Vestnik zoologii, **50**(1): 89–92, 2016
DOI 10.1515/vzoo-2016-0011

DE GRUYTER OPEN

UDC 598.296.1(497)

SONG REPERTOIRE AND ORIGINS OF CRIMEAN POPULATION OF CHIFFCHAFF, *PHYLLOSCOPUS COLLYBITA* (SYLVIIDAE)

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Song Repertoire and Origins of Crimean Population of Chiffchaff, *Phylloscopus collybita* (Sylviidae). Grishchenko, A. V., Tsvelykh, A. N., Yablonovska-Grishchenko, E. D. — Song repertoire of geographically isolated Chiffchaff population that formed in Crimean mountains in 1990s is analyzed. There are 42 song elements in the Crimean Chiffchaff repertoire. A quarter of their song elements appear to be specific for this population because it is absent in neighboring European Chiffchaff populations from regions to the north (*Ph. c. abietinus* subspecies) and west (*Ph. c. collybita* subspecies). Comparison of song elements of Crimean Chiffchaffs with those of Caucasian birds of *Ph. c. caucasica* subspecies shows that they belong to same vocal population: specific elements in Crimean Chiffchaff songs are found also in songs of Caucasian birds. This is evidence that breeding population of Chiffchaff in Crimea originated from the species expansion from Caucasus, and that Crimean Chiffchaffs belong to *Ph. c. caucasica* subspecies.

K e y w o r d s: *Phylloscopus collybita*, song, sonogram, Crimea, Caucasus, subspecies.

Introduction

The isolated breeding population of Chiffchaff in Crimean mountains formed quite recently in 1990s (Tsvelykh, Appak, 2011). The range of Crimean Chiffchaff population is separated by more than 200 km of woodless or marine territories from the other nearest populations of this species. The origin of birds of which Crimean population is generated is unknown. In our study we tried to analyze song structure of Crimean Chiffchaffs and to ascertain origins of local population by comparing vocalization characteristics of Crimean birds to those of birds from regions geographically nearest to Crimean peninsula.

Material and methods

Chiffchaff songs were recorded in central and western parts of Mountainous Crimea in May–June 2007, 2008 and 2011. Songs of 21 birds were recorded. Bird songs were recorded on a digital recorder US 550 PR Panasonic with built-in directional zoom-microphones, and on digital cameras Sony TRV 110 E and Sony TRV 550 E with external microphones. For further analysis, all sound files were saved in Wave format. Syrinx 5.2s (Burt, 1995–2005) and Sound Forge 5.0 software were used to analyze records and obtain sonograms.

Chiffchaff song is composed of simple repeated strophes. These strophes look like separate graphic elements on sonograms, in some cases such elements may include several sub-elements. Primary recognition and systematization of Chiffchaff song elements were done according to a typology method already developed for this species' songs (Grishchenko, Yablonovska-Grishchenko, 2011). Song elements with equal time-frequency characteristics (their representations on same scale sonograms were identical) were encrypted with the same code. Thus, a set of song elements intrinsic for the studied population was found. This set of song elements of Crimean Chiffchaff population was then compared to sets from three nearest to Crimean peninsula regions, located to the north, on Western Black Sea Coast and in Caucasus. For the northern population, partly published results were used (Grishchenko, Yablonovska-Grishchenko, 2013) of analysis of 231 Chiffchaff males' songs from the forest and forest-steppe zones of Ukraine. For Western Black Sea Coast we used our records of Chiffchaff songs in Danube Delta ($n = 6$) and seashore regions in South-Eastern Bulgaria ($n = 6$). For Caucasus region we obtained sonograms from Chiffchaff audio recordings in Western (Veprintsev, 2007), Central (Deroussen, 2009) and Eastern (Schubert, 2008) Caucasus, also a catalogue of song elements of Chiffchaff from

Eastern Caucasus (Martens, 1982) was analyzed. Additionally, sonograms of fragments of Chiffchaff songs recorded in Caucasus and neighboring regions (Helbig et al., 1996) were studied.

Results and discussion

Songs of Crimean Chiffchaff contained 42 different elements (fig. 1). This set can be considered sufficiently representative. For example, analysis of large numbers of songs in two large Chiffchaff populations from central and western regions of Ukraine revealed 30 elements in songs from either of them (Grishchenko, Yablonovska-Grishchenko, 2013). This diversity of song elements means that the local population in question was formed by a significant number of individuals. Otherwise there would be expected the founder effect that would manifest as poorer repertoire of local Chiffchaff population.

