

## ... ЗООЛОГІЯ ТА ЕКОЛОГІЯ ... ZOOLOGY AND ECOLOGY ...

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### Тренди та синхронія у змінах чисельності лучної (*Saxicola rubetra*) і європейської чорноголової (*S. rubicola*) трав'янок у крейдових степах Північно-східної України М.В.Банік

Проблема співіснування споріднених видів у одних і тих самих угрупованнях породжує питання про те, наскільки узгодженими є зміни їхньої чисельності. Лучна (*Saxicola rubetra*) і європейська чорноголова (*S. rubicola*) трав'янки є прикладом такої пари філогенетично споріднених видів, які входять до складу гільдії комахоїдних птахів відкритих просторів, що полюють, вистежуючи здобич з присад. В Україні обидва види є досить звичайними на луках, у степах, по перелогах та в інших біотопах із домінуванням трав'янистих рослин, зокрема, й по цілих ділянках на заповідних територіях. У Північно-східній Україні лучна і європейська чорноголова трав'янки є характерними для угруповань птахів схилів із виходами крейди, де вони репрезентують групу видів, що пов'язана із крейдовими степами. Тренди та синхронію у змінах чисельності обох видів трав'янок у цьому біотопі упродовж дев'ятирічного періоду (2010–2018 рр.) вивчали у національному природному парку «Дворічанський» у Харківській області (Північно-східна Україна). Дані отримували за результатами програми щорічних обліків птахів у крейдових степах з використанням методу суцільного обліку на площадці на трьох постійних ділянках неоднакової площі (17,8, 33,2 та 41,0 га). Тренди аналізували у програмі TRIM (TRends & Indices for Monitoring data) версії 3.53. Рівень синхронії оцінювали шляхом отримання крос-кореляцій з нульовим лагом для часових серій лог-трансформованих приростів чисельності. Додатково перевіряли ступінь збігу напрямку змін та піків у серіях даних. Тренд для лучної трав'янки був охарактеризований як достовірне стрімке падіння чисельності (мультиплікативний коефіцієнт 0,840, стандартна помилка 0,03;  $p < 0,01$ ). Тренд для європейської чорноголової трав'янки класифікується як недостовірний й невизначений (мультиплікативний коефіцієнт 0,909, стандартна помилка 0,06). Тренди для обох видів узгоджуються із загальними трендами в Європі за даними План-Європейської Схеми Моніторингу Звичайних Видів Птахів для 1980–2016 рр. і 1989–2016 рр. для лучної і європейської чорноголової трав'янок відповідно. Синхронія у змінах чисельності лучної і європейської чорноголової трав'янок у крейдових степах виявилась слабкою. Серії змін чисельності обох видів йшли у різних напрямках майже у всіх випадках, коли їх можна було аналізувати, що, ймовірно, вказує на відміни у причинах динаміки їхніх популяцій. Результати дослідження свідчать про необхідність запровадження у заповідниках і національних парках України нових схем моніторингу та підтримання тих, що вже існують, оскільки вони здатні давати надійні оцінки трендів змін чисельності звичайних та рідкісних видів птахів.

**Ключові слова:** лучна трав'янка (*Saxicola rubetra*), європейська чорноголова трав'янка (*S. rubicola*), тренди змін чисельності, синхронія коливань чисельності, моніторинг, крейдові степи, Північно-східна Україна.

### Trends and synchrony in fluctuations of the numbers of Whinchat (*Saxicola rubetra*) and European Stonechat (*S. rubicola*) in chalk steppe of North-eastern Ukraine M.V.Banik

The problem of coexistence of related species within the same communities poses a question of how similar are the fluctuations of their numbers. Whinchat (*Saxicola rubetra*) and European Stonechat (*S. rubicola*) is an example of such a pair of phylogenetically related bird species, which are members of a foraging guild of sit-and-wait insectivores in open habitats. In Ukraine both species are quite common in meadows, steppes, fallow lands and other grassland habitats including undisturbed areas in nature reserves. In North-eastern Ukraine Whinchat and European Stonechat are characteristic of the bird communities of hills with chalk outcrops where they represent a group of species linked to chalk steppe. The trends in numbers and synchrony in fluctuations in the numbers of both species in this habitat were studied in national nature park 'Dvorichanskiy', Kharkiv region, North-eastern Ukraine for 9 years' period (2010–2018). The data were retrieved from the results of yearly monitoring bird counts in chalk grassland habitats. The total-area census method was used on 3 plots of unequal size (17.8, 33.2, and 41.0 ha). The trends were analysed in programme TRIM (TRends

