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Breeding bird communities in hills with chalk outcrops in national nature park “Dvorichanskyi”

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The breeding bird communities in hills with chalk outcrops were studied in national nature park ‘Dvorichanskyi’ (Kharkiv region, Eastern Ukraine) in 2010–2016 years. The birds were counted 1–2 times per year by total-area census method at 3 plots of unequal size (17.8, 33.2, and 41.0 ha). The total of 38 breeding species was recorded. The overall mean density was 236.7 pairs/km^2. The dominants were Red-backed Shrike (*Lanius collurio*) (mean density – 38.8 pairs/km^2; relative abundance – 16.8%), Eurasian Skylark (*Alauda arvensis*) (33.5; 14.3), and Yellowhammer (*Emberiza citrinella*) (29.3; 12.6). Greater Whitethroat (*Sylvia communis*) (20.3; 7.7), Whinchat (*Saxicola rubetra*) (17.4; 7.1) and Barred Warbler (*Sylvia nisoria*) (16.7; 6.9) co-dominated. Tawny Pipit (*Anthus campestris*) (10.4; 4.6), Tree Pipit (*A. trivialis*) (10.4; 4.6), Common Stonechat (*Saxicola torquata*) (5.3; 2.2), Northern Wheatear (*Oenanthe oenanthe*) (7.7; 3.2), and European Greenfinch (*Chloris chloris*) (6.9; 3.0) are less numerous but occurred regularly. Shrubland & woodland species form a core of the breeding bird communities in hills with chalk outcrops. This group contributed much more than others to the overall species richness (61%) and overall abundance (62%).

Key words: *breeding bird communities, numbers, hills with chalk outcrops, Eastern Ukraine.*

Угруповання гніздових птахів схилів з виходами крейди на території національного природного парку «Дворічанський»

М.В.Банік

Угруповання гніздових птахів схилів із виходами крейди вивчали на території національного природного парку «Дворічанський» (Харківська область, Україна) у 2010–2016 рр. Чисельність птахів визначали 1–2 рази за сезон на 3 постійних ділянках неоднакової площі (17,8, 33,2 та 41,0 га) за допомогою методу суцільного обліку на площадці. Усього на облікових ділянках зареєстровано 38 гніздових видів птахів із сумарною середньою щільністю 236,7 пар/км^2. Домінантами населення були терновий сорокопуд (*Lanius collurio*) (середня щільність населення – 38,8 пар/км^2; частка участі у населенні – 16,8%), польовий жайворонок (*Alauda arvensis*) (33,5; 14,3) і звичайна вівсянка (*Emberiza citrinella*) (29,3; 12,6), субдомінували сіра кропив’янка (*Sylvia communis*) (20,3; 7,7), лучна трав’янка (*Saxicola rubetra*) (17,4; 7,1) і рябогруда кропив’янка (*Sylvia nisoria*) (16,7; 6,9). У структурі угруповання важливу роль відіграють також постійні, але не настільки численні види, – польовий (*Anthus campestris*) (10,4; 4,6) і лісовий (*A. trivialis*) (10,4; 4,6) щеврики, чорноголова трав’янка (*Saxicola torquata*) (5,3; 2,2), звичайна кам’янка (*Oenanthe oenanthe*) (7,7; 3,2) та зеленяк (*Chloris chloris*) (6,9; 3,0). Характер угруповання птахів схилів з виходами крейди визначають види, які пов’язані у своєму поширенні із фрагментами деревно-чагарникової рослинності. Вони дають найбільший внесок у загальну величину видового багатства (61%) і сумарну чисельність (62%).

Ключові слова: *угруповання гніздових птахів, чисельність, схили з виходами крейди, Східна Україна.*

Сообщества гнездящихся птиц склонов с выходами мела на территории национального природного парка «Двуречанский»

