A tribute to bats

edited by

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A Tribute to Bats

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A collections of contributions on selected topics of bat research and bat conservation in the Czech Republic and Slovakia (400 pp.)

by Miloš Anděra, Michal Andreas, Ondřej Balvín, Peter Bačkor, Tomáš Bartonička, Petr Benda, Hana Berková, Anna Bláhová, Zdeněk Buřič, Martin Ceľuch, Jaroslav Červený, Štefan Danko, Jiří Flousek, Jiří Gaisler, Vladimír Hanák, Vladimír Hanzal, Anna Hofmannová, Daniel Horáček, Ivan Horáček, Pavel Hulva, Helena Jahelková, Miroslav Jóža, Peter Kaňuch, Miroslav Kovařík, Ján Krištofík, Blanka Lehotská, Roman Lehotský, Vladimír Lemberk, Radek K. Lučan, Jana Neckářová, Peter Pjenčák, Antonín Reiter, Zdeněk Řehák, Petra Nová, Jiří Šafář, Přemysl Tájek, Marcel Uhrin, Jan Zukal

on the occassion of

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* EUROBATS 6th Meeting of Parties, Prague 20-22 September 2010

Includes

* a distributional survey of bats in Czech Republic and Slovakia (by Vladimír Hanák, Miloš Anděra, Marcel Uhrin, Štefan Danko and Ivan Horáček),
* a detailed bibliography of Czech and Slovak bat research literature (1693 references) compiled by Vladimír Hanák, Miloš Anděra and Marcel Uhrin, and
* 232 photographs by Miloš Anděra, Tomáš Bartonička, Anna Bláhová, Jaroslav Červený, Štefan Danko, Jiří Gaisler, Daniel Horáček, Ivan Horáček, Vladimír Hanzal, Miroslav Joža, Peter Kaňuch, Roman Lehotský, Radek Lučan, Antonín Reiter, Jiří Šafář, Přemysl Tájek

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preface

The initial idea was to produce a simple booklet on the bats of the Czech Republic and Slovakia to provide a brief snapshot of information to the participants of the 15th International Bat Research Conference and EUROBATS Meeting of Parties to be held in Prague in 2010. Yet, thanks to generous support from the Czech Environment Ministry, and particularly from the LESS a.s. and its director Ing. J. Mičánek, the possibility arose to extensively enlarge the scope of the initial concept. That possibility has since stimulated the enthusiastic endeavours of almost all people actively involved with Czech and Slovak bat research and conservation to contribute to this volume with accounts of their results and thousands of bat photographs. The editors were forced to choose between numerous and often quite heterogenous contributions and under considerable time pressure.

The book presents a mosaic of texts and pictures reminding us that bats have long been the focus of scientific and conservation interests in our countries and that much reliable information concerning these fascinating animals are available here. The survey of the distribution status of all bat species occurring in the territory of the former Czechoslovakia and the almost complete bibliography of bat research literature that has arisen from this region and/or refers to its local bat fauna are perhaps of particular interest in this respect. The other texts deal with the history and current trends in studies of Czech and Slovak bats, followed by a selection of brief research papers that supplement the texts with some pertinent case examples. Of course, this book has *not* been intended to be a rigorous scientific treatise - it is focused rather on local bats and the enthusiasm of their students. *It is* just an attempt to give

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history

History of chiropterology in the Czech Lands and Slovakia:

from earliest references to the onset of modern research

by **Vladimír Hanák and Jiří Gaisler**

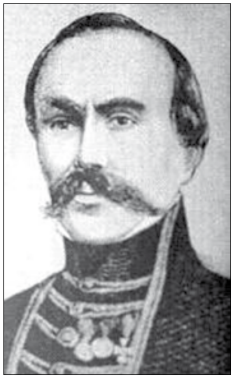
Introduction

From approximately the mid-17th century, Bohemia, Moravia, the Austrian part of Silesia, and Slovakia were all parts of one and the same state ruled by the Austrian family of Habsburg. Nevertheless, collecting items of knowledge of nature, including its fauna, took a somewhat different course in the Czech Lands and Slovakia. The Czech naturalists were rather educated under the German influence, whereas the Slovak ones were more influenced by Hungarian education, particularly since the time when the Hungarians claimed considerable autonomy and the state was hence called Austro-Hungary. Certain specificity of the Slovakian research ways, as against those in the Czech Lands, persisted even during the existence of Czechoslovakia. After the separation of Czechoslovakia into two parts, even the field and laboratory investigations have been organised separately in the two new states. For this reason, the history of bat research within the territories of the present Czech Republic and Slovakia is treated separately below.

Czech Lands

The first occasional notes on the occurrence of bats in the territory of Bohemia and Moravia are found as early as some of the medieval encyclopaedias and annals (Adam z Veleslavína 1598, Břežan 1615) as well as later educational writings (Komenský 1658, Balbín 1679). The notes, however, are just general and cannot be considered scientific data. The earliest synopsis of the mammals of Bohemia, written in German, is the *Versuch eines Verzeichnisses aller in Böhmen bisher bemerkten Thiere* by Schmidt (1795) which contains the first authentic notes on three bat species, viz., *Vespertilio auritus* (*Plecotus auritus* s. l.), *V. murinus (Myotis myotis*), and *V. noctula (Nyctalus noctula)*. This number of species was much later increased in a compilation written in Czech by Presl (1834) who already reports from our territory two horseshoe bat species *(Rhinolophus hipposideros, R. ferrumequinum)* plus 12 – 13 additional vespertilionid bat species, however without any concrete and authentic data. Even so, Jan Swatopluk Presl is considered a naturalist possessing wide encyclopaedic knowledge of mammals, and the first author of Czech zoological nomenclature. From approximately the same period (1833-1839) also comes the unpublished list of Moravian mammals by Müller, an amateur naturalist dwelling in Brno, who reports the occurrence of 9 bat species, again without any unequivocal evidence (Kratochvíl 1955). The later, widely known synopsis of Bohemian vertebrate fauna by Amerling (1852) is largely a compilation, yet it already contains 11 bat species, among them such rarer species as *Myotis bechsteinii, Nyctalus leisleri,* and *R. ferrumequinum*.

The activity of Friedrich Anton Kolenati (1812-1864) was of essential importance for the development of chiropterology in Bohemia and the whole of Europe. Kolenati was born in Prague to a Czech family, yet he published his papers in German, except for an article on beekeeping. He studied medicine at Charles University in Prague. After having graduated, he became a general practitioner in Prague, Malá Strana, while at the same time studying natural science. In 1843-1846, he was zoological assistant at the Russian Academy of Sciences in Petersburg. At hat time, he undertook many trips through the then Russia. In 1848, he habilitated at the Faculty of Medicine of Charles University in Prague in special and medical botany, zoology, and crystallography, yet from 1849 on until his death, he was professor of general natural science at the University of Technology in Brno. He was a very productive naturalist, a polymath, and his bibliography numbers over 150 titles (Flasar 1997). Of animals, he mainly studied bats, their ectoparasites, as well as insects, above all, caddis flies. He published numerous original faunal observations on the taxonomy, morphology and biology of bats, part of them still before the edition of the fundamental work of Blasius (1857) and later in correspondence with its author. Kolenati can be considered the greatest Bohemian zoologist of the mid-19th century and the foremost faunist of bats and their ectoparasites in Europe of that time. Besides his essential contribution to European and world-wide chiropterology, gathered up especially in his voluminous writings *Europas Chiroptern* (1856a, b), *Monographie der europäischen Chiroptern* (1860) and *Die Parasiten der Chiroptern* (1857a), he published many original observations on the occurrence of bats in Bohemia and especially in Moravia and Silesia (Kolenati 1851a, b, 1856 c). He was the first to systematically study the bats of the Moravian Karst. He described two bat species and several genera new to science, among them *Amblyotus atratus* from the Jeseníky Mts., the species being now considered to be synonymous with *Eptesicus nilssonii.* Of the genera described by Kolenati, the taxon *Hypsugo* is considered valid and applies to the species *Hypsugo savii* and the related forms. Some of Kolenati‘s observations on the anatomy and biology of bats were published in little known periodicals, such as the *Mitteilungen der kaiserlich-königlichen mährisch-schlesischen Gesellschaft zur Beförderung des Ackerbaues, Natur- und Landeskunde*, edited in Brno: they fell into oblivion, and their priority has been attributed to later authors. For that matter, this is also true of his paper *Beiträge zur Naturgeschichte der europäischen Chiroptern* (1857b), despite the fact that it was issued by the Isis Publishing Company in Dresden. Unfortunately, not even Kolenati's bat collection has been preserved, which was allegedly deposited in the Moravian Museum in Brno and which could elucidate some of the doubts associated with the description of *A. atratus,* the finding of the putative *Vespertilio capaccinii* (the present *Myotis capaccinii)* in Moravia, and other disputable data. Kolenati's pioneering investigations on bats in Moravian caves were continued in the papers by the well-known Moravian speleologists Wankel (1856, 1860) and Absolon (1899 a, b), which mostly just repeat and supplement Kolenati's data in their zoological parts.



