The longest migrations of three bat species to the "Nietoperek" bat reserve (Western Poland)

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With 1 map and 1 table

Summary

This paper reports the longest migration distances found for three bat species hibernating in the "Nietoperek" bat reserve in West Poland.

The longest migration distance of Daubenton's bat (Myotis daubentonii) was 257 km covered by a juvenile female ringed in a breeding colony in Wooster Teerofen (Mecklenburg) (flight direction →SE). For Brandt's bat (Myotis brandtii) the longest migration was 242.1 km, in an easterly direction. The adult female had been ringed at a summer breeding colony in Kannenberg (Saxony-Anhalt). The distances recorded for the mouse-eared bat (Myotis myotis) ranged from 226.7 km (→ESE direction) (adult female ringed at its winter roost in Waren, Mecklenburg) to 95.9 km (→ENE direction) (juvenile female from a breeding colony in Beeskow, Brandenburg). The long migrations of the three bat species from Germany to the "Nietoperek" bat reserve (which were recorded during both previous and current studies), confirmed the importance of this hibernation site for bat populations in a large area of the Central-European lowlands. Therefore, bat protection in the relatively small area of the Międzyrzecz Fortified Front, where the "Nietoperek" bat reserve is situated, has had a big impact on the survival of bat populations inhabiting of Central European bat populations.

Zusammenfassung

Der Artikel berichtet über die weitesten nachgewiesenen Wanderstrecken von drei Fledermausarten, welche im Fledermausschutzgebiet „Nietoperek“ in Westpolen überwintern.

Die weiteste Wanderung einer Wasserfledermaus (Myotis daubentonii) betrug 257 km (Flugrichtung NW→SE) und betraf ein in einer Wochenstube in Wooster Teerofen (Mecklenburg) beringtes juveniles Weibchen. Die größte von einer Großen Bartfledermaus (Myotis brandtii) zurückgelegte Entfernung betrug 242,1 km (W→E). Das adulte Weibchen war in einer Wochenstubenkolonie in Kannenberg (Sachsen-Anhalt) beringt worden.

Mausohren (Myotis myotis) kamen aus Distanzen zwischen 226.7 km (NWW→SEE, adultes Weibchen, beringt in einem Winterquartier in Waren, Mecklenburg) und 95,9 km (SWW→NEE, juveniles Weibchen aus einer Wochenstubenkolonie in Beeskow, Brandenburg) nach „Nietoperek“.

Die im Verlauf der vorliegenden Studie sowie bei früheren Untersuchungen erfassten großen Migrationsdistanzen der drei Fledermausarten von Deutschland zum Fledermausschutzgebiet „Nietoperek“ belegen die Bedeutung dieses Winterquartiers für die Fledermauspopulation in einem großen Gebiet des mitteleuropäischen Tieflands. Demnach hat der Fledermausschutz auf der vergleichsweise kleinen Fläche der Festungsfront im Gebiet Międzyrzecz einen großen Einfluss auf den Erhalt mitteleuropäischer Fledermauspopulationen.
Key words: bats, Myotis daubentonii, M. brandtii, M. myotis, migrations, bat protection, "Nietoperek" bat reserve

1 Introduction

In autumn and winter, the significant decrease of insect densities reduces the food supply for insectivorous bats inhabiting temperate zones. In the cold season of the year, bats do not have enough energy to cover the high energetic cost of flight and increased cost of thermoregulation at low ambient temperature (GRIFFIN 1986, SPEAKMAN & RACEY 1991, SPEAKMAN 1997). To avoid the energy stress in winter, bats migrate in late summer and autumn either to areas where warm climate and the presence of insects make foraging possible, or to underground places where they can hibernate reducing energy demands (DAVIS & HITCHCOCK 1965, STRELKOV 1969, PETIT 1998, HARMATA & HÄNSEL 1996, STEFFEWS et al. 2004). In spring, bats migrate back to the places left in late summer and autumn, to give birth and raise their offspring. For many bat species, mating occurs shortly before hibernation, mainly between September and November, which results in large aggregations of individuals, inside and around underground sites. Bats often migrate long distances from very large areas to such swarming places (PARSONS et al. 2003). Therefore, the protection of underground sites is also crucial for bat conservation.

