

45 years of bat study and conservation in Nietoperek bat reserve (Western Poland)

VON TOMASZ KOKUREWICZ¹, GRZEGORZ APOZNAŃSKI¹, RALF GYSELINGS², LUCINDA KIRKPATRICK³, LUC DE BRUYN^{2,3}, JOHN HADDOW⁴, ANITA GLOVER⁵, HENRY SCHOFIELD⁵, CHRISTIANE SCHMIDT⁶, FONS BONGERS⁷, LAURA TORRENT⁸ & ALEK RACHWALD⁹

¹ Wrocław University of Environmental and Life Sciences, Institute of Biology, Department of Vertebrate Ecology and Paleontology, Wrocław, Poland, E-Mail: tomasz.kokurewicz@upwr.edu.pl

² Research Institute for Nature and Forest (INBO), Brussels, Belgium

³ Evolutionary Ecology Group, Department of Biology, University of Antwerp, Antwerp, Belgium

⁴ Auritus Wildlife Consultancy, Dunblane, United Kingdom

⁵ The Vincent Wildlife Trust, Eastnor, United Kingdom

⁶ Expert Group Bat Conservation, Dresden, Germany

⁷ JP Ouderkerk a/d Amstel, Netherland

⁸ Natura Montfred, Girona, Spain

⁹ Forest Research Institute, Forest Ecology Department, Sękocin, Poland

45 Jahre Fledermausforschung und Fledermausschutz im Fledermausschutzgebiet Nietoperek (West-Polen)

Abstract

The 100 km long Międzyrzecz Fortified Front, Ostwall or Festungsfront im Oder-Warthe Bogen, is located between the rivers Odra in the south and Warta in the north and was built by Germany in 1934 – 1944. The Central Sector “Wysoka” (Zentralabschnitt or Abschnitt Hochwalde), starting south of Staropole, and ending on the lake Kursko, only ca. 15 km long, was to have a concentration of fortifications. It is a system of concrete tunnels with a total length of ca. 32 km situated 20-30 m underground. The axis of the underground system called the “main road” has a narrow gauge railway and runs from north to south and includes 10 wider “railway stations” (Bahnhof), which allowed small electric trains to pass in opposite directions. The smaller side corridors connect the main road to above ground bunkers (Panzerwerk) situated on the eastern part of the fortification system. Currently the access for bats into the underground system is through 25 surface bunkers, through two drain-

nage corridors located on the northern and southern ends of the tunnel system, and also via two ventilation shafts and a 1.43 km long side corridor (“Wysoka corridor”, named after the nearest village) sloping upwards from the main corridor to the surface. The major part of the system has a stable microclimate, but a dynamic microclimate is found near the entrances of the system and in the Wysoka corridor. The drainage system of the underground was destroyed after the war, which resulted in flooding of parts of the northern tunnels while drying out the southern part of the system. The underground system provides a wide range of temperature and relative humidity (0 – 10°C and 40 – 100% respectively) for hibernating bats. The value of the underground system for bats was first discovered in 1974 by late Dr. ZBIGNIEW URBAŃCZYK, ELŻBIETA BAGROWSKA-URBAŃCZYK, Prof. WIESŁAW BOGDANOWICZ and others. They started systematic studies of bats in 1975 and published the first short paper in 1976 (see the

selected literature below). So far 12 species have been found hibernating there and one more (the northern bat, *Eptesicus nilssonii*) regularly roosts in much cooler stand alone bunkers not connected with the underground system. According to the data of the EURO-BATS Agreement it is ranked in top 10 largest hibernation sites in Europe. The numbers of hibernating bats exceeds 39 000 individuals in some years. In 2007 the Central Sector "Wysoka" (52°25'N, 15°32' E) with the surrounding surface area of 7377.37 ha became protected as Natura 2000 site PLH080003 "Nietoperek". Ringing data collected by bat ringing center (Fledermausmarkierungszentrale Dresden) evidenced that bats migrate to "Nietoperek" from the large area of Central European Lowlands. The longest migration distances of bats from eastern part of Germany to "Nietoperek" are 257 km for *Myotis daubentonii*, 226.7 km for *M. myotis* and 242.1 km for *M. brandtii*. The role of "Nietoperek" for bats is the best shown by the estimation of minimum area of migration of the bats, mainly greater mouse-eared bat (*Myotis myotis*), to that hibernation site. The minimal convex polygon (MCP) based on the recaptured individuals was estimated as at least 17 000 km² and covers large part of Land Brandenburg, Mecklemburg-Vorpommern, Sachsen-Anhalt and also western Poland (Lubuskie, Wielkopolskie and Zachodniopomorskie Voyvodships). For these reasons, the protection of bats in the relatively small area of