F. A. Kolenati

The most outstanding personality of Czech zoology in the second half of the 19th century, Antonín Frič (1832-1913), curator of the regional museum in Prague and professor at the Czech university, all-round zoologist and palaeontologist, devoted only his marginal attention to mammals (and thus also bats). This goes someway is to explain the fact that although living and working in practically the same period of time as Kolenati and knowing each other, they did not co-operate and only exceptionally did they cite each other's papers. Like Kolenati, Frič also knew Blasius' (1857) work mentioned above and, what's more, he was directly engaged in the faunal research of Bohemia and edited the *Archiv pro přírodovědecké prozkoumání Čech* (Archive for natural history research of Bohemia) published in Prague. This enabled him firstly to publish a report on material of mammals and birds according to the collections deposited in the National Museum in Prague (Frič 1854) and later a comprehensive synopsis *Obratlovci země české* (Vertebrates of the Bohemian land) in both a Czech and a German version (Frič 1872). In that synopsis, Frič includes 58 species of mammals, mostly with concrete localities and names of persons who provided the information. Thus, he reports 15 species of bats occurring in Bohemia, documented by material evidence, among them rather rare species (*R. ferrumequinum, N. leisleri, Pipistrellus nathusii*). Basing on the experience from neighbouring countries, Frič presumes even the occurrence of *M. bechsteinii* and *Myotis dasycneme*, which was confirmed later on. Frič also wrote two articles on bats for the popular periodical Živa (Frič 1858, 1894), thus calling attention of the public to these interesting animals and stimulating further interest in their research.

Frič's activities were followed up by a number of his disciples and colleagues: mammals were studied in particular by Bayer (1880, 1894, 1903) who reports from Bohemia 14 bat species with some actual localities, but otherwise it is a typical compilatory work. In its time, the paper by Pražák (1896) was similarly valued, containing a number of interesting faunal data on the bats of Bohemia. Today, however, it is not taken quite serious due to the evident fallacies committed by Pražák in ornithology. Among Frič's associates was J. Schöbl, outstanding ophthalmologist experienced in microscopy, who was interested in studies of bat orientation. He joined up with the investigations implemented by Spallanzani (but did not blind the bats) and published, in a renowned international periodical, his pioneering paper on the anatomy of the flying membrane of bats, demonstrating its rich nerve supply. From this, he inferred that the orientation of flying bats was based on their sense of touch. For his study he used individuals of *Eptesicus serotinus* kept in captivity (Schöbl 1871). The anatomy of the auditory organs of bats was the topic of a much later paper by Staněk (1933). Unfortunately, his paper was published in Czech and therefore did not receive a well-earned appreciation. At the beginning of the 20th century, a general paper on the distribution of bats was published in German by Palacký (1901) without, however, including original data concerning the territory of Bohemia and Moravia.

In the first half of the 20th century, the faunal research on mammals in Bohemia and Moravia declined markedly, and only occasional notes on the findings of bats in individual regions can be found in the literature of that time (Loos 1915, Štěpán 1922, Canon 1927, Remeš 1927, Michel 1929, Baťa 1933, Hnízdo 1934, Vaňura 1941, 1942, 1943, etc.). Most of them reported on the results of activities of amateur regional researchers. They presented some interesting data as well as errors. This is true, above all, of the papers by Kostroň who, besides reporting valuable faunal data from the North Moravian Karst (Kostroň 1944, 1946), described two new species, *Myotis coluotus* (Kostroň 1942-1943) and *Rhinolophus moravicus* (Kostroň 1943). The former description was one of a bat with symmetrically deformed auricles, and this new taxon was doubtful from the very beginning. Only recently, has it been shown that the species concerned was *M. brandtii* (Benda 1999). The latter taxon described by Kostroň is synonymous with *R. hipposideros* (Grulich 1949). Of marginal interes and rather only rather comparative importance for the knowledge of bats of Bohemia and Moravia are some of the papers published by experts in neighbouring countries (Gloger 1827, 1828 a, b 1833, Fitzinger 1832, Blasius 1857, Rzehak 1898, Méhely 1900, Miller 1912, Paszlawski 1918, Wettstein 1925, Pax 1925, 1933, 1937, Seidel 1927, 1928, Schlott 1942). The paper by Seidel (1928) is interesting in describing the first marking of bats in the territory of Bohemia, namely in the Frýdlant district. The author marked the bats by puncturing numbers in their flight membranes, yet no report whatever is available on the results of his experiment.

Of more persistent importance are some minor papers pertaining to fossil bat fauna, being the by-products of the commencing speleological investigations in southern Bohemia (Woldřich 1881) and especially in the Moravian Karst (Knies 1900, Skutil & Stehlík 1932, Stehlík 1934). Also at that time were published the first minor papers on bat ectoparasites, joining up with the pioneering papers by Kolenati (1857a) and announcing the subsequent active research on bat parasites (Jírovec & Keller 1942, Rosický 1944 a, b, Ryšavý 1954, 1956, Grulich & Povolný 1955, 1956, Hůrka & Chalupský 1956, Hůrka 1957).

Jan S. Petényi

This period of rather occasional investigations on bats in Bohemia and Moravia in the 20th century ends with the publication of several more important papers (Grulich 1949, Hepner 1954, Šebek 1956) and, above all, a comprehensive evaluation of all hitherto faunal observations (Gaisler 1956). The increasing interest in the study of bats resulted in the compilation of a paper *Netopýři Československa* (Bats of Czechoslovakia) that included identification keys, descriptions, data on the distribution and biology of bat species known or supposed to occur within the territory of the country (Gaisler, Hanák & Klíma 1957). One of the stimuli to write this small monograph (65 pages) was the development of bat marking and recapturing which, in its time, was the beginning of modern research on bats in the then Czechoslovakia.

Slovakia

At approximately the same time, in the mid-19th century, bat research also began developing in Slovakia. In its very beginning, it was organised by persons working in the National Museum in Budapest, Hungary, some of whom were of Slovakian origin. One of them, born at Ábelová, was Jan Š. Petiani-Petényi (1799-1855), later curator of the zoological collections of the National Museum in Budapest. However, his valuable observations on mammals, incl. bats, remained in his manuscript inheritance and were published by Herman (1879, 1880), a Slovak living in Hungary. A further excellent expert in bats of Slovakia was L. H. Jeitteles, a secondary school professor, teaching at the gymnasium in Košice for a short period, who published his basic work Prodromus faunae vertebratorum Hungariae Superioris in Vienna (Jeitteles 1862). In it he reported 11 bat species from Slovakia, most of which were the first evidence from that region, including *P. nathusii* and *E. nilssonii* which were generally poorly known until that period. At approximately the same time, the bats of northern Slovakia, especially the Tatra Mts., were studied by A. Kocyan (1835-1916), a forester and excellent observer who, on the one hand, was in touch with Polish and Hungarian zoologists and supplied his material to the museums in Budapest and Poland and, on the other, he himself published his own observations (Kocyan 1867, 1887-1888, 1889). He was an excellent faunist of the vertebrate fauna of the Tatra Mts. He was the first to report, from that region, the occurrence of *R. hipposideros,* a thermophilous species, and *E. nilssonii*, a species almost unknown until his time. The occasional notes on the bats in Slovakia, contained in the comprehensive work on the fauna of the Pannonian Lowland (Mojsisovicz von Mojsvár 1897) have remained unnoticed so far.

Over the 19th century, the Slovakian fauna was studied by further zoologists who, in their lists of the Hungarian fauna, also presented occasional data on the occurrence of bats. These authors include Frivaldszky (1822-1895), a biospeleologist, and Ortvay (1843-1916), Petricskó (1851-1921) and Malesevicz (1856-1911), all regional zoologists. The beginning of the 20th century then presented to Slovakia a more modern synopsis of bat fauna by the outstanding Hungarian zoologist, L. Méhely, Magyarország denevéreinek monographiája (Monographia Chiropterorum Hungariae) (Méhely 1900). This author lists a number of species and localities in Slovakia, among others the first record of *N. leisleri*. Similar valuable observations from Slovakia are also contained in the monograph by Miller (1912), all based on material in the Budapest museum. In greater detail the Slovakian records of bats are comprised in the comprehensive work by Paszlavsky (1918). Later on, in the period between the two wars, the knowledge of Slovakian bats was enriched by native, Hungarian, Polish and Czech zoologists who visited, or worked in, Slovakia (in alphabetical order): Dudich, Éhik, Kettner, Kormos, Melichar, Sitowski, Štěpánek, and others. Among the Czechs, the greatest merit in the research on bats is due to Jirsík (1924) who published a synopsis entitled Přehled slovenských savců (Survey of Slovakian mammals), containing a number of original findings of rare bat species, and Staněk (1932 a, b) who investigated the newly discovered spaces of Domica Cave where he discovered, among others, the occurrence of the thermophilous species *Myotis emarginatus* and *Rhinolophus euryale*. A compilatory list of Slovakian bats was published, already during World War II, by Babor (1943) but his data lack criticism and some of them are erroneous.

A systematic research on Slovakian mammals, including bats and their ectoparasites, was launched, in part independently, by various Slovakian and Czech zoologists (in alphabetical order) Brteková, Ferianc, Gaisler, Grulich, Hanák, Hanzák, Mošanský, Povolný, and others. The distribution of bats in Slovakia was described within that of the whole Carpathian basin by a well-known Hungarian chiropterologist Topál (1954). At that time, the most detailed faunal research on the bats of Slovakia was implemented by Vachold, a Bratislava bat expert, who gathered up his numerous notes on the occurrence and ecology of bats, particularly in Slovakian caves, in his post-graduate thesis. The thesis was not accepted but the data, supplemented by others, were individually published (Vachold 1955 a, b, c, 1956, 1957, 1959, 1961). At the same time, Gaisler (1956) presented a faunal review of the bats of Slovakia within the whole of Czechoslovakia, and a review of the bat research in Slovakia was included in the comprehensive work on the bats of Czechoslovakia (Gaisler, Hanák & Klíma 1957) mentioned in the preceding chapter. Selective bibliography on the distribution, quantity and protection of bats in Slovakia can be found in Uhrin & Polakovičová (2000).