М.В.Баник

Сообщества гнездящихся птиц склонов с выходами мела изучали на территории национального природного парка «Двуречанский» (Харьковская область, Украина) в 2010–2016 гг. Численность птиц определяли 1–2 раза за сезон на 3 постоянных участках неодинаковой площади (17,8, 33,2 и 41,0 га) с помощью метода сплошного учёта на площадке. Всего на учётных участках отмечено 38 гнездящихся видов птиц с суммарной средней плотностью 236,7 пар/км^2. Доминантами населения были обыкновенный жулан (*Lanius collurio*) (средняя плотность населения – 38,8 пар/км^2; доля участия в населении – 16,8%), полевой жаворонок (*Alauda arvensis*) (33,5; 14,3) и обыкновенная овсянка (*Emberiza citrinella*) (29,3; 12,6), субдоминировали серая славка (*Sylvia communis*) (20,3; 7,7), луговой чекан (*Saxicola rubetra*) (17,4; 7,1) и ястребиная славка (*Sylvia nisoria*) (16,7; 6,9). В структуре сообщества важную роль играют также постоянные, но не столь многочисленные виды, – полевой (*Anthus campestris*) (10,4; 4,6) и лесной (*A. trivialis*) (10,4; 4,6) коньки, черноголовый чекан (*Saxicola*

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torquata) (5,3; 2,2), обыкновенная каменка (*Oenanthe oenanthe*) (7,7; 3,2) и обыкновенная зеленушка (*Chloris chloris*) (6,9; 3,0). Облик сообществ птиц склонов с выходами мела определяют виды, связанные в своём распространении с фрагментами древесно-кустарниковой растительности. Они вносят наибольший вклад как в общую величину видового богатства (61%), так и в суммарную численность (62%).

Ключевые слова: *сообщества гнездящихся птиц, численность, склоны с выходами мела, Восточная Украина.*

Introduction

Plant communities of chalk outcrops contribute greatly to the uniqueness of hilly terrain landscapes of river valleys in southern parts of Middle Russian plain and Donetsk upland (Kotov, 1939; Vinogradov, Golytsyn, 1954). High proportion of endemics and species with disrupted distribution e.g. with main portions of the ranges situated far to the south or east in Mediterranean, Caucasus and mountainous parts of Southern Siberia are characteristic of these communities (Khokhryakov, 1968; Morozyuk, 1971). Furthermore, they are exceptional for the low level of human impact. Hills with chalk outcrops were not ploughed and were used for grazing and cattle driving only episodically. The only serious factor which threatened virgin state of plant communities of chalk outcrops was slo and planting of conifers in Soviet time. But generally, hilly terrain with chalk outcrops remains among a few comparatively intact sites with undisturbed plant cover e.g. steppe in Eastern Ukraine.

It is not surprising that first ideas about the protection of chalk outcrops emerged way back in early XX century (Taliev, 1913). Some sites became protected as ‘zakazniks’ in 1980s (Gorelova, 1989; Tkachenko et al., 1986). A nature reserve ‘Chalk flora’ (branch of Ukrainian steppe nature reserve) was organised in 1988 in Donetsk region, while ‘Svyati Gory’ national nature park was created in 1997. ‘Dvorichanskyi’ national nature park was organised in 2010 in Kharkiv region with the main aim to protect unique plant communities of chalk outcrops in Oskil river basin. The focal communities are localised in strictly protected zone of 658.8 ha within ‘Dvorichanskyi’ national nature park.

Two main types of plant communities predominated on slopes with chalk outcrops in ‘Dvorichanskyi’ national nature park (Saidakhmedova et al., 2012). Chalk steppes with dominance of grasses (mainly, *Stipa* species) and Dwarf sedge (*Carex humilis*) are spread on gentle slopes and on saddles. The second main type is a sparse vegetation of chalk outcrops which includes distinct life forms e.g. dwarf cushion semishrubs and taproot perennials. Besides, mixed shrub-tree communities and diverse shrub thickets are spread in ravines of elevated right bank of Oskil river valley. These shrubby communities occupy small areas but greatly enhance diversity of plant cover of hilly chalk terrain.

While plant communities of chalk outcrops are comparatively well studied bird assemblages of hilly chalk terrain received considerably less attention. In 2000 the first concise assessment of bird communities of chalk rugged terrain was made based on extensive surveys of bird numbers and distribution within the whole area of chalk outcrops in Ukraine from Sumy region in the north to southern parts of Donetsk region (Banik, 2004). A list of breeding bird species of chalk hilly terrain in Voronezh region of Russia was recently published along with notes on their ecology (Vengerov et al., 2007). In this paper an assessment of breeding bird communities in hills with chalk outcrops based on the results of counts for a number of years in ‘Dvorichanskyi’ national nature park is presented.