"Nietoperek" is of key importance for conservation of the population of at least nine species of bats in Central Europe. "Nietoperek" combines the best preserved military fortification system in Europe with a large bat hibernation site and its surrounding well preserved natural habitats, under protection of the European Ecological Network Natura 2000. This place is also a good example of international co-operation in bat conservation and its current favourable conservation status was established as a result of endeavours of bat workers from Poland, Germany, UK, Belgium, Holland and other EU countries. In this article we present the results of the bat monitoring programme carried out in "Nietoperek" since 1999, and also projects on the selection of microclimatic conditions by bats and the changes of microclimatic conditions underground, probably caused by global warming (the "logger project"), "White Nose Syndrome" study, a swarming project, predation by martens and raccoon on hibernating bats, a preliminary summer study, and finally projects on bat friendly tourist use of "Nietoperek", that will hopefully lead to a balance between bat conservation and increasing tourism in the fortifications.

Key words

bats, Nietoperek, Natura 2000, bat conservation, climate change

Zusammenfassung

Die 100 Kilometer lange Międzyrzecz-Festungs-Front, Ostwall oder Festungsfront im Oder-Warthe Bogen genannt, liegt zwischen der Oder im Süden und der Warthe im Norden und wurde 1934 - 1944 unter deutscher Besatzung erbaut. Der zentrale Sektor „Wysoka“ (Zentralabschnitt oder Abschnitt Hochwalde), der südlich von Staropole beginnt und am nur ca. 15 km langen Kursko-See endet, sollte besonders mit Festungsobjekten versehen werden. Es handelt sich um ein System von Beton-Eisenbahntunneln mit einer Gesamtlänge von

ca. 32 km in 20-30 m Tiefe. Die Achse des unterirdischen Systems „Hauptstraße“ hat eine Schmalspurbahn und verläuft von Nord nach Süd und umfasst 10 breitere Bahnhöfe, die es kleinen Elektroziügen ermöglichten, in entgegengesetzte Richtungen zu fahren. Die kleineren Seitengänge verbinden die Hauptstraße mit oberirdischen Bunkern (Panzerwerk) im östlichen Teil des Befestigungssystems. Derzeit erfolgt der Zugang für Fledermäuse in das unterirdische System über 25 oberirdische Bunker, über zwei Entwässerungskorridore am



Fig. 1: Bunker PzW 716 – one of the entrances to the main underground system of „Nietoperek“ bat reserve.

Abb. 1: Bunker PzW 716 - einer der Eingänge zum unterirdischen Hauptsystem des Fledermausreservats „Nietoperek“ (Foto: JENS RYDELL).

nördlichen und südlichen Ende des Tunnelsystems sowie über zwei Lüftungsschächte und einen 1,43 km langen Seitenkorridor („Wysoka-Korridor“, benannt nach dem nächstgelegenen Dorf), der vom Hauptkorridor nach oben verläuft. Der größte Teil des Systems hat ein stabiles Mikroklima, aber ein dynamisches Mikroklima findet sich in der Nähe der Eingänge des Systems und im Wysoka-Korridor. Das Entwässerungssystem des Untergrundes wurde nach dem Krieg zerstört, was zu einer Überschwemmung des nördlichen Teils der Tunnel führte, während der südliche Teil austrocknet ist.

Die untertägigen Bereiche bieten einen weiten Temperatur- und Luftfeuchtigkeitsbereich (0 - 10°C und 40 - 100%) für überwinterte Fledermäuse. Bisher wurden dort 12 Arten im Winterschlaf gefunden und eine weitere Art (Nordfledermaus, *Eptesicus nilssonii*) schläft regelmäßig in viel kühleren, eigenständigen Bunkern, die nicht mit dem Hauptsystem verbunden sind. Nach den Daten des EURO-BATS-Abkommens rangiert das Nietoperek-Schutzgebiet unter den Top 10 der größten

Überwinterungsgebiete Europas. Die Zahl der im Winterschlaf befindlichen Fledermäuse übersteigt in einigen Jahren 39 000 Individuen.