Július Vachold

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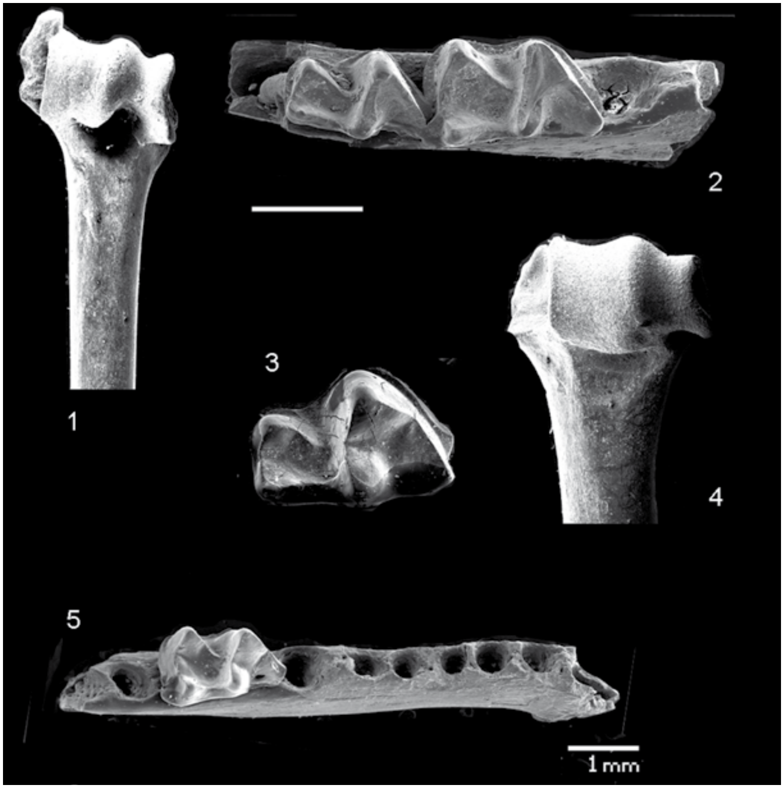
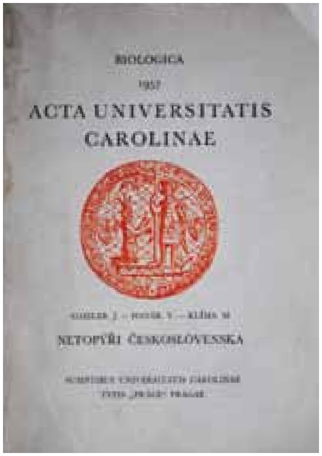
Although intensively studies in the Czech Republic and Slovakia, the fossil bats have been omitted in theis book. The plate of some items from the the Early Miocene site Ahníkov-Merkur , NW Bohemia (with Tadarida engesseri, Rhinolophus spp., Hanakia fejfari) is just to remind it.



... until now

by **Ivan Horáček**



The onset of modern bat research in former Czechoslovakia is essentially associated with two names: Vladimír Hanák (*1931) and Jiří Gaisler (*1934). They both started their interest in bats during their study in Department of Zoology, Charles University in Prague in early fifties. Vladimír Hanák started his university study in 1949, Jiří Gaisler appeared here three years later, in time when Hanák already as a student became an assistent professor to Prof.Julius Komarek, then leading personality of Czech zoology, who stimulated him to focus his interest to small mammals. Insectivores, rodents and bats presented then in European scale perhaps the least known group of vertebrates. The knowledge on biodiversity of that group in Europe was largerly the same as that of the Catalogue of European mammals by Gerit S Miller (1912) and, actually, not much exceeded the picture established already by Blasius and Kolenati more that 100 years ago. Details of distributional and taxonomic status of many species of that group were then surprisingly scarce throughout Europe, and even basic information on their biology mostly absented at all. This was particularly valid for bats. Except for a pre-war paper by Martin Eisentraut (1936) the comprehensive studies pertinent for actual knowledge on European bats and inovative as for new conceptual and methodological ideas first appeared just in that time: namelly it was Monograph on bats and bat parasites by Olof Ryberg (1949) and particularly a monumentous book Letuchye myshi (Bats) by A. P. Kuzyakin (1950) which both served as index inspiration throughout the first decades of the modern bat study. Yet, the initial task of that time was naturally to refine the basic information on structure of bat fauna and bat communities in the region - it was responded first by Jiří Gaisler who catalogized bat collections of the National Museum in Prague and compiled faunal survey of Czechoslovak bats (Gaisler 1956) which in extended form supplemented with taxonomic summary and identification keys appeared as a monograph in 1957 (Gaisler et al. 1957). Already in these years several bat species then new to the fauna of Czechoslovakia and/or those known by uncertain historical records only were discovered and thoroughly reexamined as to their distributional and taxonomical status and ecological specificities (Gaisler and Hanák 1959, Hanák and Hanzák 1957, Hanák 1958, 1959).

Independently, such a kind study was performed in Slovakia by Julius Vachold. A summary of his data on distribution and biology of bats in Slovakia in his 1956 monograph and 1960 unpublished PhD thesis (reprinted only recently in 2003) present still an impressive example of his enormous enthusiasm and deep insight into the topic of bat ecology. Yet, the academic atmosphere of that time in Slovakia was not too supporting to him – Vachold, from 1954 working in the Faunal Laboratory of the Slovak Academy of Sciences was pushed in 1959 to continue his career as a secondary school teacher.

Karel Hůrka a Vladimír Hanák

The situation in Prague Charles University was much different. As a traditional academic center of central Europe, it retained even in early 50's an athmosphere of certain academic freedom, vivid contacts with the current achievements abroad which provided a stimulating platform to ambitious projects of the fresh postwar generations of young scientist. Maybe just that atributed to the fact that almost all zoology students of early fifties grew in prominent personalities, and worth mentioning: many of them, following Hanák and Gaisler, turned at least temporarly their attention to bats. Indeed, in the Prague university, already in mid 50', the bats became subject of a very broad multidisciplinary study and a large-scale research effort. Among the personalities attending the team at least the following should be mentioned: Karel Hůrka (late professor of entomology in the Charles University who draw an extensive monographic revisions on Palearctic bat fleas and Nycteribiidae), Johana Hůrková (with a series of papers on bat trematodes), Milan Klíma (professor of anatomy in the University in Frankfurt a.M.), Jaroslav Figala (late professor of ecology in the Czech Agriculture Univesity) or Ladislav Janský (late professor of physiology who stimulated a series of studies on thermal biology of bats). Intensive study of bat parasites continuing with considerable achievements (cf. Dusbábek a.o.) begun in that time as well.

The stimulating atmosphere of the team promoted endeavour to integrate current achievements including the local distributional and ecological information to general contexts and, consequently, extensive efforts to collect corresponding data and material for comparative studies from other regions of the Palearctic region. In a small country behind the iron curtain it was the task often quite a hard. Yet still there have been vivid contacts with the colleagues in Balkan countries from the pre-war times and/or a possibility of scientific exchange with the countries of former Soviet Union which stimulated research expeditions of the post-war generation of zoologists to these regions. Already in late fifties and early sixties Hanák and his colleagues started a systematic study of bats in Bulgaria, Albania and Central Asia which essentialy contributed knowledge on bat fauna in these regions and among other brough extensive collections, which together with data resulting from revisions of the museum collections enabled large scale taxonomic investigations.

Hanák summarized results of these studies in his 1960 PhD thesis, a monumentous work establishing a precise survey of distributional status (including complete list of local records), biometric data and taxonomic analyses for all bat species of central Europe including analyses of extralimital populations and their phylogenetic relations. Although the thesis was never published in full, some outputs were later incorporated into the papers devoted to particular taxa (*Myotis mystacinus* group , *Rhinolophus bocharicus, Eptesicus bottae*, etc.). Among the most exciting results a discovery of cryptic species within the genus *Plecotus* (simultaneously achieved by K. Bauer, G. Topál, B. Lanza and V. Hanák) should be first mentioned. The discovery stimulated a series of subsequent studies by Hanák and his students (Hanák 1962,1965,1969, Šachlová 1965, 1970, Horáček 1975) extensivelly refining ideas on patterns of interspecific relations between the cryptic species of the genus.

Jiří Gaisler and Milan Klíma after finishing their university studies in 1957 became research fellows in then newly established Institute of Vertebrate Zoology of the Czechoslovak Academy of Science in Brno, a professional research institution focused on multidisciplinary study of vertebrate biology. In that time Gaisler started the continuous study of bats in the Moravian karst and, first of all, the detailed investigation of reproduction, ecology and behaviour of the Lesser Horseshoe Bat, *Rhinolophus hipposideros,* which resulted in a series of voluminous papers and his 1961 PhD thesis.