Methods

The data on the abundance of breeding birds in chalk hilly terrain in ‘Dvorichanskyi’ national nature park were gathered by counts on three permanent monitoring plots of unequal area (17.8, 33.2 and 41.0 ha) established in 2010. The boundaries of monitoring plots were delineated with use of GPS-tracking and mainly coincided with roads at the foot of chalk hills and with bending points at the hill tops (often marked by artificial forest belts).

Apart of its size the chosen plots differ by relief. The first and the smallest plot is situated upstream Oskil river of Kamyanka village. It occupies negligibly dissected and straight slopes of right bank of Oskil river valley and slopes of low parts of ‘Ship’ hollow. A plantation of Scots pine (*Pinus sylvestris*) with partly closed canopy covers the upper slope parts. The second plot is situated downstream Oskil river of Kamyanka village. The relief conditions are quite diverse including dome-shaped hills with convex slopes, hillside gullies with chalk cliffs, and flattened sites in upper slope parts covered by steppe vegetation. The third and the biggest plot is situated in Krasnoye area. Relief conditions are diverse too including hollows with forest and shrub fragments on northern slopes, hills with flattened tops, steep-sided gullies.

The birds were counted 1–2 times a season, in May to early June, by total-area census method (Stewart, Kantrud, 1972; Igl, Johnson, 1997; with mapping all encounters). The method was proposed as a trade-off for gathering the data on bird numbers within vast areas when it is necessary to minimise time expenditures (Stewart, Kantrud, 1972).

Each plot was surveyed in morning time. Observations were started at sunrise or even earlier. The observer tried to establish a route in such a manner to cover all parts of the plot adequately. All records of singing males or birds with territorial behaviour as well as encounters of pairs with mating or breeding behaviour were plotted on a sketch map. Pair territories which only some way are within the plot boundaries were recorded as ½. Birds which visit the plot to feed or those flying over it were recorded with appropriate marks. No density calculations were made for these species. The generalized scheme of the distribution of breeding territories was prepared in those years when two consecutive counts were made. Breeding densities were calculated by relating the number of encountered pairs (territories) to the area of the plot. Area-weighted means were calculated for breeding densities and relative abundance estimates to account for the differences in the plot size. Dominant (>10% of the total abundance) and sub-dominant (>5%) species were classified according to A.P.Kuzyakin (1962).

Results and discussion

38 breeding bird species (11 non-passerines and 27 passerines) were recorded within 7 seasons in 2010–2016 years on permanent monitoring plots in chalk hilly terrain in ‘Dvorichanskyi’ national nature park (Table). The total mean breeding density was 236.7 pairs/sq. km. The latter varied from 143.26 to 356.74 pairs/sq. km on certain plots in different years.

4 distinct bird species assemblages were discerned according to their nesting habitat. Only two species, Tawny Pipit (*Anthus campestris*) and Isabelline Wheatear (*Oenanthe isabellina*), comprise the first group which is characteristic of chalk outcrops with low vegetation cover. The latter species breeds solely at the bases of hills in burrows of Bobak Marmot (*Marmota bobak*) and can be considered characteristic of chalk outcrops on slopes arbitrarily. Actually, only Tawny Pipit is a typical species of chalk outcrops (irrelatively of chalk ravines) in the studied area. The percentage of the first group in the overall number of species is quite negligible (about 5%).

The second assemblage consists of 7 species which nest in burrows or holes in hillside gullies with chalk cliffs. They are Ruddy Shelduck (*Tadorna ferruginea*), Common Kingfisher (*Alcedo atthis*), European Bee-eater (*Merops apiaster*), Common Hoopoe (*Upupa epops*), White Wagtail (*Motacilla alba*), Northern Wheatear (*Oenanthe oenanthe*), and Tree Sparrow (*Passer montanus*). The percentage of this group in the overall number of species is 18%.

The third assemblage consists of 6 species (16% of the overall number) which nest in chalk steppe e.g. Grey Partridge (*Perdix perdix*), Common Quail (*Coturnix coturnix*), Corncrake (*Crex crex*), Eurasian Skylark (*Alauda arvensis*), Whinchat (*Saxicola rubetra*) and Common Stonechat (*S. torquata*).