Im Jahr 2007 wurde der Zentralsektor „Wysoka“ (52°25'N, 15°32' E) mit einer Fläche von 7.377,37 ha als Natura 2000-Gebiet PLH080003 „Nietoperek“ geschützt. Die von der Fledermausmarkierungszentrale (Dresden) erhobenen Ringdaten belegen, dass viele Fledermäuse aus dem großen Gebiet der mitteleuropäischen Tiefebene nach „Nietoperek“ wandern. Die längsten Wanderwege von Fledermäusen aus Ostdeutschland nach „Nietoperek“ betragen 257 km für *Myotis daubentonii*, 226,7 km für *M. myotis* und 242,1 km für *M. brandtii*. Die Bedeutung von „Nietoperek“ für die Fledermäuse ist am besten durch die Schätzung der minimalen Migrationsfläche der Fledermäuse dargestellt, hier hauptsächlich die des Großen Mausohrs (*Myotis myotis*). Das sogenannte Minimal-Convex-Polygon (MCP), das auf den wiedergefangenen Individuen basiert, wurde auf mindestens 17 000 km² geschätzt und umfasst einen großen Teil des Landes Brandenburg, Mecklenburg-Vorpommern,

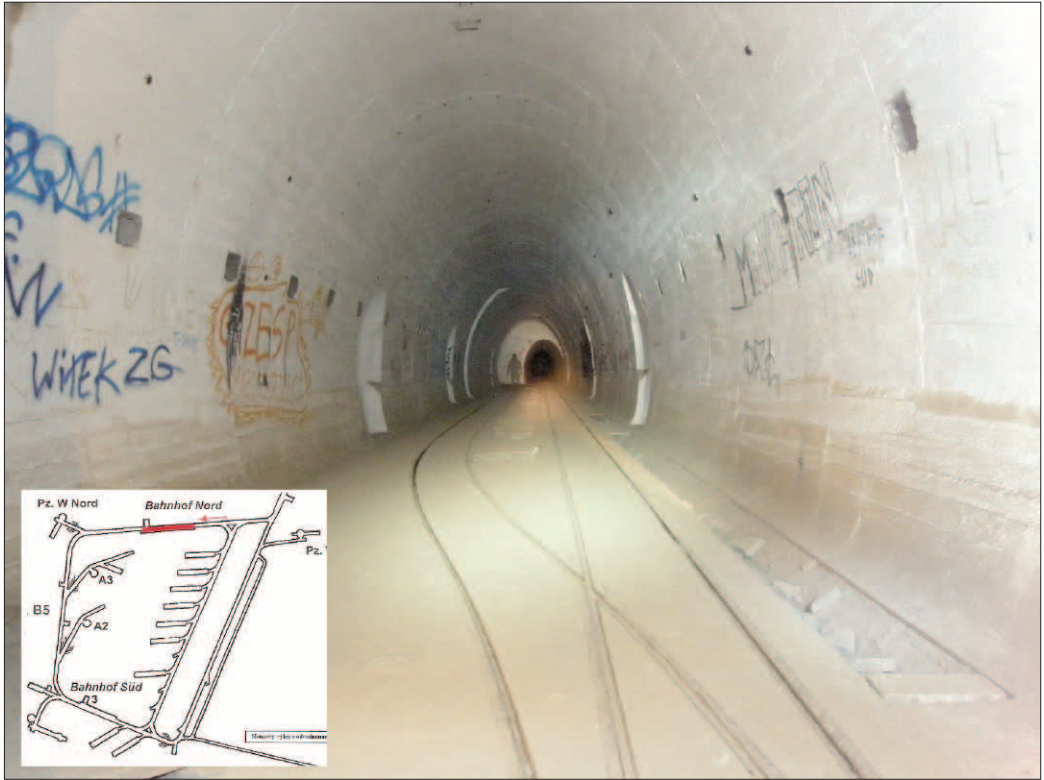


Fig. 2: Underground railway station „Bahnhof Nord“ in Borysżyńska Loop in southern part of the underground system.
 Abb. 2: Untergrund „Bahnhof Nord“ in der Borysżyńska Schleife im südlichen Teil des Untergrund-Systems (Foto: PETER SUCHÁNEK)