At the same time, a large-scale project of bat banding with special bat bands and well organized administration centre was started in 1957 (short under leading by Jiří Gaisler and Jaroslav Figala, and then from 1960 onwards by Vladimír Hanák). Similarly as in other countries, bat banding became in sixties an index component of field study of bats and its outputs provided indispensable insight in various aspects of bat biology. This fact become clear even from the first voluminous report on banding results by Hanák, Gaisler and Figala (1962). The color bands introduced by Gaisler and Nevrlý (1963) further extended the scope of the method into a sphere of behaviored studies. The banding was extensivelly applied until late seventies particularly in long-term studies of population biology of selected model species (see e.g. Horáček 1976, 1985 for *Myotis myotis*), later the banding has been largerly restricted and is used in a very limited extent.

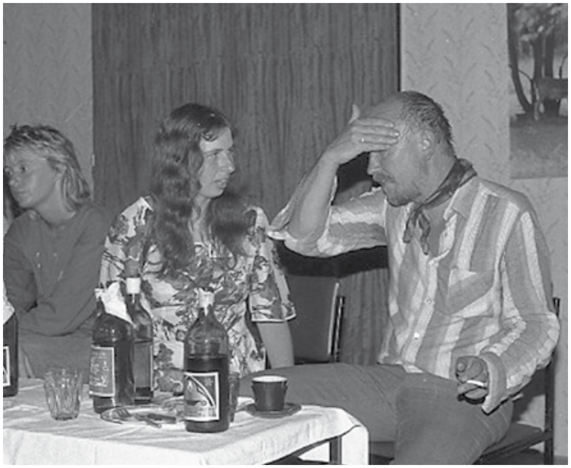
The stage of intensive banding attained its impressive extent also thanks to contribution by numerous students which diploma projects, mostly supervised by Vladimír Hanák, were focused on bats, and who later took positions of professional zoologists in various regional museums where they further contributed to bat study often in an essential way. First of all it is valid for Miloslav Nevrlý, Jan Sklenář, Luděk Hůrka, Petr Rybář, Jiří Krátký, Zdeněk Bárta, Zdeněk Rumler, Petr Zbytovský, Petr Bürger or e.g. Antonín Reiter and Vladimír Lemberg of the recent generation.

It should be remembered, of course, that field study of bats in fifties and sixties differed quite a much from its contemporary form. No detectors, no night-vision, no mist nets, often also no vehicles except for the public transportation were available. All that limited the scope of field studies to controls in roosts, mostly underground spaces and lofts of buildings. The only technique available for study of flight activity was either direct observation or shooting.

Since then the techniques of bat investigation was contributed with a considerable amount of instrumental innovations and the conceptual shifts largerly derived of them. Three of them, which essentially rearranged a design of bat studies, should be mentioned explicitely. First, it was application of mist-netting particularly in combination with study of swarming behaviour and the until then a mysterious period in life cycle of temperate bats between disappearance from summer roosts and hibernation. Fascinating discoveries concerning these topics were achieven already since 1970 when Ivan Horáček with his friends and Jiří Gaisler introduced regular use of mist-netting as a basic method of field bat study. Next step that substantially changed field study of bats is characterized by appearance of bat detectors. Gaisler experienced some first models already at beginning of eighties, Hanák and Horáček obtained their QMC, then newly produced first detectors designed for routine field use, in 1982 from G.Neuweiler. Although the current standard of bat detectoring with time expansion and computer analyses has been achieven only during 1990's, the QMC stage was quite important for improving of the routine bat studies with aspects of acoustic biology and reorientation of new generation of bat students into that direction. The impact of a routine application of molecular techniques in biology at the onset of the 21st Millenium has played exactly the same role and is well reflected by a standard design of current diploma and PhD projects produced in nowdays academic centers of bat research in the Czech Republic (Hulva, Vallo, Bryja, a.o).

At least five centers are to be mentioned: (1) Department of Zoology at Charles University in Prague, (2) National Museum Prague, (3) Department of Botany and Zoology at Masaryk University in Brno, (4) Institute of Vertebrate Zoology of the Czech Academy of Sciences in Brno, and (5) Department of Zoology at the South Bohemian University in České Budějovice.

The Prague centre predominantly influenced by activity of Vladimír Hanák produced a vast majority of professional zoologists working with bats. Thanks to extensive collections, now mostly deposited in the National Museum Prague (under care of Petr Benda, former student of Ivan Horáček), a number of projects were devoted to morphological themes and large-scale morphologic and taxonomical comparisons. Leo Sigmund (with 1960 PhD thesis on osteological design of *Myotis myotis*) also supervised some of them (comparative brain morphology, inner ear morphology, vision). Considerable achievement in neuromorphology were attained by Pavel Němec (formerly a student of Leo Sigmund and Ivan Horáček) and his students. The osteological, myological and developmental topics have also been steadily studied (Červený, Žalman, Vlček, Hotový, Srbková). A series of projects were focused onto *Myotis myotis* as a model species of ecological, morphological, behavioral or parasitological studies (Sklenář 1960, Krátký 1967, Horáček 1976, Futerová 1978, Holečková 1982, Benda 1993, Weinfurtová 1996).



Zdena Bauerová a Jan Sklenář

Particularly the generation of Hanák's bat students of seventies has played an indispensable role in further development. Ivan Horáček, Jaroslav Červený, Jan Zima, Hynek Burda and their friends of the age who begun with their activity in bat research already in late sixties during their secondary school study continued the ongoing projects and contributed new accents: e.g. focus on chromosomal and genetic studies (Zima) or fossil bats, faunal history or dental morphology (Horáček). They further promoted attractivity of bat topics (e.g. a book Flying mammals by Horáček 1985) and further contributed continuity of bat studies in the respective research centres.

Currently, the bat research group at Department of Zoology, Charles University in Prague is represented by Ivan Horacek and his former students Petr Benda, Pavel Němec, Pavel Hulva, Helena Jahelková and Radek Lučan who all take care in supervision of the further generation of bat students and the research projects covering a broad spectrum of themes from details of roosting and acoustic biology, neuromorphology and detailed morphometric studies to phylogeography and molecular demographic studies or foraging biology (particularly contributed by Michal Andreas of the Silva Tarouca Research Institute). Also Jan Zima (since 1976 a member and later a director of the CAS Intitute of Vertebrate Zoology in Brno) and his Prague students contribute the group as well.

The bat research centre in Brno has traditionaly largerly profited from integration of research capacities of the university department and CAS Institute of Vertebrate Zoology (represented by Jiří Gaisler and Jan Zima, respectivelly). Of the bat student of mid seventies generation supervised by Jiří Gaisler, at least Jan Dungel, later becoming a prominent painter, and Zdena Bauerová should be remembered. It is particularly pertinent for Zdena Bauerová who essentialy improved techniques of dietary studies in bats and produced a series of pioneering papers on trophic ecology of several bat species. Unfortunately she died young in 1988 by a traffic accident. Jiří Gaisler, Jan Zima, Zdeněk Řehák, Tomáš Bartonička, Josef Bryja and Jan Zukal and their students personify the current core of the academic platform of bat studies in Brno. Besides of multiple projects concerning roosting and foragaing ecology, behaviour or host-parasites interactions (Bartonička), the projects focused to molecular phylogeograpy and molecular ecology are here also in progress (Bryja, Vallo, Fornůstková, Martínková).


Tomáš Bartonička

At the Department of Zoology of the South-Bohemian University in České Budějovice, newly established in 1990's, where bat studies were iniciated by Ivan Horáček who supervised several MSc. and PhD projects devoted to bats, the bat study continues now under predominant influence of Horáček's student Radek Lučan.

Last but not least it should be remembered that works by either Vladimír Hanák and Jiří Gaisler or Ivan Horáček and Jan Zima express a considerable interest in topics of faunal research, taxonomy and biogeography (comp. e.g. a monographic survey of Palearctic bats by Horáček et al. 2000) and that tradition is responded also in activity of the current generation of Czech bat students. First of all it is valid for Petr Benda, the curator of mammals in the National Museum Prague and his numerous contributions in taxonomy of bats, particularly the voluminous series of monographs on Bats of the Eastern Mediterranean and Middle East resulting of the extensive field studies continuing the research projects of his teachers.

The vivid development in the professional research particularly arised with social rearrangements after the Czechoslovak „velvet revolution" in 1989 has also been accompanied by enlarged activity in bat conservation topics, interest in bats by amateur naturalist and related development that are briefly characterized in the next chapters.

Finally, it should be remembered that vivid development in that time takes place also in Slovakia, particularly after split of former Czechoslovakia in 1993. Despite interest in bats by local students (Mošanský, Danko, Paláštyh, Olejár, Matoušek)

Radek K. Lučan a Jiří Bajer

major efforts in study of bats in Slovakia were prior that time undertaken by Czech students (Hanák, Gaisler, Horáček, Červený, Zima a.o.) though mostly in close cooperation with Slovak collegaues. An essential contribution by Ján Obuch, who during last 40 years collected enormous amount of quite important records from osteological deposits of owl and raptor food remains, should be particularly mentioned. Yet, after 1993 a new generation of bat students, first of all represented by Marcel Uhrin (now in Pavel Jozef Šafárik University in Košice) or Peter Kaňuch and Martin Cel'uch (University Zvolen) started a large scale study of Slovak bats and essentially refined current knowledge on their biology and distribution and in cooperation with colleagues of older generation (Obuch, Danko) stimulated an extensive current progress in bat study in that country.