& Indices for Monitoring data) vers. 3.53. The extent of synchrony was estimated by means of zero-lag cross-correlation between the time series of log-transformed growth rates. Additionally, the coincidence of the direction of changes and the coincidence of peaks in series were checked. The trend in Whinchat abundance is characterised as significant steep decline (multiplicative slope 0.840, standard error 0.03;  $p < 0.01$ ). The trend in European Stonechat abundance is classified as non-significant uncertain (multiplicative slope 0.909, standard error 0.06). The trends in both species correspond to general trends in Europe evidenced in Pan-European Common Bird Monitoring Scheme for 1980–2016 and 1989–2016 for Whinchat and European Stonechat accordingly. The synchrony in fluctuations of the numbers of Whinchat and European Stonechat in chalk steppe habitats proved to be weak. Time series of both species abundances run in different directions almost in all cases where the comparison was possible that indicates probable differences in the causes of the dynamics of their populations. The study prompts to launch new or extend existing monitoring schemes in nature reserves and national parks in Ukraine to get reliable estimates for the trends in numbers of both rare and common bird species.

**Key words:** Whinchat (*Saxicola rubetra*), European Stonechat (*S. rubicola*), trends in numbers, synchrony in fluctuations, monitoring, chalk steppe, North-eastern Ukraine.

## Тренды и синхрония в изменениях численности лугового (*Saxicola rubetra*) и европейского черноголового (*S. rubicola*) чеканов в меловых степях Северо-восточной Украины

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Проблема сосуществования близких видов в одних и тех же сообществах порождает вопрос о том, насколько согласованными могут быть изменения их численности. Луговой (*Saxicola rubetra*) и европейский черноголовый (*S. rubicola*) чеканы могут служить примером такой пары филогенетически близких видов, входящих в состав гильдии насекомоядных птиц открытых пространств, охотящихся с помощью выслеживания добычи с присад. В Украине оба вида достаточно обычны на лугах, в степях, на залежах и в других биотопах с доминированием травянистых растений, в частности, и на целинных участках на заповедных территориях. На северо-востоке Украины луговой и европейский черноголовый чеканы характерны для сообществ птиц склонов с выходами мела, где они представляют группу видов, связанных с меловыми степями. Тренды и синхронию в изменениях численности обоих видов чеканов в этом местообитании на протяжении девятилетнего периода (2010–2018 гг.) изучали в национальном природном парке «Двуречанский» в Харьковской области (Северо-восточная Украина). При этом использовали данные мониторинга населения птиц в меловых степях, полученные с применением метода сплошного учёта на площадке на трёх учётных участках неодинаковой площади (17,8, 33,2 и 41,0 га). Тренды анализировали в программе TRIM (TRends & Indices for Monitoring data) версии 3.53. Уровень синхронии оценивали путём получения кросс-корреляций с нулевым лагом для временных серий лог-трансформированных приростов численности. Дополнительно проверяли степень совпадения направления изменений и пиков в сериях данных. Тренд для лугового чекана характеризовался как достоверное резкое падение численности (мультипликативный коэффициент 0,840, стандартная ошибка 0,03;  $p < 0,01$ ). Тренд для европейского черноголового чекана классифицировался как недостоверный и неопределённый (мультипликативный коэффициент 0,909, стандартная ошибка 0,06). Тренды для обоих видов согласуются с известными для Европы по данным Пан-европейской Схемы Мониторинга Обычных Видов Птиц для 1980–2016 гг. и 1989–2016 гг. для лугового и европейского черноголового чеканов соответственно. Синхрония в изменениях численности лугового и европейского черноголового чеканов в меловых степях оказалась слабой. Серии изменений численности обоих видов шли в разных направлениях почти во всех случаях, когда их можно было проанализировать, что, вероятно, указывает на отличия в причинах динамики их популяций. Результаты исследования свидетельствуют о необходимости внедрения в заповедниках и национальных парках Украины новых и поддержки уже существующих схем мониторинга, дающих возможность надёжно оценивать тренды изменения численности обычных и редких видов птиц.