The fourth assemblage comprises species which are characteristic of gullies with bush and forest fragments. This group is the most species-rich and consists of 23 species or 61% of the total number. It includes Turtle Dove (*Streptopelia turtur*), Common Cuckoo (*Cuculus canorus*), European Nightjar (*Caprimulgus europaeus*), Eurasian Wryneck (*Jynx torquilla*), Woodlark (*Lullula arborea*), Tree Pipit (*Anthus trivialis*), Red-backed Shrike (*Lanius collurio*), Eurasian Golden Oriole (*Oriolus oriolus*), Eurasian Jay (*Garrulus glandarius*), Eurasian Magpie (*Pica pica*), Barred Warbler (*Sylvia nisoria*), Greater Whitethroat (*S. communis*), Thrush Nightingale (*Luscinia luscinia*), Eurasian Blackbird (*Turdus merula*), Song Thrush (*T. philomelos*), Great Tit (*Parus major*), European Greenfinch (*Chloris chloris*), European Goldfinch (*Carduelis carduelis*), Common Linnet (*Acanthis cannabina*), Common Rosefinch (*Carpodacus erythrinus*), Corn Bunting (*Emberiza calandra*), Yellowhammer (*E. citrinella*), and Ortolan Bunting (*E. hortulana*).

Bush and forest species numerically totally outweigh others (62% of the overall abundance). Some of them breed in forest fragments (e.g. Turtle Dove and Song Thrush) while others prefer to breed on slopes where single trees or tall shrubs are widely scattered throughout open landscape (Red-backed Shrike, Corn Bunting). Chalk steppe species also contribute markedly to the overall abundance (25%) while those characteristic of chalk outcrops and chalk ravines are in minority (4% and 9%, respectively). Therefore, the structure of bird communities in chalk hilly terrain is dominated by species which nest in bush and forest fragments. These species contribute largely to the overall species diversity and breeding density.

Resident species are in vast minority among those found to breed in chalk hilly terrain (only 13% of the total number of species) while long-distance migrants predominate (53%). Short-distance migrants comprise about one third of the total number of species (34%). The breeding density reaches its peak in

late spring in mid May because 4 out of 6 most numerous species are long-distance migrants and 2 out of 6 are short-distance migrants.

Table.

Mean density and relative abundance of breeding bird species on permanent monitoring plots in chalk hilly terrain in 'Dvorichanskyi' national nature park in 2010–2016 years

Species	Weighted mean breeding density, pairs/ sq. km	Weighted mean relative abundance, %	Species	Weighted mean breeding density, pairs/ sq. km	Weighted mean relative abundance, %
Ruddy Shelduck *Tadorna ferruginea*	0,47 ± 0,25	0,19 ± 0,10	Eurasian Magpie *Pica pica*	0,31 ± 0,23	0,11 ± 0,08
Grey Partridge *Perdix perdix*	0,62 ± 0,29	0,26 ± 0,13	Barred Warbler *Sylvia nisoria*	16,69 ± 1,75	6,88 ± 0,51
Common Quail *Coturnix coturnix*	1,09 ± 0,57	0,42 ± 0,21	Greater Whitethroat *Sylvia communis*	20,26 ± 4,46	7,69 ± 1,32
Corncrake *Crex crex*	0,54 ± 0,31	0,25 ± 0,14	Whinchat *Saxicola rubetra*	17,39 ± 3,47	7,07 ± 0,95
Turtle Dove *Streptopelia turtur*	0,31 ± 0,23	0,13 ± 0,09	Common Stonechat *Saxicola torquata*	5,28 ± 1,16	2,20 ± 0,52
Common Cuckoo *Cuculus canorus*	2,10 ± 0,69	0,97 ± 0,39	Northern Wheatear *Oenanthe oenanthe*	7,70 ± 1,39	3,17 ± 0,47
European Nightjar *Caprimulgus europaeus*	0,08 ± 0,16	0,04 ± 0,07	Isabelline Wheatear *Oenanthe isabellina*	0,24 ± 0,26	0,10 ± 0,12
Common Kingfisher *Alcedo atthis*	0,31 ± 0,23	0,14 ± 0,11	Thrush Nightingale *Luscinia luscinia*	0,31 ± 0,29	0,13 ± 0,11
European Bee-eater *Merops apiaster*	3,89 ± 1,93	1,76 ± 0,88	Eurasian Blackbird *Turdus merula*	3,88 ± 0,74	1,71 ± 0,32
Common Hoopoe *Upupa epops*	1,48 ± 0,54	0,57 ± 0,21	Song Thrush *Turdus philomelos*	0,47 ± 0,28	0,22 ± 0,15
Eurasian Wryneck *Jynx torquilla*	0,16 ± 0,18	0,07 ± 0,08	Great Tit *Parus major*	0,62 ± 0,45	0,22 ± 0,16
Woodlark *Lullula arborea*	0,23 ± 0,19	0,10 ± 0,08	Tree Sparrow *Passer montanus*	6,52 ± 1,18	2,84 ± 0,52
Eurasian Skylark *Alauda arvensis*	33,46 ± 3,65	14,27 ± 0,99	European Greenfinch *Chloris chloris*	6,91 ± 1,55	2,97 ± 0,62
Tawny Pipit *Anthus campestris*	10,40 ± 1,26	4,55 ± 0,53	European Goldfinch *Carduelis carduelis*	2,48 ± 1,20	0,90 ± 0,45
Tree Pipit *Anthus trivialis*	10,35 ± 1,82	4,61 ± 0,89	Common Linnet *Acanthis cannabina*	2,33 ± 0,80	0,99 ± 0,36
White Wagtail *Motacilla alba*	2,02 ± 0,68	0,88 ± 0,28	Common Rosefinch *Carpodacus erythrinus*	0,39 ± 0,65	0,12 ± 0,19
Red-backed Shrike *Lanius collurio*	38,75 ±3,38	16,82 ± 1,59	Corn Bunting *Emberiza calandra*	7,61 ± 2,16	3,38 ± 0,93
Eurasian Golden Oriole *Oriolus oriolus*	0,55 ± 0,32	0,22 ± 0,13	Yellowhammer *Emberiza citrinella*	29,27 ± 3,14	12,61 ± 1,13
Eurasian Jay *Garrulus glandarius*	0,70 ± 0,51	0,27 ± 0,19	Ortolan Bunting *Emberiza hortulana*	0,54 ± 0,49	0,22 ± 0,17