Sachsen-Anhalt und auch Westpolen (Lubuskie, Wielkopolskie und Zachodniopomorskie Voyvodships). Aus diesen Gründen ist der Schutz von Fledermäusen im relativ kleinen Gebiet von „Nietoperek“ von wichtiger Bedeutung für die Erhaltung der Population von mindestens neun Fledermausarten in Mitteleuropa. „Nietoperek“ vereint das besterhaltene militärische Befestigungssystem Europas mit einem großen Fledermauswinterschlafgebiet und gut erhaltenen natürlichen Lebensräumen, die im europäischen ökologischen Netzwerk Natura 2000 geschützt sind. Dieser Ort ist auch ein gutes Beispiel für die internationale Zusammenarbeit beim Fledermausschutz und sein derzeit günstiger Erhaltungszustand wurde durch die Bemühungen von Fledermausschützern aus Polen, Deutschland, Großbritannien, Belgien, Holland und vielen anderen EU-Ländern geschaffen. In diesem Artikel stellen wir die Ergebnisse des Fledermausmonitoring-Programms vor, das

seit 1999 in „Nietoperek“ durchgeführt wurde. Außerdem stellen wir verschiedene Forschungsschwerpunkte vor, wie die mikroklimatischen Veränderungen im unterirdischen Quartier aufgrund der Erderwärmung (sog. „Loggerprojekt“), die Studie „White Nose Syndrome“, das Schwärmprojekt, der Einfluss von Mardern und Waschbären auf überwinternde Fledermäuse, die vorläufige Sommerstudie und schließlich die Projekte zur fledermausfreundlichen touristischen Nutzung von „Nietoperek“, die es hoffentlich ermöglichen werden, das Gleichgewicht zwischen dem Schutz der Fledermäuse und der zunehmenden touristischen Nutzung der Festungsanlagen zu finden.

Schlüsselwörter

Fledermäuse, Nietoperek, Natura 2000, Fledermausschutz, Klimawandel

sites. Recently, in riparian woodlands (*Fraxino-Alnetum*, Natura 2000 code: 91E0-3) near the underground we caught lactating females of western barbastelle (APOZNAŃSKI et al. in preparation). This was the first breeding record of this species for “Nietoperek”. In addition, a pregnant female Leisler’s bat (*Nyctalus leisleri*) previously caught only once in the Lubuskie Voyvodeship (APOZNAŃSKI, KOKUREWICZ 2018). These preliminary observations indicate the need for further summer projects in “Nietoperek” to supplement the data accumulated over the years during winter and autumn study.

While our research in “Nietoperek” has yielded a great amount of valuable information on its bats, there is a constant awareness of the necessity for conservation, and the need to minimise the impact of any research on this internationally important multi-species bat colony. All our research activity is licensed by regional and/or national nature conservation authorities, and some research is further sanctioned after consultation with the Local Ethical Commission in Wrocław. Finally, while much has been discovered so far during years of observation and study in “Nietoperek”, there is clearly yet more to be understood, and consequently the need for more research projects in future.

Acknowledgements

We would like to express our sincerest gratitude to Arbeitskreis Fledermäuse Sachsen-Anhalt, especially Bernd Ohlendorf and Marcus Fritze, for kind invitation to the seminar “Dreidimensionaler Fledermausschutz” (Roßla, Saxony-Anhalt, 15th – 17th March 2019) that started our co-operation. We are grateful to the “Nyctalus” readers and subscribers for financial support to Society for Nature Conservation “Nietoperek” that will be used for statutory purposes.

We would like to thank the Regional Nature Conservation Management in Gorzów Wielkopolski, especially Mr. Jan Rydzanicz, Stanisław Bąkowski, Wincenty Piworun and Grzegorz Karcz for all the help and good co-operation.

