of Blue tits may prevent the formation of large flocks during their stopover time in the local forest and bushy. Significantly more tits were displaced to poorer grassland with scrub during the intensive migration (2004) than during the weak migration (2003).

The spatial distribution of Blackcaps was related to the patchy distribution of the preferred berries. Blackcaps were grouped in the grassland with bushes habitat type where many Ground elder bushes were available during autumn migration. It previously was shown in Robins and other migratory passerines that the pattern of spatial distribution was related to the distribution of their prey (Titov 1999a, 1999b, Chernetsov & Titov 2001). The most Robins captured in LACY were leaner because of their fat reserve exhausted during nocturnal migration (Gyimóthy *et al*. 2011b). The more even distribution of Robins in SACY and LACY compared to distribution of other species could be due to the bulk of the migratory Robins remained within 350 m during their stopovers in autumn migration (Chernetsov 2005). Titov (1999b) shown that stopover Robins did not start the fat accumulation until they established a small defined stopover home range. These patterns probably also true for Chiffchaffs during stopover.

Habitat selection during post-breeding period varies among species and habitat change after breeding and dispersion is a frequent phenomenon for migrating birds. Usually the migratory passerines seem to use wider habitat during stopovers compared to breeding period, behaving as generalists in the habitat selection (Barlein 1983, Vega Rivera *et al*. 2003, Chernetsov 2006, Preiszner & Csörgő 2008). This behaviour reduces intra- and interspecific competition (Berthold 1993). The studied species occurred in all four habitats of the study stopover area, but their clumped spatial distribution showed habitat preference. The Robins were captured in many habitat types in Hun-

gary during autumn migration but the most Robins occurred in stopover sites surrounding forest and bushy areas (Gyimóthy *et al*. 2011a). The abundance – dependent shift of habitat selection was found only in Great tit. The most of them captured in SACY concentrated in grassland with bushy, while the ones captured in LACY grouped in forest habitat type. The bushy and forest habitats were supposed primarily refuges for Great tits because the fat reserves of the recaptured tits did not change significantly during their stopovers.

According to the above mentioned results we assumed that local abundance of stopover passerines can be one of the major causes for the observed spatial distribution and habitat shifts beside the interspecific competition and other ecological factors.

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