Red-backed Shrike (mean breeding density – 38.8 pairs/sq. km; 16.8% of total breeding density of all species), Eurasian Skylark (33.5 pairs/sq. km; 14.3%), and Yellowhammer (29.3 pairs/sq. km; 12.6%) are absolute dominants in chalk hilly terrain in 'Dvorichanskyi' national nature park. Another three species

are sub-dominants namely Greater Whitethroat (20.3 pairs/sq. km; 7.7%), Whinchat (17.4 pairs/sq. km; 7.1%), and Barred Warbler (16.7 pairs/sq. km; 6.9%). The cumulative abundance of six dominant and sub-dominant species comprises about two-thirds of the total breeding density of all species (65.4%). 3 of 6 mentioned species (Red-backed Shrike, Eurasian Skylark, and Whinchat) were recorded in all surveys on all three plots within the whole study period. Other three species were recorded in 80% of all surveys.

Other common species also play appreciable role in community structure despite their considerably lower abundance. They can be treated as fairly regular species because were found in almost all surveys at all plots. This group includes Tawny Pipit which was recorded in all surveys on all three plots within the whole study period (10.4 pairs/sq. km; 4.6%). Besides, the group consists of Tree Pipit (10.4 pairs/sq. km; 4.6%), Northern Wheatear (7.7 pairs/sq. km; 3.2%), Corn Bunting (7.6 pairs/sq. km; 3.4%), European Greenfinch (6.9 pairs/sq. km; 3.0%), and Common Stonechat (5.3 pairs/sq. km; 2.2%). Among mentioned species only Corn Bunting was recorded in less than 50% of counts.

All three plots differ by the number of breeding species and partly also by the assemblage of dominants and sub-dominants, and by the set of fairly regular and regular species recorded for 7 or 5–6 seasons, accordingly. The highest species diversity was found at 2nd plot (35 species) followed by 3rd (30) and 1st (23) plots. Red-backed Shrike was the only dominant species at every plot in all years of the survey. Apart from Red-backed Shrike, Tree Pipit, Whinchat, and Greater Whitethroat dominated on 1st plot, Eurasian Skylark and Yellowhammer were among dominants on 2nd plot while Eurasian Skylark, Barred Warbler, Greater Whitethroat, and Yellowhammer – on 3rd plot. Eurasian Skylark, Tawny Pipit, Common Stonechat and Yellowhammer were sub-dominants on 1st plot and Whinchat sub-dominated on 3rd plot.