We are grateful to Mr Leszek Lisiecki (Museum of Fortifications and Bats in Pniewo, Międzyrzecz Community), Mr Ryszard Skonieczek and Ms Beata Studzińska (Lubrza Community) for good co-operation and help with on-site bat conservation.

We are grateful to Bat Ringing Centre (Fledermausmarkierungszentrale, Dresden, Germany), especially to Dr. Ulrich Zöphel and Dagmar Brockmann, for data about bats ringed in Germany and hibernating in “Nietoperek”.

We thank the “Nietoperek Team”, Marcin Rusiński, Tomasz Kliś, Michał Jaśkiewicz, Tomasz Marszałek, Ewa Marszałek, Justyna Błesznowska, Monika Górka, Dr. Mateusz Ciechanowski and Aneta Zapart (Poland), Iain Hysom (UK), Wout Willems, Ben Van Der Wijden, Kris Boers, Filip Borms, Dirk Swaenen (Belgium), Toni Bellstedt, Joachim Frömert, Otto Schäfer (Germany) and Ruud Kaal (Netherlands), for all the studies and conservation work we did together.

We are grateful to John Haddow for correcting and improving the English text.

Last but not least, the winter bat censuses could not continue without the help of more than two hundred volunteers from all over Europe who assisted in data collection over the last 20 years. Thank you very much indeed for your time, passion and invaluable help.

Literatur

- ANDRZEJCZAK W., BATYCKI A., KASPRZAK A., KOKUREWICZ T., MATRAJ M., RUSIŃSKI M., ŚWIERKOSZ K., WYLĘGAŁA P., WEIGLE A. & KAIM, K. (2009): Documentation of the Management Plan of the Natura 2000 site „Nietoperek” (PLH080003). National Foundation for Environmental Protection, Warszawa [In Polish].
- APOZNAŃSKI, G., KOKUREWICZ, T., RUSIŃSKI, M. & GÓRSKA, M. (2018): Changes in bat number in the undergrounds of Natura 2000 PLH 080003 „Nietoperek” outside hibernation season and problems related with conservation of the largest hibernation site of those mammals in Poland. *Przegląd Przyrodniczy*, **29** (3) 47–55 [In Polish with English summ.].