For detailed list of references see bibliography at the last chapter, bibliographic record to selected topics is below (vast majority of bibliographic records – mostly dealing with distributional status, ecology or taxonomy – is ommited, however)

Virus infections

487, 488, 741, 905, 943-944, 1127, 1438

Parasites: Protozoa

778-779, 784, 1122-1123

Parasites: helminths

74, 249, 403, 580, 649-654, 784, 884-888, 1001, 1044-1047, 1379, 1546, 1569, 1613, 1631

Parasites: Acarina

119, 219, 220, 244, 251-289, 728, 732-733, 736, 780, 784, 826, 1096, 1179-1180, 1330, 1534-1535

Parasites: Insecta

57, 59, 192, 245, 127-428, 497, 592-626, 628, 632, 637, 639, 655, 676-677, 694, 726, 730, 739, 770-771, 784, 975, 996, 1019-1022, 1024-1025, 1044, 1104, 1129, 1142, 1264, 1267-1268, 1509, 1574-1576, 1616, 1636, 1684

Diet

14, 32, 68, 78, 81, 82, 84, 122, 125, 694, 701, 982, 1259-1263, 1278, 1353, 1446, 1507, 1508, 1514, 1530, 1551-1552, 1625

Bats as prey of owls and raptors

19, 214, 215, 240, 242, 303, 304, 910, 911, 913-926, 928-941, 953, 980, 1031, 1077-1086, 1437, 1441, 1529, 1623-1624

Fossils

157, 158, 187, 239, 492-495, 511, 515, 518, 520-522, 524, 526, 529, 531-533, 535, 537-538, 542, 544-546, 548-549, 559-566, 573, 577, 548, 549, 559-566, 573, 577, 590, 664, 755-766, 818-822, 919, 923, 925, 929, 930, 937, 981, 1035, 1036, 1040-1042, 1069-1070, 1081-1085, 1116, 1223, 1228, 1361, 1368-1372, 1374, 1391, 1436, 1565-1567, 1627

Morphology and development

193, 195, 216, 249, 332, 336, 340, 393, 517, 710-714, 726, 765-766, 835-837, 868-869, 881-882, 977, 1032, 1091-1095, 1114, 1132-1133, 1141, 1200-1202, 1207, 1212, 1257-1258, 1285, 1329, 1376, 1328-1385, 1429, 1435, 1492, 1547-1548, 1591-1592, 1596-1597, 1607, 1618, 1619, 1635, 1638, 1639, 1643, 1646, 1651, 1657, 1659, 1677, 1682, 1692, 1693

Physiology

477, 478, 489, 665, 871, 872, 900, 1200-1202, 1491, 1554-1544, 1558, 1599, 1610, 1612

Karyology and genetics

115, 117, 119, 120, 124-128, 587-591, 678, 702-703, 833, 1068, 1113, 1194, 1231-1237, 1239, 1241-1247, 1281, 1286-1287, 1292-1295, 1297-1299, 1313-1315, 1332, 1386-1387, 1393-1394, 1399-1403, 1409, 1410, 1427, 1448-1449, 1463, 1484, 1485-1488, 1496-1498, 1518, 1542-1543, 1573, 1584, 1595, 1673, 1687, 1688

International Bat research meetings in former Czechoslovakia

The infamous Iron Curtain essentially limited possibilities of contact of Czechoslovak bat researches with the colleagues from Western countries. Its weakening by political movement of the year 1968 and again in eighties made it possible to organize in this country the international meetings which provided a unique chance to put together both the western scientist and colleagues from the countries behind the Iron Curtain, particularly the former Soviet Union, whose chances to meet the Western colleagues were even more restricted than those for the Czechoslovak students.

Here we will remember three such meetings: (1) the 1st International Bat Research Conference in 1968 (organized by Vladimír Hanák and Jiří Gaisler) - the meeting starting the ongoing tradition of the International Bat Research Conferences. (2) The 2nd Mammalogical Congress (2nd Congressus Theriologicus Internationalis) which took place in Brno 1978 (organized by Josef Kratochvil and collaborators - including Jiří Gaisler, Jan Zima a.o.) and (3) the 4th European Bat Research Symposium held in 1987 in Prague (convened by Vladimír Hanák, Jiří Gaisler and Ivan Horáček).

First International Bat Research Conference

by **Jiří Gaisler and Vladimír Hanák**

The idea to organize an international conference of experts in bat research began with discussions between Beatrica Đulić (Zagreb, Yugoslavia) and Jiří Gaisler (Brno, Czechoslovakia) in 1965. The inspiration came from the 1960 Symposium Theriologicum, the first international meeting of mammalogists, convened by Josef Kratochvíl in Brno. The discussions were facilitated by exchange visits of Đulić to Brno and Gaisler to Zagreb during collaborative field studies. At this time Europe was divided into democratic "west" and communist "east" and it was easier for westerners to visit an eastern country than vice versa. The then Czechoslovakia seemed to be a good place for an international meeting since it provided relatively good opportunities (politically) for participation of scientists from both parts of Europe and even from the US and other remote countries.

Subsequent meetings between J. Gaisler, Vladimír Hanák, and Milan Klíma concluded that the 1st International Bat Research Conference should be held in Hluboká n. Vltavou, a small town in southern Bohemia with a large castle. Preparations were made, including financial backing from Charles University in Prague (employer of Hanák) and the Institute of Vertebrate Zoology in Brno (employer of Gaisler and Klíma), to convene the meeting in 1967. At the time, such an international meeting required the support of the Czechoslovak Academy of Science who, in addition to having the scientific responsibility, was supervised by the state security office (STB). However, the Presidium of the Academy refused to allow the bat research conference to be held in 1967 because "the meeting had not been sufficiently prepared". In the following months, Hanák, Gaisler, and Klíma persuaded the Academy leaders to allow them to organize the meeting in 1968, the year of political changes introduced by Alexander Dubček and his "progressive" communist clique. Although the regime was still far from democratic, the citizens of Czechoslovakia had witnessed a renewed sense of freedom. The conference was scheduled for 6-9 September 1968 and announcements were sent to colleagues from both "western" and "eastern" countries. The proposed conference met with great enthusiasm, about 100 participants were registered. Yet, two weeks before the scheduled date, Soviet military troops invaded Czechoslovakia.

References

Gaisler J., Hanák V., 1969: Foreword. Proceedings of the First International Bat Research Conference. Lynx, n.s., 10: 5-6.

Kunz T. H., Gaisler J., Koopman K. F., Racey P. A., Findley J. S., Marimuthu G., Augee M. L., Horst G. R., 1995: International bat research conferences. Historical glimpses. 10th IBRC, Boston, 9 pp.

Participants at the conference on 7th September 1968.

From left to right: Paul and Priscilla Racey, J. Dorgelo, S. Daan, J. Kopecká, G. Neuweiler, B.Neuweiler, S. Braaksma, W. Černý, M. Klíma, V. Hanák, R. Obrtel, J. Nesvadbová, H. Roer, V. Novotný. Photo by J. Gaisler.

In spite of the ominous situation, the 1st IBRC was held at the art gallery of Hluboká Castle, on 6th and 7th September, i.e. two days less than planned. The meeting was convened by Jiří Gaisler (Institute of Vertebrate Zoology, Czechoslovak Academy of Sciences, Brno) and Vladimír Hanák (Department of Zoology, Faculty of Science, Charles University, Prague). Fifteen participants attended the conference, seven from Czechoslovakia, three from the Netherlands, three from the Federal Republic of Germany, and two from the United Kingdom. Oral papers were presented by S. Braaksma (Vreeswijk), S. Daan (Amsterdam), J. Dorgelo (Amsterdam), G. Neuweiler (Tübingen), V. Novotný (Brno), P. Racey (London), and H. Roer (Bonn). The results of bat banding in Czechoslovakia by J. Gaisler and V. Hanák were displayed as a single poster. An excursion through southern Bohemia was made on 7th September. A part of the participants then

joined a post conference trip to Moravia where they visited the caves in the Moravian Karst as well as southern Moravia. The excursion was closed at Lednice on 9 th September 1968. The proceedings of the 1st IBRC, edited by J. Gaisler and V. Hanák, were published in the journal Lynx, Vol. 10, 1969, and included 14 papers. Some of these papers were submitted by scientists who had planned to attend the meeting, but were discouraged to participate because of the military intervention against Czechoslovakia. For details see Gaisler & Hanák (1969) and Kunz et al. (1995).

The meeting in Hluboka, 1968, started a conference series which by its geographic and conceptual coverages, number of participated scientists, and/or by its impact upon the progress of the discipline presents undoubtedly the most important and respectful assembly of bat scientists. Starting in 1968, the IBRC series has mapped the pathways of development of the discipline, and has provided a prominent platform for introducing new conceptual and methodical issues and fruitful discussions on biology, taxonomy, biogeography, morphology, behavior, evolution and all other topics in study of bats.