6 species (Eurasian Skylark, Tawny Pipit, Tree Pipit, Red-backed Shrike, Whinchat, and Common Stonechat) were recorded on 1st plot in all 7 years of the study. Likewise 9 species were similarly regular on 2nd plot (same species as on 1st plot except Tree Pipit and Common Stonechat, and also Barred Warbler, Greater Whitethroat, Northern Wheatear, European Greenfinch, and Yellowhammer) and on 3rd plot (same species as on 1st plot and also Barred Warbler, Greater Whitethroat, and Yellowhammer). 4 species were regular on 1st plot e.g. recorded in 5–6 years of the study period (Greater Whitethroat, European Greenfinch, European Goldfinch, and Yellowhammer). 6 and 5 species were equally regular on 2nd plot (Common Cuckoo, Common Hoopoe, White Wagtail, Eurasian Blackbird, Tree Sparrow, and Corn Bunting) and 3rd plot (Northern Wheatear, Eurasian Blackbird, Tree Sparrow, European Greenfinch and Corn Bunting), accordingly.

Some species were recorded only at one of the plots and never were observed on others e.g. European Nightjar and Common Rosefinch (1st plot), Turtle Dove, Common Kingfisher, Eurasian Wryneck, and Isabelline Wheatear (2nd plot) and Thrush Nightingale (3rd plot).

An absence or extremely low abundance of some species is an important aspect of community organisation. Notably, Western Yellow Wagtail (*Motacilla flava*) and Lesser Whitethroat (*Sylvia curruca*) don't breed in chalk hilly terrain in 'Dvorichanskyi' national nature park. However, both species are common in adjacent habitats e.g. Western Yellow Wagtail breeds in Oskil river floodplain and at margins of agricultural fields on watershed areas while Lesser Whitethroat frequents tree and shrub belt along Oskil river bed and forest edges. No Starlings (*Sturnus vulgaris*) breed in chalk ravines within monitoring plots although they are rather common in other areas where chalk outcrops are spread (see e.g. Vengerov et al., 2007). Eurasian Wryneck, Eurasian Magpie, Thrush Nightingale, and Ortolan Bunting are all quite rare in chalk hilly terrain but the numbers of Eurasian Wryneck and Thrush Nightingale are comparatively high in those parts of Oskil floodplain adjacent to river channel while Ortolan Bunting is common in breeding time in artificial forest belts in agricultural landscape of left-bank parts of Oskil valley and in steppe hollows without chalk outcrops.

Many bird species regularly visit hills with chalk outcrops in spring and summer but use them only as feeding grounds. Black Kite (*Milvus migrans*), Eurasian Buzzard (*Buteo buteo*), Booted Eagle (*Hieraaetus pennatus*), Common Swift (*Apus apus*), Barn Swallow (*Hirundo rustica*), House Martin (*Delichon urbica*), Common Raven (*Corvus corax*), and Hawfinch (*Coccothraustes coccothraustes*) are among those regular visitors.

The bird communities in chalk hilly terrain in Eastern Ukraine meet their close analogues in Western Black Sea region e.g. in Bulgaria where principally the same species breed on pastures on slopes with xerophytic vegetation (Nikolov, 2010). 31 species comprise the breeding bird community in Ponor area in Western Bulgaria and of them 22 species breed in chalk hilly terrain in 'Dvorichanskyi' national nature park. The set of dominants (Eurasian Skylark, Whinchat, and Red-backed Shrike in Bulgaria) as well as the total breeding densities of all species are also similar.

The data gathered in 'Dvorichanskyi' national nature park stress the role forest and shrub fragments play in sustaining bird species diversity and numbers in chalk hilly terrain. These findings are in good agreement with the data on breeding bird communities of sub-Mediterranean pastures in Bulgaria where species diversity is higher on plots with greater shrub cover (Nikolov et al., 2011). The presence of trees and shrubs is necessary for breeding of those species relying upon them for nesting and feeding. Meanwhile typical steppe species tolerate the presence of forest and shrub fragments if they are reasonably small (Nikolov et al., 2011). Therefore, the more mosaic are the habitats within chalk hilly terrain the higher is the diversity and numbers of breeding bird species.

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