Ringing is a good and relatively harmless method to use when investigating bat migrations. It began in the United States of America, where A. A. Allen ringed 6 individuals of Pipistrellus subflavus in 1916. In Europe, bat ringing began in 1932, first in Germany and Sweden, later in other countries: in the Netherlands (1936), the Soviet Union (1937), Belgium and Poland (1939) and in 1940 in Bulgaria (KOWALSKI et al. 1957). From 1964 to 2000, 87 452 bats belonging to 20 species were ringed in East Germany and all information concerning the recaptured individuals was accumulated by the Bat Ringing Centre in Dresden (Fledermausmarkierungszentrale, Dresden) (STREET et al. 2004). These conditions opened up an opportunity to study bat migrations on large scale, especially migration to neighbouring countries. The systematic study of bat migrations from Germany to Poland undertaken between 1975 and 1994 (HARMATA & HÄNSEL 1996) and accidental observations (URBANCKY 1991, KOKUREWICZ 2000) proved that a few bat species migrate to Międzyrzecz Fortified Front (Festungsfront im Oder-Warthe-Bogen) (West Poland), where the "Nietoperek" bat reserve is situated. This phenomenon has not been studied systematically since 1994.

In lowland areas, bats find only few proper hibernation places; the situation is different in the mountains and uplands, where natural and artificial caves can be found. Therefore the bunkers and tunnels of the Międzyrzecz Fortified Front are very important for bats arriving there from a large area of the entire belt of Central-European lowlands. Thus, the bat protection in the Międzyrzecz undergrounds is of international importance.

The aims of the study were to describe the longest distances of migrations of particular bat species, from all geographical directions, to the "Nietoperek" bat reserve. This data would allow the evaluation of the importance of this hibernaculum for Central European bat populations.

2 Materials and Methods

Study area

Międzyrzecz Fortified Front (M.F.F) (15°32'E; 52°25'N), was built by the Germans in the 1930s and during World War II. Its Central Sector (Abschnitt Hochwalde), 15 km long, was especially studded with above-ground fortification objects, connected by the system of underground corridors totalling 32 km in length and the surface area being 7.5 hectares (WOŹNIAK 1996). After the World War II, the underground fortifications were deserted and
became the largest bat hibernaculum in Central Europe. The maximum number of hibernating bats, 32,537 individuals, was recorded on 14th January 2006. Until now, 12 species (Myotis bechsteinii, M. brandtii, M. dasycneme, M. daubentonii, M. myotis, M. mystacinus, M. nattereri, Pipistrellus pipistrellus, Eptesicus serotinus, Barbastella barbastellus, Plecotus auritus and P. austriacus) were found hibernating there. The next one, northern bat (Eptesicus nilssonii), was recorded in the area of M.F.F., but is still not recorded in the main underground system (KOKUREWICZ 1996, KOKUREWICZ unpublished observations).

In 1980, approximately one third of the surface area of corridors became protected under the “Nietoperek” bat reserve. In the early 1990s, due to the increased tourist movement and the modest area actually covered by the reserve, the protection of bats seemed to be insufficient. In September 1997, the “Natural-Landscape Complex” was created to protect the bat's maternity colonies, feeding grounds, migratory routes and surrounding underground fortifications – an area of 5117.72 hectares. In January 1998, in the village “Nietoperek”, a Chiropterological Station was created, to increase the protection of bats in the M.F.F., to develop the education programmes and to support the study of bats. The preparation of the “Nietoperek Management Plan” began in October 1998 and as a result, the remaining 67 % of underground corridors became protected as bat reserve “Nietoperek II” in December of the same year. The Plan was finally accepted as local law in June 2000. In 2002, both bat reserves situated in M.F.F. were combined into one, and named “Nietoperek”.

Four bat species hibernating in the M.F.F. are included in Appendix II of the EC Directive on the Conservation of Natural Habitats and of Wild Fauna and Flora (92/43/EEC). They are recorded to be species demanding the creation of special areas of conservation (SAC) in a Natura 2000 network. In 2004, after Poland joined the European Union, the “Nietoperek” bat reserve and the area surrounding the undergrounds were included into the Natura 2000 network (area code: PLH080003).

Data collection
The information concerning bat migrations to the “Nietoperek” bat reserve were collected from all available published and unpublished data sources. The ring numbers of bats hibernating in “Nietoperek” were accidentally recorded during winter bat censuses in 1999–2006 and during a systematic survey carried out on 18–19 February and 11–12 March 2006, under the license of Polish Ministry of Environment (licence no. IDOPogiz – 4200/IV.D – 01/89000/05/aj). All bats captured in "Nietoperek" were ringed in Germany and the information concerning the date and place of ringing, migration distance and direction were obtained from identification cards kindly provided by the Fledermausmarkierungszentrale in Dresden (see acknowledgements).