- APOZNAŃSKI, G. & KOKUREWICZ, T. (2018): New breeding record of Leisler's bat *Nyctalus leisleri* (Kuhl, 1817) in Lubuskie province. Parki Narodowe i Rezerwaty Przyrody, **37** (3) 93–97 [In Polish with English summ.].
- BAGROWSKA, E. & URBAŃCZYK, Z. (1976): The station of Bechstein's bat *Myotis bechsteini* (Kuhl) in the Lubuskie lake district. Przegląd Zoologiczny, **20** 367–369. [In Polish with English & Russ. summ.].
- BAGROWSKA-URBAŃCZYK, E. & URBAŃCZYK, Z. (1983): Structure and dynamics of a winter colony of bats. Acta Theriologica, **28** 183–196.
- BANDOUCHOVA, H., BARTONIČKA, T., BERKOVA, H., BRICHTA, J., KOKUREWICZ, T., KOVACOVA, V., LINHART, P., PIAČEK, V., PIKULA, J., ZAHRADNÍKOVÁ, A. JR. & ZUKAL, J. (2018): Alterations in the health of hibernating bats under pathogen pressure. Scientific Reports, **8** 6067. DOI:10.1038/s41598-018-24461-5.
- BŁESZNOWSKA, J., KWASIBORSKA, E., MARSZALEK, T., KOKUREWICZ, T., GLOVER, A., HADDOW, J. & APOZNAŃSKI, G. (2017): Changes in numbers and reproductive status of bats during swarming in Natura 2000 site PLH080003 "Nietoperek", Poland. Pp. 57, in Abstract book of the 14th European Bat Research Symposium - EBRS 2017, 1-5 August 2017. Donostia, The Basque Country.
- BORATYŃSKI, J., RUSIŃSKI, M., KOKUREWICZ, T., BEREZYŃSKI, A. & WOJCIECHOWSKI, M. S. (2012): Clustering behavior in wintering greater mouse-eared bats *Myotis myotis* - the effect of micro-environmental conditions. Acta Chiropterologica, **4** (2) 417–424.
- BORATYŃSKI, J. & KOKUREWICZ, T. (2011): Współwystępowanie gatunków nietoperzy w skupieniach podczas zimowania w podziemiach Centralnego Odcinka Frontu Umocnionego Łuku Odry i Warty. Nietoperze, XII, **1-2**: 23–28 [In Polish with English summ.].
- DE BRUYN, L., KOKUREWICZ, T., GYSELING, R., KIRKPATRICK, L., GLOVER, A., SCHOFIELD, H., CIECHANOWSKI, M., HADDOW, J., SCHMIDT, C., BONGERS, F., WILLEMS, W., RUSIŃSKI, M., KLIŚ, T., APOZNAŃSKI, G., RACHWALD, A. & ZAPART, A. (2018): Changes in overwintering bat numbers, an effect of global warming? Benelux Congress of Zoology, Brussels, 14–15 December 2018.
- HUTTERER, R., IVANOVA, T., MEYER-CORDS, C. & RODRIGUES, L. (2005): Bat migrations in Europe: a review of banding data and literature. Naturschutz und Biologische Vielfalt, Bonn **28**:1–176.
- JONES, G. & KOKUREWICZ, T. (1994): Sex and age variation in echolocation calls and flight morphology of Daubenton's bats *Myotis daubentonii*. Mammalia, **58** 41–50.
- JURGA, R. M. & KĘDRYNA, A. M. (2000): Festungsfront Oder-Warthe-Bogen. Donjon, Boryszyn, 180 pp.
- KICZYŃSKA, A., KOKUREWICZ, T., BŁASZCZYK, M., HORBACZ, A., JAŚKIEWICZ, M., KIEROŃSKI, D., KOWALEWSKI, H., M. RUSIŃSKI (2010): Expertise on the impact of the A2 motorway on the Natura 2000 site „Nietoperek” on the Świecko - Trzciel section (km 1 + 995 - 92 + 533) in the Lubuskie voivodship. National Foundation for Environmental Protection, Warszawa [In Polish].
