

Contents lists available at [ScienceDirect](https://www.sciencedirect.com)

## Journal of Arid Environments

journal homepage: [www.elsevier.com/locate/jaridenv](http://www.elsevier.com/locate/jaridenv)

# The Indo-European flyway of migrating songbirds: Crossing the arid plains of central Eurasia

Nikita Chernetsov<sup>a,b,\*</sup>, Mikhail Markovets<sup>c</sup>

<sup>a</sup> Ornithology Lab, Zoological Institute, Russian Academy of Sciences, 1 University Emb., 199034, St. Petersburg, Russia

<sup>b</sup> Department Vertebrate Zoology, St. Petersburg State University, 7-9 University Emb., 199034, St. Petersburg, Russia

<sup>c</sup> Biological Station Rybachy, Zoological Institute, Russian Academy of Sciences, 32 Pobedy St., 238535, Rybachy, Russia

## ARTICLE INFO

## Keywords:

Bird migration  
Desert  
Central Asia  
Migratory route  
Detour

## ABSTRACT

The arid belt of Central Asia is a major barrier for many migrating songbirds. It has to be crossed by passerines that breed in Siberia and winter in Africa, but also by the species that breed in eastern Europe and winter in southern and south-eastern Asia. Many passerine migrants breeding in Siberia and wintering in Africa avoid crossing the deserts in autumn; instead, they make a detour to the north and northwest and fly north of the Caspian Sea. Here we show that some, but not all, European-Indian migrants (e.g. scarlet rosefinches and greenish warblers) in autumn also make a detour and fly towards the east north of the arid belt before crossing in its central or eastern part. Other species, which include e.g. red-breasted flycatchers, Blyth's reed warblers and possibly booted warblers, take the shortest route between their (north)east European breeding grounds and Indian winter quarters.

The arid belt of Central Asia, which extends over thousands of kilometres from the Caspian Sea to the Altai, is a major barrier for many migrating songbirds (Dolnik 1990; Bolshakov 2003). This is especially true during autumn migration, when the desert is dry, green plants are scarce and mainly restricted to oases and agricultural areas, and invertebrates are largely restricted to area with green plants. Many woodland species of songbirds that breed in the vast forest belt of the Palaearctic and winter in Africa, Indian subcontinent or in southeastern Asia, have difficulty finding appropriate habitats in the steppe or deserts. In the 1980s – early 2000s, a series of studies dealt with how songbird migrants cross the deserts and highlands of Central Asia (Dolnik 1982, 1985a, b, 1990; Bolshakov, 2002, 2003; Bulyuk and Chernetsov, 2005; Chernetsov et al., 2007). These studies were based on direct observations of nocturnal passage by moon-watching method and on the analysis of captures at stopovers in different parts of the arid belt. They allowed the authors to suggest the idea that nocturnal passerine migrants breeding in Siberia and wintering in Africa avoid crossing the deserts in autumn; instead, they make a detour to the north and northwest and fly north of the Caspian Sea. This hypothesis that was originally based on indirect data, was subsequently supported by direct tracking data based on light-level geolocation (Sokolovskis et al., 2018). It is worth noting that whereas Alaskan Northern wheatears *en route* to East

Africa seemed to cross Central Asian deserts (Bairlein et al., 2012), willow warblers from Chukotka apparently circumvented the most arid areas and flew north of the Caspian Sea (Sokolovskis et al., 2018), as predicted by moon-watching and trapping data (Bolshakov, 2002, 2003).

Less attention was paid to migration of songbirds that follow the Indo-European flyway, i.e. breed in the eastern part of Europe and spend their winter on the Indian subcontinent. They include e.g. scarlet rosefinches *Carpodacus erythrinus*, booted warblers *Iduna caligata*, Blyth's reed warblers *Acrocephalus dumetorum*, red-breasted flycatchers *Ficedula parva*, and greenish warblers *Phylloscopus trochiloides*. These birds also need to cross the same deserts, but from the north-west to the south-east.

In the early 2000s, we performed fieldwork on the western edge of the central Asian desert in Dzhanibek on the border between Russia and Kazakhstan. This work included both the study of avian migration aloft by moon-watching (Bulyuk and Chernetsov, 2005) and mist-netting songbird migrants at stopover to study their diversity and body condition (Chernetsov et al., 2007, 2010). We showed that the study site was located on the crossroads between Siberian-African and Indo-European flyways, as suggested by both moon-watching results and by captures on the ground. We recorded large numbers of red-breasted flycatchers and some Blyth's reed warblers, but few scarlet rosefinches and no greenish

\* Corresponding author. Ornithology Lab, Zoological Institute, Russian Academy of Sciences, 1 University Emb., 199034, St. Petersburg, Russia.