Comparison of song element set of Crimean Chiffchaffs with the elements found in songs of birds to the north of Crimean peninsula (represented by subspecies *Ph. c. abietinus*) showed that a quarter of song elements of Crimean Chiffchaff was absent in the other set (fig. 1). The same Crimea-specific elements were absent (with one exception) in songs of Chiffchaffs of Western Black Sea Coast (of subspecies *Ph. c. collybita*). Also four new elements were discovered in songs of Chiffchaff from the latter territory that were absent in songs of Crimean birds. Thus, set of song elements of *Ph. c. collybita* of Western Black Sea Coast is different from same set of Crimean birds even more than the set of song elements of *Ph. c. abietinus* from territories to the north of Crimean peninsula.

Songs of Crimean Chiffchaffs included 2–13 different elements. Most of the songs included 1–4 specific elements. Only six songs recorded in Crimea did not contain these elements. But all these songs were incomplete or short, including in average three various elements. Songs with specific elements were much more diverse, including in average six different elements. The probable explanation may be the method constraints: mountainous conditions did not always permit recording complete songs. It is possible that a fuller recording would allow revealing the specific elements. According to our calculations the more different elements (x) were discerned in a Chiffchaff song, the more it contained specific elements (y): $y = -0{,}333 + 0{,}318\,x$ ($r = 0{,}683$, $n = 21$, $p < 0.001$).

Comparing the song element set of Crimean Chiffchaff to these of Caucasian birds (of subspecies *Ph. c. caucasica*) revealed that a significant part of elements specific for Crimean Chiffchaff was also present in songs of birds from Caucasus. Similar to Crimean Chiffchaff's, Caucasian bird songs contained 1–3 such elements. Song of some bird from Western Caucasus had three specific elements found only in Crimean set (fig. 2), as well as two elements very similar in structure to two other Crimean-specific elements that can be considered as variations of Crimean elements. Thus, this song contained five specific elements. Sonogram analysis of a short fragment of Chiffchaff song from Northern Caucasus (Helbig et al., 1996) allowed for distinguishing only three elements, not one of which was specific (reasons for lack of specific elements in recordings of incomplete and short songs of Crimean birds are discussed above). Yet our analysis of the same study revealed specific elements in song fragments of Chiffchaff subspecies with ranges directly bordering the range of *Ph. c. caucasica*. These are Chiffchaffs of *Ph. c. menzbieri* and *Ph. c. brevirostris* subspecies. In their songs respectively two and two specific elements were found (it is possible that all three subspecies are conspecific, at the very least there are no significant genetic differences between *Ph. c. caucasica* and *Ph. c. brevirostris* (Helbig et al., 1996)).

All this suggests that Crimean and Caucasian Chiffchaffs belong to same vocal population and specific elements can be used as markers for identification of birds from this population. From this it follows that the breeding population of Chiffchaffs in Crimea originated from expansion of birds from Caucasus and birds of Crimean and Caucasian populations belong to *Ph. c. caucasica* subspecies.

It should be noted that there was an earlier attempt to understand the origins of Crimean Chiffchaff population by identifying the subspecies of local birds based on their plum-