**Ключевые слова:** луговой чекан (*Saxicola rubetra*), европейский черноголовый чекан (*S. rubicola*), тренды изменения численности, синхрония колебаний численности, мониторинг, меловые степи, Северо-восточная Украина.

### Introduction

One intriguing question of community ecology is how synchronous are the fluctuations in numbers of related species e.g. members of a habitat or foraging guild (Smith, 1986; Henderson et al., 2014)? Do

they experience roughly the same ups and downs or are doing quite distinctly over time? If the latter is the case it's reasonable to assume that this facilitates their coexistence in the same communities.

A good example of ecologically similar species, which often are members of the same bird communities in open grassland habitats (e.g. meadows and steppes of various types or fallow lands) is Whinchat (*Saxicola rubetra*) and European Stonechat (*S. rubicola*). The latter is treated here as a separate taxon, a member of a group of species formerly united in a Common Stonechat (*S. torquatus*) complex, according to recent works on phylogeny and the 4<sup>th</sup> edition of The Howard and Moore Complete Checklist of the Birds of the World (Urquhart, 2002; Zink et al., 2009; Fesenko, Shydlovskyy, 2017; Christidis et al., 2018). Whinchat and European Stonechat are comparatively small passerine birds of Muscicapidae family and chiefly sit-and-wait insectivores with similar diet and foraging habits (Kuz'menko, 1977; Pudil, Exnerová, 2015). Nevertheless, both species are quite distinct in other key ecological traits. Whinchat is a long-distance migrant wintering in sub-Saharan Africa while main winter quarters of European Stonechat are situated fairly closer to breeding areas within Mediterranean region. In North-eastern Ukraine Whinchat is a dominant species in bird communities of meadows and steppes of some kinds. European Stonechat is a far less abundant bird (Banik, 2007). Multi-broodiness of European Stonechat and single-broodiness of Whinchat both add to mentioned distinctions. It is worth to note as well that European Stonechat colonised North-eastern Ukraine, an area previously inhabited by Whinchat only comparatively recently, in 1960–1970s (Banik, 2006).

Whinchat and European Stonechat are characteristic of the bird communities of hills with chalk outcrops in North-eastern Ukraine and represent a group of species linked to chalk steppe habitats with continuous plant cover dominated by grasses and sedges (Banik, 2017). They breed in chalk steppe mainly at the foot of chalk hills (both species) or on flattened tops of the slopes (Whinchat). Besides, both species breed in semi-natural meadows of the Oskil River flood-plain which are subject to changes due to fluctuations in flooding regime and the level of human disturbance. Unlike meadows chalk steppes represent a more stable environment being probably also a primary habitat of Whinchat in North-eastern and Eastern Ukraine (Banik, 2007). Therefore it's reasonable to have a look at the dynamics of focal species' numbers in conditions where local disturbance of the structure of breeding habitat is minimized. Gradual accumulation of the data on annual changes in the numbers of Whinchat and European Stonechat in chalk steppe allows to investigate how concerted are the fluctuations in numbers of both species and if certain trends in changes are apparent.

### Study area

The study was done in a national nature park 'Dvorichanskyi', the only national park in Ukraine organised to protect chalk steppe habitats. The park is situated in north-eastern part of Kharkiv region, North-Eastern Ukraine at the border with Russian Federation. The territory of the park comprises a portion of the Oskil River valley landscape with partly forested ravines, elevated right banks of the valley covered by chalk grasslands, and flood-plain areas with meadows and willow & alder forests (Saidakhmedova et al., 2012). The total area of the park is 3131 ha of which 658.8 ha are covered by chalk steppe and sparse vegetation of chalk outcrops. These chalk grasslands are within strictly protected core of the park territory. The vegetation of chalk outcrops falls within E1.13 category of EUNIS classification of habitats (continental dry rocky steppic grasslands and dwarf scrub on chalk outcrops) while chalk steppe is well within E1.2 category (perennial calcareous grassland and basic steppes) (EUNIS habitat classification, 2012).