E-mail address: [nikita.chernetsov@gmail.com](mailto:nikita.chernetsov@gmail.com) (N. Chernetsov).

<https://doi.org/10.1016/j.jaridenv.2022.104786>

Received 16 November 2021; Received in revised form 26 April 2022; Accepted 2 May 2022

Available online 8 May 2022

0140-1963/© 2022 Elsevier Ltd. All rights reserved.

**Table 1**  
Proportion of European-Indian migrants of the total sample of long-distance migrants captured in Dzhanbybek during autumn migratory seasons.

Species	Trapping figure	Total for long-distance migrants
3–18 September 2003		
<i>Iduna caligata</i>	0	572
<i>Acrocephalus dumetorum</i>	5	
<i>Ficedula parva</i>	181	
<i>Carpodacus erythrinus</i>	6	
22 August – 7 October 2004		
<i>Iduna caligata</i>	0	2438
<i>Acrocephalus dumetorum</i>	30	
<i>Ficedula parva</i>	571	
<i>Carpodacus erythrinus</i>	11	
9–17 August 2021		
<i>Iduna caligata</i>	10	215
<i>Acrocephalus dumetorum</i>	17	
<i>Ficedula parva</i>	0	
<i>Carpodacus erythrinus</i>	0	

warblers or booted warblers (Table 1).

Our autumn trapping sessions in 2003–2004 covered the period between 22 August and 7 October. A possibility remained that greenish warblers and booted warblers migrated earlier and complete their passage by 20 August. To test for this possibility, we performed a new series

of captures in mid August.

The study was carried out on 9–17 August 2021 at the Dzhanbybek field station of the Institute for Forest Science, Russian Academy of Sciences (49°24' N 46°48' E). The field station is located on the border between the Volgograd region of Russia and the Western Kazakhstan region of Kazakhstan, in the clay semi-desert 375 km north of the Caspian Sea (Fig. 1). The field station has a forest plantation of very diverse composition, including Pedunculate Oak *Quercus robur*, different maple species *Acer* spp., Horse Chestnut *Aesculus hippocastanum*, White Poplar *Populus alba*, Silver Birch *Betula pendula*, Ash *Fraxinus excelsior*, Red Ash *F. pennsylvanica* and many other species of trees and shrubs (for a more detailed description see Chernetsov et al., 2007). This plantation has a total area of 10 ha and is an artificial oasis in semi-desert, which offers shelter and good foraging opportunities to both insectivorous and frugivorous passerine migrants.

The nets were inspected once per hour from 5:00 to 9:00 and from 17:00 to 20:00 local time. High air temperatures prevented us from mist-netting between 9:00–17:00. Ringing protocol followed the specifications of the ESF project (Bairlein 1995), including the measuring of wing length and fat scoring. Birds were also weighed to the nearest 0.1 g. The overall length of mist nets was c. 50 m in 2021. During the previous trapping sessions the overall length of mist-nets was c. 150 m in 2003 and c. 250 m in 2004 (Chernetsov et al., 2010). It should be mentioned



**Fig. 1.** Map of Eurasia showing the two migratory routes of songbird migrants from Eastern Europe to Indian winter quarters: the direct way across the western part of the arid belt and the way involving the detour and crossing the arid belt in its central or eastern part. The trapping site (Dzhanbybek field station of the Institute of Forest Science of the Russian Academy of Science, 49°24' N 46°48' E) is shown by a triangle. The map is based on <https://www.freeworldmaps.net/asia/asia-physical-map.jpg> © [www.freeworldmaps.net](http://www.freeworldmaps.net) 2005–2021, with permission.

**Table 2**  
Numbers of long-distance passerine nocturnal migrants captured in Dzhanibek on 9–17 August 2021.

Species	Number
Winter quarters in Africa	
<i>Anthus trivialis</i>	2
<i>Luscinia luscinia</i>	4
<i>Locustella fluviatilis</i>	2
<i>Acrocephalus palustris</i>	1
<i>Acrocephalus schoenobaenus</i>	1
<i>Acrocephalus scirpaceus</i>	6
<i>Lanius collurio</i>	3
<i>Phylloscopus trochilus</i>	67
<i>Sylvia nisoria</i>	3
<i>Sylvia borin</i>	33
<i>Sylvia communis</i>	28
<i>Sylvia curruca</i>	25
<i>Muscicapa striata</i>	12
<i>Emberiza hortulana</i>	1
Winter quarters in India	
<i>Acrocephalus dumetorum</i>	17
<i>Iduna caligata</i>	10

that especially in highly fragmented habitats like the one we performed our study in, trapping efficiency is strongly dependent on the position and orientation of particular nets. The same number of nets, placed differently, may have very different trapping efficiency.