- KOKUREWICZ, T. (1990): Hibernation of two age classes of *Myotis daubentonii* (Kuhl, 1819) in the nature reserve “Nietoperek” (W Poland) and effect of microclimate on cluster formation. Bat Research News, **31** 43.
- KOKUREWICZ, T. (1999): Hibernation ecology of Daubenton's bat *Myotis daubentonii* (Kuhl, 1817). Ph.D. Thesis, Museum and Institute of Zoology, Polish Academy of Sciences, Warsaw, 141 pp. (in Polish).
- KOKUREWICZ, T. & BARTMAŃSKA, J. (1992): Early sexual maturity in males of Daubenton's bat (*Myotis daubentonii* (Kuhl, 1819) (Chiroptera: Vespertilionidae); field observations and histological studies on the genitalia. Myotis, **30** 95–108.
- KOKUREWICZ, T., BONGERS, F., CIECHANOWSKI, M., DUVERGÈ, L., GLOVER, A., HADDOW, J., RACHWALD, A., RUSIŃSKI, M., SCHMIDT, C., SCHOFIELD, H., WAWROCKA, K., WILLEMS, W. & ZAPART, A. (2014): Bat research and conservation in “Nietoperek” bat reserve (Western Poland). Pp. 93–94, in Abstracts of the 13th European Bat Research Symposium, September 01– 05.2014, Šibenik, Croatia.
- KOKUREWICZ, T., KIRKPATRICK, L., GLOVER, A., HADDOW, J., SCHMIDT, C., SCHOFIELD, H., BONGERS, F., WILLEMS, K. & APOZNAŃSKI, G. (2017): An influence of climatic factors on numbers of bats hibernating underground – the consequences for methodology of winter monitoring. Pp. 122, in Abstracts of the 14th European Bat Research Symposium, EBRS 2017, 1-5 August 2017. Donostia, The Basque Country.
- KOKUREWICZ, T., OGÓREK, R., PUSZ, W. & MATKOWSKI, K. (2016): Bats increase the number of cultivable airborne fungi in the “Nietoperek” bat reserve in Western Poland. Microbial Ecology, **72** (1) 36–48.
- KOKUREWICZ, T., PASZKIEWICZ, R. & SZKUDLAREK, R. (1993): Hibernation strategies of five bat species in the “Nietoperek” bat reserve (Western Poland). Str. 28–29, w: Abstracts of the Sixth European Bat Research Symposium, 22–27 August, Evora, Portugal.
- ŁUPICKI, D. & CICHOCKI, J. (2008): Occurrence of the bats in area of Międzyrzecz Fortified Region during the summer period. Nietoperze IX, **1** 19–27 [In Polish with English summ.].
- ŁUPICKI, D. & KOKUREWICZ, T. (1995): Jesienna akumulacja tłuszczu nocka rudego (*Myotis daubentonii*) w warunkach naturalnych i laboratoryjnych. Str. 20 w: Streszczenia referatów IX Ogólnopolskiej Konferencji Chiropterologicznej, Zakład Systematyki i Ewolucji Zwierząt PAN w Krakowie, Kraków 25–26 listopada 1995.
- ŁUPICKI, D., SZKUDLAREK, R., SCHICK, P. & DUDEK, I. (2001): The utilisation of underground objects by bats in „Nietoperek“ reserves in autumn season. Nietoperze II, **1** 93–101 [In Polish with English summ.].