3 Results

Daubenton’s bat (Myotis daubentonii)

The longest migration distance of this species to the “Nietoperek” bat reserve was 257 km. The juvenile female was ringed in a breeding colony in Wooster Teerofen (Mecklenburg) and was found hibernating in Nietoperek (URBANČZYK 1991). The direction of flight was NW→SE (tab. 1, map 1). The migration distance estimated by URBANČZYK (1991) was 260 km.
Tab. 1: The longest migrations of bats to the "Nie toperek" bat reserve. F – female, M – male, J – juvenile individual, AD – adult individual.

<table>
<thead>
<tr>
<th>No.</th>
<th>Species &amp; ring number</th>
<th>Sex &amp; age</th>
<th>Date, place of ringing, geographic co-ordinates of place of ringing and type of roost</th>
<th>Date, place of recapture, geographic co-ordinates of recapture location and type of roost</th>
<th>Distance (km) &amp; direction of migration</th>
<th>Data source</th>
<th>Ringer</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.</td>
<td>Myotis myotis X62562</td>
<td>F/AD</td>
<td>18.02.1990 Strasburg 13°45'E 53°31'N winter roost</td>
<td>Nietoperek 15°32'E 52°25'N winter roost</td>
<td>70.9 NW → SE</td>
<td>HARMATA &amp; HAIENSEL 1996</td>
<td>Dr. G. Heise</td>
</tr>
<tr>
<td>7.</td>
<td>Myotis myotis X62354</td>
<td>M/J</td>
<td>03.03.1988 Bln.-Friedrichshagen 13°39'E 52°27'N winter roost</td>
<td>Nietoperek 15°32'E 52°25'N winter roost</td>
<td>127.7 W → E</td>
<td>HARMATA &amp; HAIENSEL 1996</td>
<td>Dr. J. Haensel</td>
</tr>
<tr>
<td>8.</td>
<td>Myotis myotis A18525</td>
<td>F/J</td>
<td>23.07.1999 Beeskow, Niewisch 14°14'E 52°05'N breeding colony</td>
<td>Nietoperek 15°32'E 52°25'N winter roost</td>
<td>95.9 SWW → NEE</td>
<td>Fledermaus-markierungs-zentrale, Dresden</td>
<td>Dr. A. Schmidt</td>
</tr>
</tbody>
</table>

Brandt’s bat (Myotis brandtii)

The adult female of this species, ringed in a summer breeding colony in Kannenberg (Saxony-Anhalt) migrated 242.1 km east (W→E) to the "Nie toperek" bat reserve, where it was found hibernating on 15th January 2005 (tab. 1, map 1).
Mouse-eared bat (*Myotis myotis*)

The longest migration distance of this species to the "Nietoperek" bat reserve was 226.7 km. The adult female was ringed in the winter roost in Waren (Mecklenburg) and after six years was found hibernating in the "Nietoperek" bat reserve (Kokurewicz 2000). The recorded flight direction was NWW→SEE (tab. 1, map 1). Another two exceptionally long flights were also recorded from Mecklenburg. The first one concerned a juvenile male, ringed in a maternity colony in Burg Stargard on 24th July 2004 and was found hibernating in January 2006 in the "Nietoperek" bat reserve. The direction of this migration was NW→SE and its distance was 191.2 km (tab. 1, map 1). The second one was made by an adult female, ringed on 18th February 1990 in the winter roost in Strasburg and after four years was found wintering in the "Nietoperek" bat reserve (Harmata & Haensel 1996). The migration distance of this individual was 170.0 km, and its direction was NW→SE (tab. 1, map 1).
The longest migration from NNW direction (NNW→SSE) was observed from autumn transitory roost. The adult male ringed on 20th September 1999 in Szczecin (W Poland) flew 130.9 km and spent the winter season 2005/2006 in the "Nietoperek" bat reserve (tab. 1, map 1). The longest migration distance from an easterly direction (W→E) was made by a juvenile male ringed in the winter roost in Berlin-Friedrichshagen (HARMATA & HAENSEL 1996). Its length was 128.0 km (tab. 1, map 1). The longest migration distance from a SWW direction (SWW→NEE) was made by a juvenile female ringed in a breeding colony in Beeskow (Brandenburg). The length of this flight was 95.9 km (tab. 1, map 1).