We captured 215 individuals of 16 species of long-distance passerine migrants (Table 2). Most common species were Palaearctic-African migrants willow warblers *Phylloscopus trochilus* and garden warblers *Sylvia borin* that also were common in autumn 2004 (252 and 439 out of 3868 songbirds; Chernetsov et al., 2010). Our sample of Indo-European migrants included 17 Blyth's reed warblers and 10 booted warblers *Iduna caligata*. Scarlet rosefinches and greenish warblers were not captured during our August 2021 trapping session.

We suggest that our relatively small sample of woodland songbird migrants adequately reflected the composition of woodland and marshland songbird migrants that made stopover on the northwestern edge of the arid belt of Central Asia. Our earlier field studies showed that relatively large numbers of red-breasted flycatchers and Blyth's reed warblers occur at this site, and probably cross the desert during their post-breeding migration towards south Asian winter quarters. In this study, we recorded booted warblers that apparently also follow this flyway and cross the desert, as also shown by trapping results in Central Asia (Bulyuk, 1985; Yablonkevich et al., 1985).

The absence of red-breasted flycatchers from captures performed in August and of greenish warblers in any part of autumn is apparent (Table 1). Red-breasted flycatchers constituted a significant proportion of long-distance migrants captured in late August – early October (Table 1), and their lack in mid August was probably explained by ringing operation performed too early in the season. Conversely, greenish warblers were not recorded at all. Our 2021 study was specifically designed to test the hypothesis that greenish warblers, not recorded in September or early October 2003 and 2004, migrated through the region earlier in the season. New data allow us to refute this hypothesis. Certainly, the possibility remains that some greenish warblers do migrate from their breeding grounds in European Russia to Indian winter quarters across the arid areas north of the Caspian Sea, but we argue that their numbers are low. The size of the breeding greenish warbler breeding population in European Russia west of the Urals is estimated at 3.2–6 million breeding pairs, whereas the breeding population of booted warblers is estimated at 0.2–2 million pairs (Kalyakin and Voltzit, 2020). Strikingly, we captured 10 booted warblers and not a single greenish warbler.

We captured relatively few scarlet rosefinches in Dzhanibek in autumn (Table 1), especially as compared with the large number of red-breasted flycatchers. Breeding populations of these species in European Russia are estimated at 2.9–5.5 and 1.4–2.5 million breeding pairs,

respectively (Kalyakin and Voltzit, 2020), whereas in autumn in Dzhanibek we captured 6–11 scarlet rosefinches and hundreds of red-breasted flycatchers. Their data suggests that scarlet rosefinches also mainly avoid the western part of the arid belt and proceed towards along its northern edge of the arid zone towards the east and cross the desert east of the Urals. This idea is supported by light-level geolocator tracking data (Lisovski et al., 2021) and by a recovery of a bird ringed in Finland in Kazakhstan at 73° E (Valkama et al., 2014).

In conclusion, European-Indian songbird migrants show different strategies of crossing the arid belt of Kazakhstan and Central Asia between the Caspian Sea and the Altai. Whereas red-breasted flycatchers, Blyth's reed warblers and possibly booted warblers take the shortest route between their (north)east European breeding grounds and Indian winter quarters, scarlet rosefinches and, as we show here, greenish warblers make a detour towards the east before crossing the desert in its eastern part (Fig. 1). These different migratory routes cannot easily be attributed to different foraging ecology and fattening strategies; they might rather be explained by the history of colonization of the forest belt of Eurasia after the most recent glacial event.

### Author contributions

NC designed the study. NC and MM performed the fieldwork. NC wrote the initial draft, which was commented on by MM. Both authors discussed results and assisted in the revisions.

### Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

### Acknowledgements

The authors are most grateful to Victor Bulyuk, Pavel Ktitorov and Ilya Panov who participated in the trapping sessions in 2003–2004. Our thanks are due to Mamay Sapanov and Marina Sizemskaya who made our fieldwork at the Dzhanibek field station of the Institute of Forest Science of the Russian Academy of Science possible. Financial support for this study was made available through the Zoological Institute of the Russian Academy of Sciences (research projects 122031100261-7 and 122031100282-2).