- MARTÍNKOVÁ, N., PIKULA, J., ZUKAL, J., KOVACOVA, V., BANDOUCHOVA, H., BARTONIČKA, T., BOTVINKIN, A. D., BRICHTA, J., DUNDAROVA, H., KOKUREWICZ, T., IRWIN, N. R., LINHART, P., ORLOV, O. L., PIACEK, V., ŠKRABÁNEK, P., TUNOV, M. P. & ZAHRADNÍKOVÁ, A. JR. (2018): Hibernation temperature-dependent *Pseudogymnoascus destructans* infection intensity in Palearctic bats. *Virulence*, **9** (1): 1734–1750. DOI: 10.1080/21505594.2018.1548685.
- OGÓREK, R., K. GUZ-REGNER, T. KOKUREWICZ, E. BARANIÓK & KOZAK, B. (2018): Airborne bacteria cultivated from underground hibernation sites in the Nietoperek bat reserve (Poland). *Journal of Cave and Karst Studies*, **80** (4) 161–171. DOI: 10.4311/2017MB0124.
- PASZKIEWICZ, R. & SZKUDLAREK, R. (1996): Predation of martens on bats wintering in the „Nietoperek” Reserve. Pp. 52, in: Abstracts of the Seventh European Bat Research Symposium, 12-16 August 1996, Veldhoven, The Netherlands.
- PIKULA, J., AMELON, S. K., BANDOUCHOVA, H., BARTONIČKA, T., BERKOVA, H., BRICHTA, J., HOOPER, S., KOKUREWICZ, T., KOLARIK, M., KÖLLNER, B., KOVACOVA, V., LINHART, P., PIACEK, V., TURNER, G. G., ZUKAL, J. & MARTÍNKOVÁ, N. (2017): White-nose syndrome pathology grading in Nearctic and Palearctic bats. *PLoS ONE* **12** (8) e0180435. <https://doi.org/10.1371/journal.pone.0180435>.
- POWER, J. (2015): Non-invasive genetic monitoring of pine marten (*Martes martes*) and stone marten (*Martes foina*) in and around the Nietoperek bat hibernation site, Poland. Ph.D. Thesis, Waterford Institute of Technology, Department of Chemical and Life Sciences, Waterford, 254 pp.
- ROGOWSKA, K. & KOKUREWICZ, T. (2007): The longest migrations of three bat species to the „Nietoperek” bat reserve (Western Poland). *Berichte der Naturforschenden Gesellschaft der Oberlausitz*, Supplement zu Band **15** 53–60.
- ROMANOWSKI, J. & LESIŃSKI, G. (1988): Martens are hibernating bats. *Wszczęświat*, **89** (9): 210 [In Polish].
- SCHICK, P. (1998): Zimowe żerowanie osobników nocka rudego *Myotis daubentonii* w Międzyrzeckim Rejonie Umocnionym. Str. 32-33, w: Streszczenia referatów XII Ogólnopolskiej Konferencji Chiropterologicznej, Wrocław, 14-15 listopada 1998.
- STEFFENS, R., U. ZÖPHEL, BROCKMANN, D. (2004): 40th Anniversary Bat Marking Centre Dresden – Evaluation of Methods and Overview of Results. Saxon State Office for Environment and Geology, Dresden, 126 pp.
- SZKUDLAREK R., R. PASZKIEWICZ., T. BLOHM, E. NOWAK, ŁUPICKI, D. (2001): Bunkers of Ziemia Lubuska as the bat shelters. *Nietoperze* 2: 83-92 [In Polish with English summ.].
- THOMAS, D. W., M. DORAI & BERGERON, J. M. (1990): Winter energy budgets and cost of arousals for hibernating little brown bats, *Myotis lucifugus*. *Journal of Mammalogy*, **71** 475–479.
- THOMAS, D. W. (1995): Hibernating bats are sensitive to nontactile human disturbance. *Journal of Mammalogy*, **76** 940–946.
- TORRENT, L. (2014): Bat assemblages in the Nietoperek bat reserve (Western Poland) and their conservation strategies. Final Project, Universitat de Vic, 42 pp.
- TRYJANOWSKI, P. (1997): Food of the stone marten (*Martes foina*) in Nietoperek Bat Reserve. *Zeitschrift für Säugetierkunde*, **62** 318-320.
- URBAŃCZYK, Z. (1981): Fledermäuse (Chiroptera) in der Nahrung des Marders (*Martes sp.*). *Säugetierkundliche Mitteilungen*, **29** 77–79.
- URBAŃCZYK, Z. (1989): Bats of the Międzyrzecz Fortified Front. *Przyroda Ziemi Lubuskiej. Muzeum Regionalne w Świebodzinie, Świebodzin* [In Polish].
- URBAŃCZYK, Z. (1989). Results of the winter census of bats in Nietoperek 1985-1989. *Myotis*, **27** 139-145.
- URBAŃCZYK, Z. (1991a): Hibernation of *Myotis daubentonii* and *Barbastella barbastellus* in Nietoperek bat reserve. *Myotis*, **29** 115–120.
- URBAŃCZYK, Z. (1991b): Nietoperek Bat Reserve. *Przyroda Ziemi Lubuskiej. Lubuski Klub Przyrodników, Świebodzin* [In Polish].
- URBAŃCZYK, Z. & GÓLSKI, Z. (1994): Winter bat censuses in Ziemia Lubuska in 1988–1992. Pp 149–157, in *Winter bat censuses in Poland: 1988-1992. Results and evaluation of effectiveness.* (B.W. Wołoszyn, ed.). Publications of Chiropterological Information Center (CIC) ISEZ PAN Kraków [In Polish].
- WARCHAŁOWSKI, M., D. ŁUPICKI, J. CICHOCKI, M. PIETRASZKO, A. RUSEK, A. ZAWADZKA & MAZUR, N. (2013): Wintering bats Chiroptera in selected stand-alone objects of the Fortified Front of the Odra-Warta Arch. *Kulon*, **18** 139-149 [In Polish].
- WAWROCKA, K. (2011): Foraging ecology of Mouse-eared bat (*Myotis myotis*) (Borkhausen, 1797) on Natura 2000 site “Nietoperek” (western Poland). MSc thesis, Wrocław University of Environmental and Life Sciences, 53 pp [In Polish].
- WOŁOSZYN, B. W., M. KOWALSKI, URBAŃCZYK, Z. (1990): Monitoring of the underground hibernation sites of bats in Poland, winter 1990. Str. 79, w: Abstracts of the Fifth European Bat Research Symposium, 20-25 August 1990, Nyborg Strand, Denmark.
- WOŹNIAK, C. (1996): History and architecture of the undergrounds of the Międzyrzecki Rejon Umocniony. Pp 78–113, in *The nature of the Gorzów Voivodeship. Bat reserve “Nietoperek”* (T. Kokurewicz, ed.). Voivodeship Fund for Environment Protection and Water Management, Gorzów Wielkopolski, 195 pp [In Polish with English and German summ.].
- ZAHN, A., H. HASELBACH & GÜTTINGER, R. (2004): Foraging activity of central European *Myotis myotis* in a landscape dominated by spruce monocultures. *Mammalian Biology*, **70** 265–270.