4 Discussion

Daubenton's bat is considered to be a sedentary species, performing short distance migration between summer and winter roosts (BOGDANOWICZ 1994). In the United Kingdom, its migrations did not exceed 19 km (SPEAKMAN 1991), while in the eastern part of Germany, 84 % of all flights were recorded to be between 0.5 and 88.0 km long (HAENSEL 1978). The migration distance of 257 km, estimated by URBANCZYK (1991) at 260 km, is the longest recorded for this species (BOGDANOWICZ 1994).

Brandt's bat is also considered to be a sedentary species. The longest movement known in Europe (800 km) was made by an individual ringed in Lithuania and recaptured in the Czech Republic (PAUZA pers. comm., in: RODRIGUES et al. 2002). The migration from the summer breeding colony in Kannenberg (Saxony-Anhalt) to the "Nietoperek" bat reserve (242.1 km, W→E) is the second longest recorded so far in Europe. Knowledge on the migratory behaviour of this species is poor, because the majority of data was gathered before the taxonomic segregation of Myotis mystacinus and M. brandti.

The Mouse-eared bat is known to regularly migrate between summer and winter roosts (RODRIGUES et al. 2002). The longest movement known in Europe is 390 km and was recorded in Spain (PAZ et al. 1986). During the migration study of this species made in Poland between 1939 and 1953, the long migration distances recorded were 233 and 146 km. These two individuals were ringed in August in Kraków and in Tarnów (S. Poland) and recaptured in hibernation sites in Szokolya (Hungary) and in Stos (Slovakia) (KOWALSKI et al. 1957). Comparing the longest movements of this species known in Europe (PAZ et al. 1986) and previously recorded in Poland (KOWALSKI et al. 1957) with the longest migration distance of this species to the "Nietoperek" bat reserve (226.7 km, tab. 1) we can expect that mouse-eared bats could migrate to "Nietoperek" from longer distances than recorded so far. However, the analysis of the map presented by STEFFENS et al. (2004) showed that mouse-eared bats ringed in southern parts of Saxony and Saxony-Anhalt, did not migrate to "Nietoperek" for winter. It is possible that this was caused by the presence of hibernation sites in the Sudety Mountains located closer to other ringing locations than the "Nietoperek" bat reserve. This presumption is consistent with the suggestion that the length of migrations of mouse-eared bats depends on the distance of suitable winter roosts (RODRIGUES et al. 2002). If this assumption is correct, we can begin to understand the changes of winter roosts observed in M. mystis during both previous (HARMATA & HAENSEL 1996) and current studies. Three records of bats ringed in winter roosts in Germany and found hibernating in the "Nietoperek" bat reserve (tab. 1) prove that mouse-eared bats could change their winter roosts after some years. Due to the severe, continental climate in Eastern Europe, the dominant direction of bats migration is NE→SW (STRELCOV 1969). During the present study, the migrations in opposite directions (SWW→NEE and W→E) were observed (tab. 1, map 1). The microclimatic conditions i.e. ambient temperature from 0° C to 10° C, relative humidity exceeding 100 % and slow air flow, in the underground tunnels of "Nietoperek" bat reserve are very favourable for hibernating bats. Additionally, prior to hibernation, bats can forage and effectively accumulate fat in the mixed forests, lakes and artificial canals surrounding "Nietoperek" (KOKUREWICZ 1996, ŁUPICKI & KOKUREWICZ 1995, DUDARZ 2005). The results of winter bat censuses in M.F.F. demonstrated that the number of mouse-eared bats has been constantly increasing since 1985 (KOKUREWICZ, unpublished observations). This seems to confirm the assumption of immigration of mouse-eared bats from border areas of Germany to
"Nietoperek", first proposed by HARMATA & HAENSEL (1996). This assumption, however, needs confirmation through a further study. The confirmation also needs to address the suggestion that mouse-eared bats hibernating in "Nietoperek" are not returning to summer colonies in Germany, but give birth and raise their offspring in Poland, closer to their hibernation site (HARMATA & HAENSEL 1996).

The long migrations of three bat species from border areas of Germany to the "Nietoperek" bat reserve recorded during previous (HARMATA & HAENSEL 1996) and current studies have demonstrated the importance of this hibernation site for the existence of bat populations in large areas of Central-European lowlands. Therefore, bat protection in a relatively small area of the Międzyrzecz Fortified Front, has made a big impact on survival of bat populations inhabiting Central Europe.

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