LIST OF INTERNATIONAL BAT RESEARCH CONFERENCES

1ST	1968	CZECHOSLOVAKIA, HLUBOKA N. V.
2ND	1970	THE NETHERLANDS, AMSTERDAM
3RD	1972	YUGOSLAVIA, PLITVICE
4TH	1975	KENYA, NAIROBI
5TH	1978	USA, ALBUQUERQUE
6TH	1982	NIGERIA, IFE
7TH	1985	UK, ABERDEEN
8TH	1989	AUSTRALIA, SYDNEY
9TH	1992	INDIA, MADURAI
10TH	1995	USA, BOSTON
11TH	1998	BRAZIL, PIRENOPOLIS
12TH	2001	MALAYSIA, BANGI
13TH	2004	POLAND, MIKOLAJKI
14TH	2007	MEXICO, MERIDA
15TH	2010	CZECH REPUBLIC, PRAHA

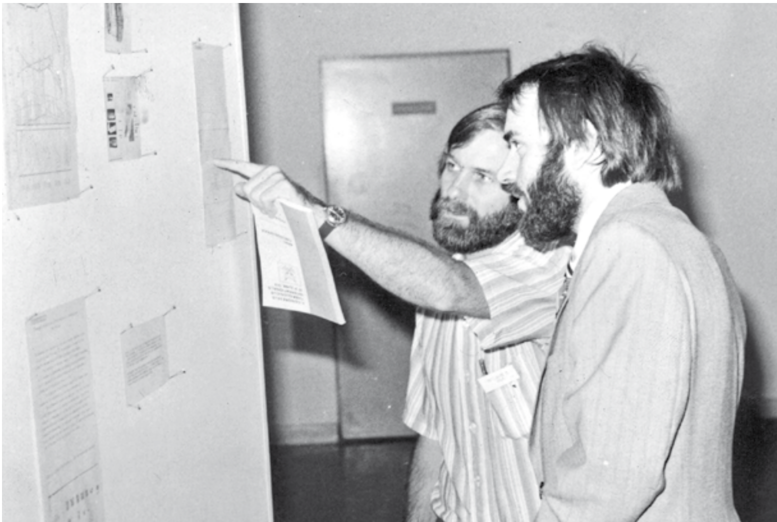
The 2nd International Mammalogical Congress (2nd Congressus Theriologicus Internationalis) was held in 1978 in Brno, four years after the 1st Congress in Moscow became a unexpectedly large and successfull meeting of the mammalian specialists throughout the World. It was attended by almost all then prominent mammalogist from both sides of Iron Curtain and number of the your scientists for whome it become a vivid platform for actual integration of conceptual and methodological issues and actual international cooperation. The Congress was attended by a number of bat specialists and provided a paintfull illustration of current trends in bat research and interfaces of bat studies with other topics of mamalian zoology.

The people at the 2nd ITC 1978:

among others J. Kratochvíl, A. Kolb, J. Niethammer, Z. Bauerová, J. Gaisler, A. F. De Blase, S. Andeson, K. F. Koopman, G. Topál, B. Đulic, G. Corbet, J. Zima, I. Horáček, B. W. Woloszyn, F. Dusbábek, K. Bauer, F. Spitzenberger, D. E. Wilson





The 4th European Bat Research Symposium was another large international bat meeting organized in former Czechoslovakia. It attracted then quite a large number of participants and resulted also in a voluminous proceedings „European Bat Reserch 1987“ edited by V. Hanák, I. Horáček and J. Gaisler in Charles University Press, 1989. The series of the European Bat Research Symposia started in 1981 in Bonn by the 1st EBRS convened by Uwe Schmidt and Hubert Roer. Starting with the Aberdeen and Prague EBRS are the largest assemblies of European bat students, both professional and amateur naturalists interested in bat research and conservation.

EUROPEAN BAT RESEARCH SYMPOSIA:

1ST 1981 BONN
2ND 1982 BONN
3RD 1985 ABERDEEN
4TH 1987 PRAHA
5TH 1990 NYBORG
6TH 1993 EVORA
7TH 1996 VELDHOVEN
8TH 1999 KRAKOW
9TH 2002 LE HAVRE
10TH 2005 GALWAY
11TH 2008 CLUJ

Fourth European Bat Research Symposium, Prague, August, 1987

Prague is a wonderful city: the buildings are ancient and impressive, decoration is ornate, there is no litter and almost no graffiti. It was an excellent setting for the Fourth European Bat Research Symposium, held at the Charles University, 18-23 August 1987.

The conference itself lasted for four days with a morning and afternoon session each day. The programme of presented papers included sessions on particular aspects of bat work, such as echolocation, faunistics, foraging behaviour and conservation. There was also a wide range of other subjects covered, including a welcome opportunity to hear about some of the studies in Russia and of work on tropical bats. Those papers submitted for publication will be published in a special volume entitled *European Bat Research: 1987*, under the editorship of the convenors of the symposium. The official language was English, but the more universally understood language was probably German, and many of the talks were delivered in that language. Several talks were in Russian, and a couple were in French. This truly international flavour was interesting, but a bit wearing for someone with the 'English Language Disease'. Although Jiri Gaisler was always on hand, instantly ready to translate from any one language to any other, I confess to missing a few foreign language sessions.

For several reasons this was not important. Firstly, I used the spare time to look around the city, and to examine the 90, mostly excellent, poster presentations. Secondly, the standard of the English spoken papers was enough to compensate, but thirdly because conferences are really little to do with spoken papers. If they were, you would only need a copy of the conference proceedings and a few hours to read them to substitute for attendance. The papers are a means of stimulating discussion and questioning data, but conferences are really about meeting people, exchanging ideas and sharing experiences. The organizers, Drs Hanak, Gaisler and Horacek are to be commended for arranging the many events where this was possible: a boat trip, two excursions into the more rural parts of the country, a sumptuous reception with more than enough food for double the 230 delegates. There was also a concert of early Czech music. Of course, the excursions were not entirely without bat interest. At an evening barbecue at Zihobce in southern Bohemia, one of the major study areas, there was the opportunity to see an impressive range of bat species, which had been trapped for examination and ringing. And an excursion to the Karst region incorporated a visit to a quarry that has produced fossil bats, when one of the delegates found a rare fossil of *Megaderma*.

We left Prague, seven long days after arriving, with more tangible benefits, agreements for collaborative work and new perspectives than from any other conference I have attended. In a decade or so Czechoslovakia will hopefully be host to another European bat research symposium. I for one will be there.

Meanwhile, the Fifth European Bat Research Symposium will be held in Denmark in 1990.

John Speakman
Aberdeen University
(with additional material from the editor)

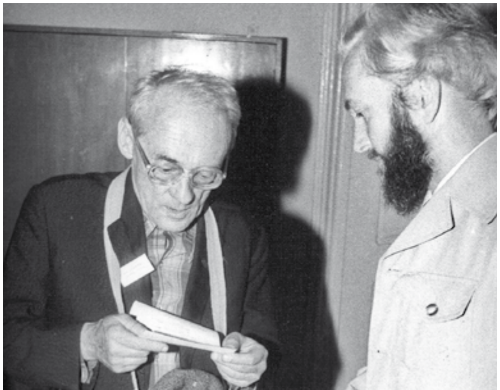






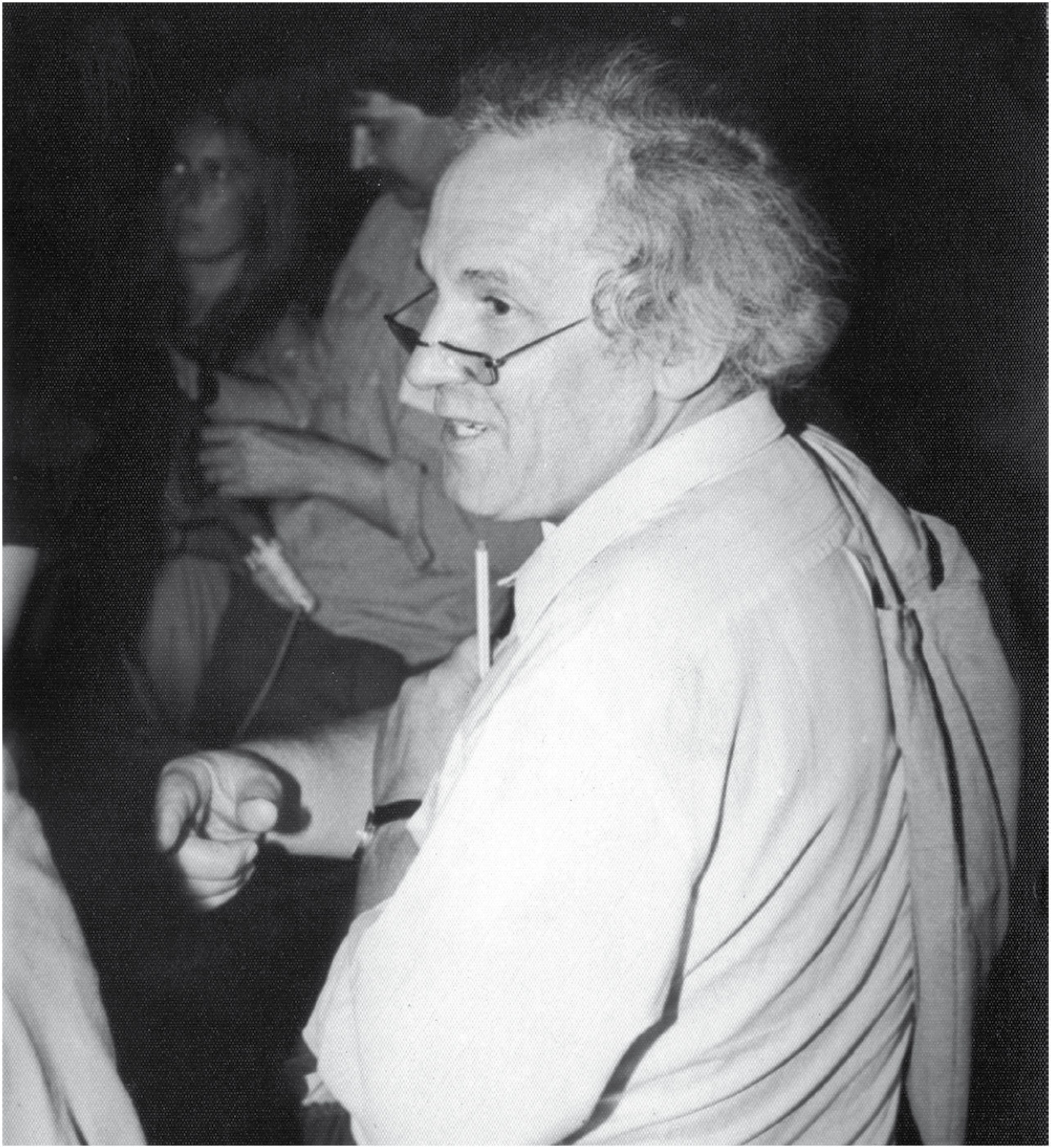
The plenary assembly of the 4th EBRS and some participants:

G. Baron, P. Racey, V. Hanák, G. and B. Neuweiler, U. Schmidt, G. Topál, J. D. Osborn, D. Makin, I. Horáček, A. I. Konstatinov, M. F. Kovtun, S. N. Rybin, A. Krzanowski, R. Stebbings, G. Storch


Some meetings at the 4th EBRC:

W. Bogdanovicz and J. D. Pye, P. P. Strelkov and J. Zima, I. K. Rakhmatulina and B. Đulic, B. W. Woloszyn and R. Obrtel, G. Neuweiler at night field excursion.



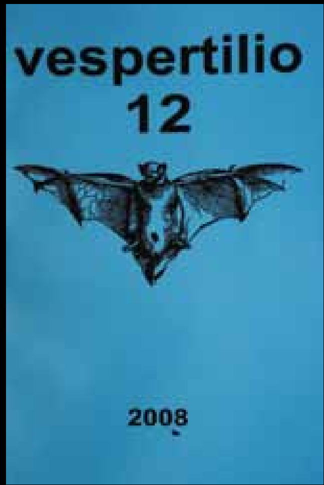
CESON - Czech Bat Conservation Trust

founded in 1991 as a coordination platform of bat research and bat conservation in former Czechoslovakia, since 1993 in the Czech Republic

At beginning of the year 1991, in response to increasing number of bat students, a need of a formal platform for integration of regional bat studies with the projects of then newly establishes Environment Ministry (including international projects such as EUROBATS) and in care for continuity of the long-lasting monitoring of underground hibernacula, the Czechoslovak Bat Conservation Trust (Československá společnost pro ochranu netopýrů – ČESON) was established. After a split of former Czechoslovakia into the Czech Republic and Slovakia in 1993, the regional scope of CESON is restricted to the Czech Republic and its role in Slovakia was taken by a newly established Slovak Bat Conservation Group (SON).

Since then CESON is designed as a non-governmental non-profit organization exclusivelly responsible for coordination of regional bat research and bat conservation efforts in the Czech Republic. It associates about 115 bat students, mostly professional zoologists but also a number of amateur naturalists, speleologists and environmental activists. CESON coordinates a large scale system of bat monitoring programs and a number of various bat research and bat conservation efforts and last but not least organizes the economical support for these activities. It keeps extensive databases of monitoring and distributional records (about 200,000 items), the database of bat banding data (nearly 100,000 items) and archives results of particular ad hoc bat research and conservation efforts. Besides that it promotes various activities in public education (European Bat Nights, exhibitions, editing various materials promoting bat conservation topics – postcards, brochures, leaflets etc.) and provides an instant public information and advisory service. In the recent years some of these activities are in care of two professional employees. Thanks to them CESON started a large-scale programme of a strict control upon current rebuilding projects which might threat bat roosts and spread its focus onto huge number of local and regional bodies engaged in these projects.

For its members, CESON provides a standard platform for presentation of particular outputs and promoting methodical innovations in study of bats. It organizes the annual plenary assemblies (with awarding particular achievements of young bat students with the F.A.Kolenati award), annual field meetings and



in cooperation with SON, it edits the journal Vespertilio founded in 1997. In 14 volumes appearing since then the Vespertilio (edited by Petr Benda and Marcel Uhrin) published more than 200 research papers and notes. Of them the voluminous issues 5 and 6 catalogizing the underground hibernacula in Czech Republic (5) and Slovakia (6) and summarizing the monitoring data from ther are particularly worth of mentioning.

Promotion of bats and environmental activities for public

Daniel Horáček, Blanka Lehotská, Roman Lehotský

Bats as the animals which public view is traditionally draped in mysteries and fables influencing the way people perceive the world around and environmental topics, present the group which promotion can play a role of a key point of the public environmental education. This fact has been in full responded particularly during the last 15 years.

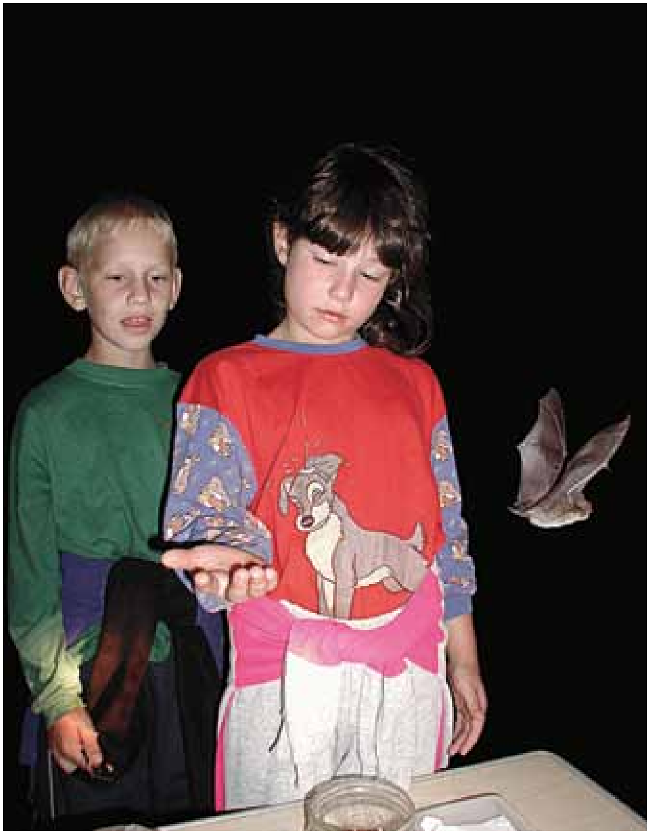
In the Czech Republic, Czech Bat Conservation Trust (Česká společnost pro ochranu netopýrů, ČESON) plays since its beginning a key role in that direction. Czech Union for Nature Conservation (Český svaz ochránců přírody, ČSOP) as well as Czech Speleological Society (Česká speleologická společnost, ČSS) are also active in promotion of bat conservation topics in the Czech Republic.

In the Slovak Republic, several associations work with environmental education in the field of bats conservation: Slovak Bat Conservation Society (Spoločnosť pre ochranu netopierov na Slovensku, SON), Miniopterus – Basic organization of the Slovak Union for Nature and Landscape Conservators (Základná organizácia Slovenského zväzu ochrancov prírody a krajiny Miniopterus, ZO SZOPK Miniopterus) and Bambi – Center for Environmental Education (Stredisko environmentálnej osvety Bambi, SEO Bambi). Slovak Caves Administration (Správa slovenských jaskýň, SSJ), State Nature Protection of the Slovak Republic (Štátna ochrana prírody Slovenskej republiky, ŠOP SR), East-Slovakian Museum in Košice and Homeland Museum in Hanušovce nad Topľou.

The above mentioned organizations provide information about bats and current events also on their webpages: www.ceson.org, www.csop.cz, www.netopiere.sk, www.miniopterus.sk, www.ssj.sk, www.sopsr.sk, and other.

European Bat Night

European bat night is a yearly highlight of bats conservation promotion. The Czech and Slovak Republic joined this European event already in 1998, when it took place for the second time in Europe. The original number of localities in the Czech Republic grew from three to 34 and the initial number of visitors grew from 100 (1998) to more than 3400 in 2009 (Tab. 1). The localities where the European bat night takes place cover evenly the whole territory of the Czech



Republic. European bat night is also very well known in Slovakia. It takes place in a number of towns. It has already taken place in Bratislava several times, as well as in Jasov, Liptovský Hrádok, Košice, Nitra and Revúca (Tab. 2). Museums, ZOOs and other institutions co-organize this event as well.

Beside its direct impact on the public, this event also had a very positive feedback in the media. It proved very suitable to organize the European bat night in a place easily accessible from the city or town, where it is possible to catch bats, show them alive and release them immediately afterwards. Lectures on bats focused also thematically are mostly completed by netting, detectoring, demonstration of chiropterological and speleological tools, games and competitions for children.

Other activities

* *Winter sleepers (Zimní spáči, Modra, 2000-2002)* – weekend camps were targeted at elementary school pupils with a deeper interest in nature. Activities were aimed at getting to know the life of bats, determining them and at basics of a safe stay in the underground. Pupils in small groups searched for and (using a simplified key for determination) also determined hibernating bats. Games and competitions with the topic of

Table 1: European Bat Nights (EBN) in the Czech Republic.