### Methods

The data on the changes of Whinchat's and European Stonechat's abundance in chalk steppe were based on the results of monitoring for nine years' period, 2010 to 2018. The data were gathered by counts made one or two times per breeding season in May to early June on three plots of unequal area (17.8, 33.2 and 41.0 ha; thereafter 1<sup>st</sup>, 2<sup>nd</sup> and 3<sup>rd</sup> plot) situated in hilly terrain of right elevated bank of the Oskil River valley within strictly protected zone of the national park. Total-area census method (Stewart, Kantrud, 1972; Igl, Johnson, 1997; with mapping all encounters) was used to get estimates of breeding abundance. The birds were counted early in the morning in to-and-fro movement along the plot when all the encounters of singing males, territorial disputes, or pairs showing mating or breeding behaviour were plotted on a sketch map. The number of breeding pairs was then estimated and related to the area of the

plot to obtain density values. The habitat and relief conditions of each of three plots and some aspects of the application of the method were described in more detail elsewhere (Banik, 2017).

The trends in the changes of the numbers of Whinchat and European Stonechat were analysed with use of programme TRIM (TRends & Indices for Monitoring data) vers. 3.53 (TRIM, 2019). Generalized linear models (log-linear regression models) are the main algorithm in TRIM programme (Pannekoek, van Strien, 2005). For these models the data on the number of breeding pairs on the plots were used as input data with and without weighing by plot area. The method allows obtaining the trends of changes in abundance, classifying them and checking their significance. Trends are expressed in terms of multiplicative slopes or multiplication factors for percentage changes between years when e.g. the slope for the stable trend is close to 1. Trends are then classified according to their magnitude and significance.

The degree of synchrony in changes of abundance of Whinchat and European Stonechat within monitoring plots was calculated using so-called 'zero-lag cross-correlation' between the time series of log-transformed growth rates (Bjørnstad et al., 1999). Literally, for each species-plot series of initial data the series of differences between log-transformed successive abundance values was constructed. Spearman rank correlation coefficients were used as a primary measure of synchrony in changes, which is invariant to log-transformation of the data (Buonaccorsi et al., 2001). Additionally two other simple measures of synchrony were calculated both proposed by J.P. Buonaccorsi with co-authors (2001). The first one is a coincidence in the direction of changes in series  $i$  and  $j$ ,  $A_{ij}$ , calculated as a number of times series in comparison moved in the same direction related to  $T-1$  number of times if  $T$  is the length of a series. That measure was then transformed into some kind of a modified Kendall's tau coefficient  $\tau_{ij}=2A_{ij}-1$ , which is similar to correlation coefficient and ranges -1 to 1 (Buonaccorsi et al., 2001). The second additional measure of synchrony calculated in this study is an index of coincidence in both series  $C=N/M$ , where  $N$  is a number of peaks in series in comparison while  $M$  is a maximum number of peaks in either series (Buonaccorsi et al., 2001). The analysis was performed with use of Statistica 7.0 software package.

### Results and discussion

The trend of changes in numbers of Whinchat in chalk steppe habitats of national nature park 'Dvorichanskyi' is characterised as steep decline (Fig.) (TRIM, 2019). That means the abundance declined considerably, by no less than 5% per year. The trend is significant (multiplicative slope 0.840, standard error 0.03;  $p<0.01$ ). Nearly the same trend was found for the data weighed by area (multiplicative slope 0.841, standard error 0.04;  $p<0.01$ ). The mean decrease in Whinchat abundance is thus 15.9–16 % per year. Such clearly negative trend corresponds quite well to the overall trend of decline of this species in Europe evidenced in the results of Common Bird Species Monitoring Scheme and some other studies (Sanderson et al., 2006; Henderson et al., 2014; Vickery et al., 2014; PanEuropean Common Bird Monitoring Scheme, 2019). The Common Bird Monitoring Scheme produced overall trend of moderate decline for 1980–2016 period. Negative trends in Europe are generally attributed to changes of breeding habitats which are unfavourable for the species e.g. intensification of agricultural practice such as transformation of meadows for silage production, shifts of the onset of mowing and so on (Müller et al., 2005; Britschgi et al., 2006; Henderson et al., 2014). No such habitat transformation is evident for chalk steppes of the studied area where the greatest impact was wildfires, which destroyed vegetation cover for some parts of the monitoring plots in a few years within this study. Negative trend for chalk steppe may therefore be a by-product of general decline of the adjacent populations acting as sources of breeding birds' influx or even an indication of some unfavourable processes caused by climate changes (Henderson et al., 2014).