### References

- Bairlein, F., 1995. European–African Songbird Migration Network. Manual of Field Methods. Vogelwarte Helgoland, Wilhelmshaven.
- Bairlein, F., Norris, D.R., Nagel, R., Bulte, M., Voigt, C.C., Fox, J.W., Hussell, D.J.T., Schmaljohann, H., 2012. Cross-hemisphere migration of a 25 g songbird. *Biol. Lett.* 8, 505–507. <https://doi.org/10.1098/rsbl.2011.1223>.
- Bolshakov, C.V., 2002. The Palaearctic–African bird migration system: the role of desert and highland barrier of western Asia. *Ardea* 90, 515–523.
- Bolshakov, C.V., 2003. Nocturnal migration of passerines in the desert-highland zone of western Central Asia: selected aspects. In: Berthold, P., Gwinner, E., Sonnenschein, E. (Eds.), *Avian Migration*. Springer, Berlin, Heidelberg, New York, pp. 225–236.
- Bulyuk, V.N., 1985. Body weight and fat of birds netted in the South-East Karakum Desert and east coast of the Caspian Sea. In: Dolnik, V.R. (Ed.), *Energy Resources of Birds Migrating across the Arid and Mountainous Regions of Middle Asia and Kazakhstan*. Zoological Institute, Leningrad, pp. 98–118.
- Bulyuk, V.N., Chernetsov, N., 2005. Nocturnal passage of passerines in Western Kazakhstan in autumn. *J. Arid Environ.* 61, 603–607. <https://doi.org/10.1016/j.jaridenv.2004.10.013>.
- Chernetsov, N., Bulyuk, V.N., Ktitorov, P., 2007. Migratory stopovers of passerines in an oasis at the crossroads of the African and Indian flyways. *Ring. Migr.* 23, 245–251. <https://doi.org/10.1080/03078698.2007.9674372>.
- Chernetsov, N.S., Bulyuk, V.N., Ktitorov, P.S., 2010. Role of the Dzhanibek oasis as a migratory stopover site for forest passerines. *Povolzhsky Ecological J.* 2, 204–216.
- Dolnik, V.R., 1982. Problems of bird migration across arid and mountainous areas of Middle Asia. *Ornithologia* 17, 13–17 (in Russian).

- Dolnik, V.R. (Ed.), 1985a. Energy Resources of Birds Migrating across the Arid and Mountainous Regions of Middle Asia and Kazakhstan. Zoological Institute, Leningrad (in Russian).
- Dolnik, V.R. (Ed.), 1985b. Spring Nocturnal Bird Passage over Arid and Mountainous Areas of Middle Asia and Kazakhstan. Zoological Institute, Leningrad (in Russian).
- Dolnik, V.R., 1990. Bird migration across arid and mountainous regions of Middle Asia and Kazakhstan. In: Gwinner, E. (Ed.), Bird Migration. Springer, Berlin, Heidelberg, New York, pp. 368–386.
- Kalyakin, M.V., Voltzit, O.V. (Eds.), 2020. Atlas of the Breeding Birds of European Part of Russia. Fiton XXI, Moscow.
- Lisovski, S., Neumann, R., Albrecht, T., Munclinger, P., Ahola, M.P., Bauer, S., Cepak, J., Fransson, T., Jakobsson, S., Jaakkonen, T., Klvana, P., Kullberg, C., Laaksonen, T., Metzger, B., Piha, M., Shurulinkov, P., Stach, R., Ström, K., Velmala, W., Briedis, M., 2021. The Indo-European flyway: opportunities and constraints reflected by common rosefinches breeding across Europe. *J. Biogeogr.* 48 (6), 1255–1266. <https://doi.org/10.1111/jbi.14085>.
- Sokolovskis, K., Bianco, G., Willemoes, M., Solovyeva, D., Bensch, S., Åkesson, S., 2018. Ten grams and 13,000 km on the wing – route choice in willow warblers *Phylloscopus trochilus yakutensis* migrating from Far East Russia to East Africa. *Mov. Ecol.* 6, 20. <https://doi.org/10.1186/s40462-018-0138-0>.
- Valkama, J., Sauola, P., Lehtikoinen, A., Lehtikoinen, E., Piha, M., Sola, P., Velmala, W., 2014. The Finnish Bird Ringing Atlas, vol. II. Finnish Museum of Natural History and Ministry of Environment, Helsinki.
- Yablonkevich, M.L., Bolshakov, C.V., Bulyuk, V.N., Eliseev, D.O., Efremov, V.D., Shamuradov, A.K., 1985. Body weight and fat of birds passing across the Middle Asia deserts in spring. In: Dolnik, V.R. (Ed.), Energy Resources of Birds Migrating across the Arid and Mountainous Regions of Middle Asia and Kazakhstan. Zoological Institute, Leningrad, pp. 11–59.