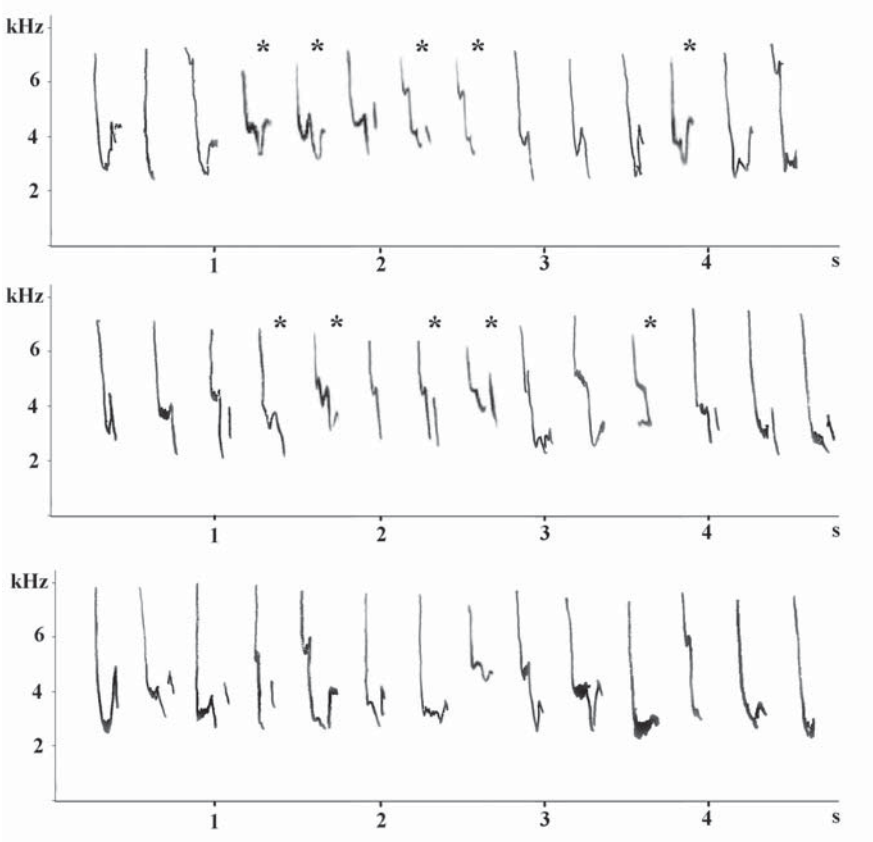

Fig. 1. Catalogue of song elements of the Crimean Chiffchaffs. * Specific Crimean song elements.

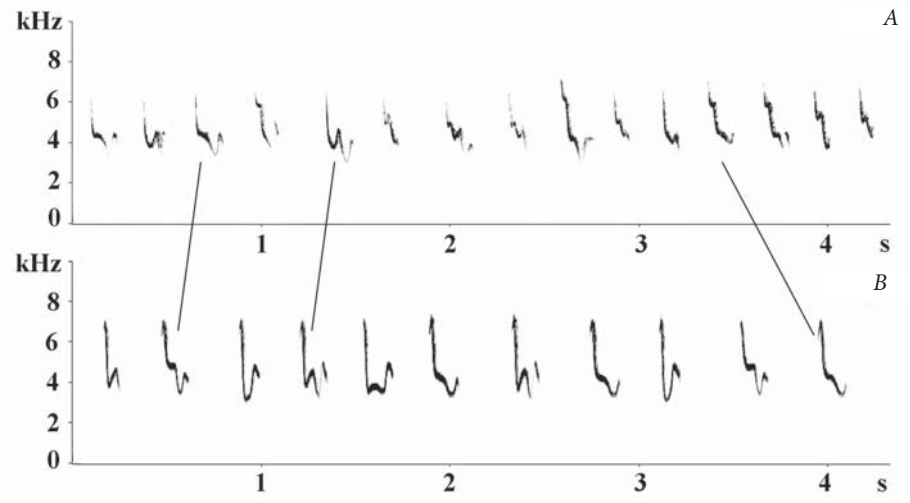

Fig. 2. Songs of Crimean (*A*) and Caucasian (*B*) Chiffchaffs with identical specific Crimean song elements (marked).

age coloring (Tsvelykh, Appak, 2011). The authors concluded that two female Chiffchaffs from Mountainous Crimea obtained in breeding season (June) belonged to subspecies *Ph. c. abietinus,* and that supported Eastern-European origins of Chiffchaffs in Mountainous Crimea. But one of these birds was collected outside of breeding range of Chiffchaffs in Mountainous Crimea, had no morphological characteristics consistent with participation in breeding and was evidently unpaired summering bird (Tsvelykh, Appak, 2011). Sub-

species identification of the second bird involved difficulties (Tsvelykh, Appak, 2011) — in summer (June–July) the worn plumage of *Ph. c. abietinus* and *Ph. c. caucasica* show minimal differences allowing for subspecies identification for only half of the birds (Loskot, 1991). Thus, for one of the birds, belonging to local breeding population stayed unproved and subspecies of the second bird could be misidentified.

Conclusion

Song repertoire of Crimean Chiffchaffs is shown to be quite diverse. There are 42 song elements suggesting that a significant number of individuals took part in formation of local population. A quarter of elements of Crimean Chiffchaff repertoire is specific to them and absent in repertoires of Chiffchaffs of nearest to Crimea European populations. A lot of these specific elements are found in songs of Caucasian birds, suggesting that Crimean and Caucasian Chiffchaffs belong to one vocal population. Thus, Chiffchaff breeding population in Crimea was founded by birds expanding from Caucasus and Crimean birds belong to *Ph. c. caucasica* subspecies.

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Received 6 October 2015
Accepted 29 October 15