The trend of changes in numbers of European Stonechat is classified as uncertain e.g. there is no apparent increase or decline but between-year changes may be well above 5% per year (Fig.) (TRIM, 2019). The trend is non-significant (multiplicative slope 0.909, standard error 0.06;  $p>0.05$ ). As in Whinchat case, this corresponds to the European trend for the species abundance according to Common Bird Species Monitoring Scheme (PanEuropean Common Bird Monitoring Scheme, 2019). In Europe the trend is stable for the period of 1989–2016 according to Common Bird Monitoring Scheme. The numbers of European Stonechat in chalk steppe habitats of national nature park 'Dvorichanskyi' fluctuated considerably year-to-year showing some kind of non-significant decline.

The trends of changes in the numbers of both species in chalk steppe habitats of national nature park 'Dvorichanskyi' are quite different according to our results. Probably, it's an indication that the dynamics of populations of both species in chalk steppes are driven by different factors and hardly can be interpreted as being interrelated.

The synchrony in fluctuations was estimated for both within- and between-species series. In Whinchat Spearman rank correlation coefficients for log-transformed growth rates for all three monitoring plots ranged between 0.054 (1 versus 2 plot) to 0.635 (1 versus 3 plot) but all proved to be non-significant ( $p > 0.05$ ). Time series at all three plots moved in same directions in 50% of times that means tau coefficient equalled zero in all three sets of comparison. The measure for the coincidence of peaks C was 0.33 for plots 1–2 and 1–3 and 0.66 for plots 2–3. The overall data evidenced that the level of synchrony in changes of Whinchat abundance on monitoring plots in chalk steppe of national nature park 'Dvorichanskyi' was comparatively low and especially in the coincidence of the direction of changes.

The synchrony in fluctuations of European Stonechat abundance might have been estimated only for plots 1 and 3 because the number of the species within 2<sup>nd</sup> plot was zero for 5 out of 9 seasons. Spearman correlation coefficient for log-transformed growth rates for plots 1 and 3 equalled 0.054 (non-significant), tau coefficient was -0.25 while the measure for the coincidence of peaks C was 0. There was a very little synchrony in the changes of European Stonechat abundance on plots 1 and 3.

The synchrony in fluctuations of Whinchat and European Stonechat abundances might have been estimated only for plots 1 and 3 for the above-mentioned reason. Spearman coefficients for log-transformed growth rates for plots 1 and 3 were 0.179 and -0.524 accordingly (both non-significant). The coincidence of the direction of changes in Whinchat and European Stonechat abundances was negative for both plots (tau coefficient equalled -0.143 and -0.714 for plots 1 and 3 accordingly). The measure of peak coincidence C was 0.5 and 0 for plots 1 and 3 accordingly. The results demonstrate a little degree of synchrony in the changes of Whinchat and European Stonechat abundances in chalk steppe habitats of national nature park 'Dvorichanskyi'. This negligible between-species synchrony is predictably lesser than within-species synchrony on the same plots.



**Fig. Yearly indices of Whinchat (*Saxicola rubetra*) and European Stonechat (*S. rubicola*) abundance in chalk steppes in national nature park 'Dvorichanskyi' (Kharkiv region, Ukraine) calculated by TRIM (The index of the base year, 2010, is set to 1)**

The absence of significant synchrony in fluctuations of Whinchat and European Stonechat abundances in chalk steppes of national nature park 'Dvorichanskyi' is apparent for both within- and between-species comparisons. Time series of both species abundances run in different directions almost in all cases where the comparison was possible. That may be a weak indication of the differences in the causes of the dynamics of their populations. However, these conclusions should be treated as preliminary, to be confirmed and substantiated by the use of larger data sets for larger territories in Ukraine in the future.

The monitoring of the numbers of Whinchat and European Stonechat in national nature park 'Dvorichanskyi' indicates the existence of highly significant negative trend in changes of the numbers of the former species. This is in line with alarming decline of Whinchat almost everywhere in Europe.

This study demonstrates the importance of launching monitoring programmes within the network of nature reserves and national parks in Ukraine. Such monitoring efforts can provide the background for sound estimates of the changes of the numbers of both common and rare bird species. It is desirable to apply monitoring data for the assessment of trends in changes of the numbers of certain species and in setting a background for reliable estimates of their conservation status both in certain regions and in Ukraine as a whole.

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