

Short Note

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Bats can migrate farther than it was previously known: a new longest migration record by Nathusius' pipistrelle *Pipistrellus nathusii* (Chiroptera: Vespertilionidae)

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Abstract: Bat migrations have been studied for a long time, but large areas remain poorly explored in this regard. This note reports a record migration distance of the Nathusius' pipistrelle – 2486 km from Russia to the French Alps. This distance exceeds the previous record flight from Latvia to Spain by 260 km. Hibernating colonies of Nathusius' pipistrelle are known in the Caucasus. However, our data show that Nathusius' pipistrelle can fly much longer for hibernating.

Keywords: distance; France; migration; record; Russia.

Bat migrations have been studied for a long time (Hutterer et al. 2005), but information about this phenomenon is coming slowly, and the migration routes have not been fully identified. Large areas outside Europe and North America remain poorly explored in this regard (Fleming 2019). There is some lack of knowledge even in different parts of Europe, due to the lack of bat banding in most countries (Hutterer et al. 2005). Although interest in bat migrations has grown rapidly over the last decades (Popa-Lisseanu and Voigt 2009), this is mostly due to the development of wind farms

(Lehnert et al. 2014). Wind turbines cause large numbers of bat fatalities (Rydell et al. 2010), and migration routes studies are important in order to plan the location of new wind farms and implement mitigation measures (Thaxter et al. 2017).

In temperate climates, bat migrations are usually associated with suitable hibernation sites (Hutterer et al. 2005). If bats hibernate in cool underground shelters or are cold-hardy, they can hibernate in cold climates. Migrations of such bats usually do not exceed tens of kilometres, rarely up to 350 km for the pond bat *Myotis dasycneme* (Haarsma et al. 2019) or up to 450 km for the northern bat *Eptesicus nilssonii* (Hutterer et al. 2005). However, if bats prefer shallow shelters (hollows, shallow cavities) and need a relatively high ambient temperature during hibernation, then they migrate much further (Popa-Lisseanu and Voigt 2009). In Europe, such species include noctule bats *Nyctalus* spp., pipistrelle bats *Pipistrellus* spp. and particoloured bat *Vespertilio murinus* (Dietz and Kiefer 2016). According to ringing data, these species often fly over several hundred kilometres, rarely more than 1000. Similar information is known for North American migratory species (Cryan et al. 2014; Ellison 2008). In the tropics, some bats feeding on nectar or fruits can also migrate seasonally over distances up to 2000 km (Richter and Cumming 2008): if in neighbouring territories flowering and fruiting of plants occurs at different times (Fleming 2004, 2019).

A record migration distance of 2224 km was recently described: a Nathusius' pipistrelle *Pipistrellus nathusii* ringed in 2015 in Latvia was caught in Spain in 2017 (Alcalde et al. 2021). However, it has now become clear that bats fly over greater distances in approximately this direction. We ringed a yearling female Nathusius' pipistrelle in the North-West of Russia, and it flew away at least 2486 km to the French Alps in 63 days (Figure 1). Ringing was performed on July 25 2009 in the vicinity of the village of Borok in the Darwin Nature Biosphere Reserve in the south of the Vologda region (N 58° 34' 14"; E 037° 33' 17").

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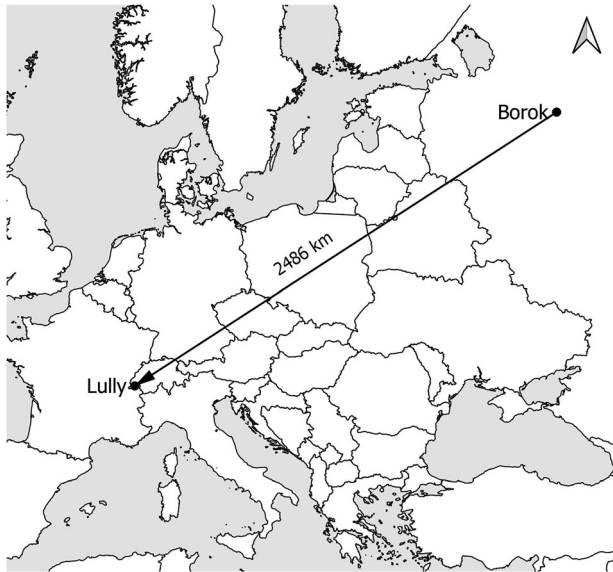


Figure 1: Long-distance movement of a Nathusius' pipistrelle *Pipistrellus nathusii* from Borok (Russia) to Lully (France).

Its carcass was found in Lully (Haute-Savoie, France) in a water tank near houses on September 25 2009 (N 46° 17' 01"; E 006° 24' 54"). There are three other long-distance Nathusius' pipistrelles evidences (2 males and 1 female) in the vicinity of Lully. All three individuals were ringed in Germany 860–930 km northeast of the recovery site (Desmet 2016).

The distance of 2486 km is the shortest distance between the ringing and death places of the animal. Obviously, bats do not fly in straight line. Their migrations follow routes that are partly directed by the shores of large water streams (Cortes and Gillam 2020; Heist et al. 2018). The Baltic Sea coast can be such a guiding line for bats. Bat concentrations have been observed at bird ringing stations located in this region during the migratory season (Markovets et al. 2004). We suspect that our bat also used this path. In this case, it turns out that it has flown at least 3000 km.

A total of 237 bats of 7 species were ringed in the Darwin Reserve in 2006–2010. We received 10 recoveries of bats of 3 species (*M. daubentonii*, *Nyctalus noctula*, *P. nathusii*) besides the mentioned record, all of them near the ringing site. Therefore, other directions of bats migration remain unknown. It seems that yearling female Nathusius' pipistrelle ringed in Darwin Reserve should fly south to the Caucasus, because it is much closer than the French Alps. Wintering colonies of Nathusius' pipistrelle are known in the Caucasus (Ivanitskiy 2018; Rakhmatulina 2005), but it is unknown whether bats arrive there from the northern part of the range. Other returns of ringed bats in

Russia indicate that there are both southwestern and southern directions of migration (Hutterer et al. 2005). However, the small number of recoveries makes it too difficult to describe the migration paths in detail.

It is likely that the longest migration record flight from the Darwin Reserve to Lully is not the limit for the migratory flight. If Nathusius' pipistrelles reach Spain from the Baltic countries (Alcalde et al. 2021), it is possible that they can also fly from neighbouring regions of Russia (Kruszynski et al. 2021). The migration distance is growing towards the centre of Eurasia due to the cold continental climate. Our bat shows that they do not always choose the nearest places with a suitable climate and are physically able to travel thousands of kilometres. We do not know why the yearling female *P. nathusii* used such a long and seemingly "suboptimal" migrating route. Perhaps this is a deviation from the common migration routes of this species, or perhaps it is more common than we might think. It is possible that bats migrate over almost the entire range. The range of Nathusius' pipistrelle reaches the Urals in the east (Dietz and Kiefer 2016), and it turns out that in this case bats can migrate over most of Europe.

Most likely, other bats of the temperate zone of Europe and Asia also fly farther than shown in the known records. This is indirectly confirmed by the data on panmixia of the Noctule bat (Petit and Mayer 1999). Isolation of populations is not observed within most of the European range for this species. This is not surprising because there are few geographic obstacles for flying animals. We can expect new longest migration records of different species of bats from the interior regions of Eurasia with a continental climate. Some of them have very large ranges, they cover the whole of Europe or even southern Siberia and part of the Far East (Dietz and Kiefer 2016; Kruskop et al. 2012). Short summers and low temperatures constraints govern the lives of bats at the northeastern and northern range boundaries (Michaelsen 2016). Migratory species have to travel long distances to reach areas suitable for wintering. Migration direction choice is still unknown. Therefore, further studies of bat migrations are required in order to identify migration routes, and also go into details regarding the orientation system of bats (Genzel et al. 2018; Lindecke et al. 2019). This is very important for species facing threats of increasing wind farms all over Europe.

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