Year	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Number of places	3	?	?	14	10	16	18	21	21	26	27	34
Number of participants	100?	?	?	838	897	1756	1766	1731	1742	2176	2607	3414

Table 2: European Bat Nights (EBN) in the Slovak Republic.

Year	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Number of places	1	1	0	1	0	1	1	3	6	3	2	3

bats were also a part of the camp stay. The project received a prize from Slovak environ-mental agency and Field Studies Council (Great Britain).

* *The international bat camp in Záhorie region (Medzinárodný tábor špirhoncov a trulelkov, Malacky, 2005)* – a camp aimed at experience and techniques exchange when acquiring data on bats and mapping their occurrence in Záhorie region. The participants, mostly high school and university students, were from Slovakia, Czech Republic and Germany. This camp served as an inspiration for other similar, also professionally oriented terrain meetings in Slovakia.

* *Myths, superstitions and reality (Mýty, povery a skutočnosť, Hanušovce nad Topľou, 2005-2008)* – a public event aimed at lectures on bats and demonstrations of catching them. It takes place regularly as a part of the Museum night.

* *Bat rescue (Netopieria záchranka, Bratislava, since 2008)* – the aim of this project is active help for public when dealing with bats related problems. It is actually a telephonic and e-mail counseling; in Bratislava and its surroundings also catching of bats "gone astray", solving problems of summer and winter colonies in buildings and a short-term rehabilitation of worn-out or injured bats. In 2008, 74 cases were solved and in 2009 up to 140.

* *Park as a green oasis for people and bats (Park ako zelená oáza pre ľudí i netopiere, Nitra, 2008)* – the aim of this project was to plant trees and to improve roosting possibilities of bats in the public park in Nitra by installing bat-boxes. Two information boards about bats in the town park and those in the town were installed within the project. 30 boxes for bats were hung and high school and university students helped with their construction.

** School upside-down (Škola hore nohami, Nitra, 2009)* – this project was aimed at creating compensatory shelters for wintering species *Nyctalus noctula* in blocks of houses, where because of the insulation works gaps suitable as their shelters disappear. Boxes for bats were installed on the building of an elementary school. Pupils helped with painting of these boxes.

** Bats in buildings – problems and solutions (Netopiere v budovách – problémy a riešenia, 2009)* – seminars organized in several Slovak towns aimed at solving problems with bats in the buildings, caused mainly by massive insulation works on blocks of houses in towns and cities. They were designed for professional public – construction companies, housing associations, environmental authorities, state nature protection, NGOs, but also for interested persons from the public.

Exhibitions

** Mysterious neighbours* - a museum exhibition on bats, bat research and bat protection with accompanying lectures and public promotions by Dita Weinfurtová and Antonín Reiter in 2001. Several thousands of visitors appreciated the exhibition first in Central Bohemian Museum Beroun and then in the South Moravian Museum in Znojmo.

** Bats of Liberecko or they live here with us (Netopýři Liberecka aneb žijí tu s námi, Czech Republic, 1999-2001)* – this vernissage took place in the cellars of the Grábštejn castle and then wandered across several places within Liberec. It was also installed in the municipalities Osečná, Jablonec, in the museum in Česká Lípa, in the foyer of Bozkov dolomite caves, in Museum na Jizerce, and a number of schools in Lužické hory Mts.

** Caves fauna (Fauna jaskýň, Košice, 1999-2000)* – exhibition for public was installed in the Eastern Slovakia Museum at the occasion of a scientific seminar with international participation "Caves fauna". Photographs and museum preparations of bats from the whole Slovakia were a part of the event.

** Špirhač – Gacek – Trúlelek (Slovakia, since 2005)* – this is the first traveling exhibition of bats in Slovakia. It introduces the issue of bats occurrence and conservation to the broad public through the form of 14 exhibition panels, as well as museum preparations of particular bat species and exhibition of publications about bats. Gradually it was installed in the following towns: Trebišov, Michalovce, Ružomberok, Rožňava, Moldava nad Bodvou, Košice, Hanušovce nad Topľou, Dlhá Ves, Prešov, Rimavská Sobota, Veľký Šariš, Bratislava, Levice, Banská Bystrica.

Promotion materials

The quality of promotion depends on the willingness of renowned scientists to dedicate their free time and skills to this activity, but it also very much depends on the volume of finances available. Thanks to this many publications could have been published. Pexeso, jigsaw, puzzles, and coloring books, various kinds of postcards, bookmarks, stickers, calendars and similar promotion materials are designed for children and youth in particular. More professionally oriented are brochures and booklets, which introduce methods of bats conservation and eventually also care for handicapped individuals. In the Czech Republic, the following materials have been published recently: Bats in buildings (Netopýři v budovách), Care for bats (Péče o netopýry) and Protection of swifts and bats at buildings reconstructions (Ochrana rorýsů a netopýrů při rekonstrukcích budov). In Slovakia: Bats in undergrounds (Netopiere v podzemí), Bats in attics (Netopiere v podkroviach), Bats in blocks of houses (Sídliskové netopiere), Bats in towns (Netopiere v mestách), Conservation of bats in Slovakia (Ochrana netopierov na Slovensku), Conservation of bats at reconstructions of blocks of houses and in buildings attics (Ochrana netopierov pri rekonštrukciách panelových budov a podkroví budov). A 20 min TV document Censusing bats (by Jan Hošek and Ivan Horáček) from 1995, and recenty finished 30 min. TV movie Bats in the Darkness by the same authors are also worth of mentioning.

The best known Slovak book for broad public „Bats – mysterious inhabitants of caves“ (Netopiere – tajomní obyvatelia jaskýň), was recently supplemented also by video presentations Bats – mysterious inhabitants of caves (Netopiere – tajomní obyvatelia jaskýň), Insight into the life of a mouse-eared bat summer colony (Pohľad do súkromia letnej kolónie netopiera obyčajného) and a student

DRUHY VYUŽÍVAJÚCE PANELOVÉ DOMY

PREČO SÚ NETOPIERE V MESTÁCH?

ČO ROBIŤ, AK CHCETE MAŤ NETOPIERE?

Netopiere v mestách

Spoločnosť pre ochranu netopierov na Slovensku

film Unknown neighbors (Neznámi susedia) is being finished.

Promoting conservation of bats and environmental education in this field has reached a significant progress in recent years in the Czech and Slovak Republic. Besides concrete events and publishing of promotion materials also media (television, radio, press, and internet) play their role in familiarizing public with bats. The contribution of all these activities becomes evident mainly through the fact that the public view of bats is positively changing and when encountering bats or problems related to bats, people more frequently search for a qualified help from professionals – chiropterologists.

Bat rescue center in Prague

Helena Jahelková, Anna Bláhová, Jana Neckářová, Dagmar Zieglerová

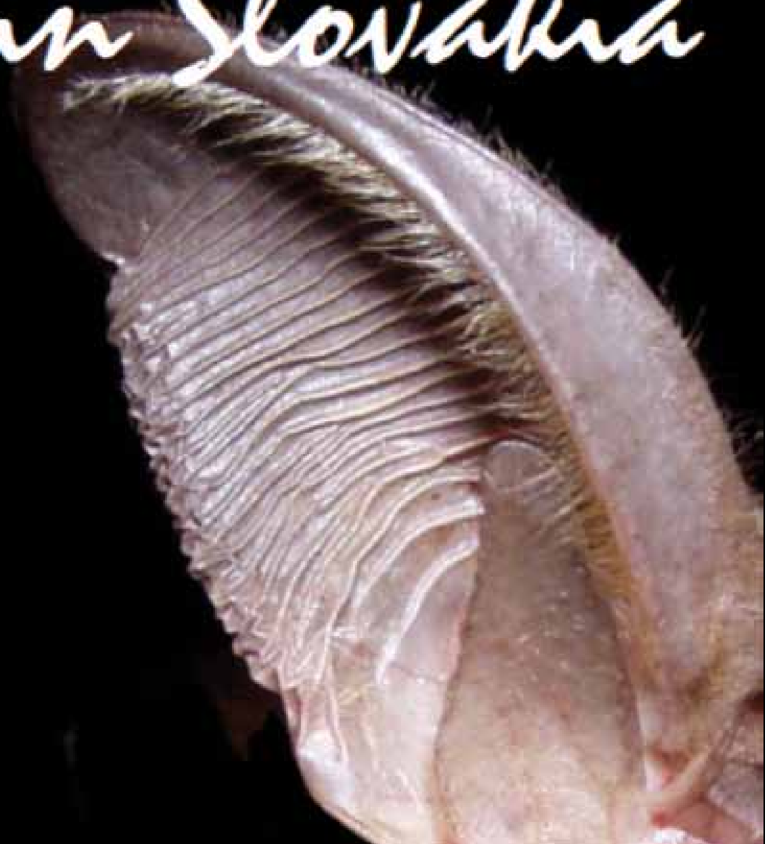
The Bat rescue center „Nyctalus“ was established in 2006. The main aims are rescue of individual bats and colonies, care for handicapped bats (close cooperation with vet specialist), monitoring of bat occurrence in Prague and surroundings, and public education. Since 2005, when constituent members worked separately, were accepted 702 bats of 16 species, above all *Nyctalus noctula* (84%), *Vespertilio murinus* (6%), *Eptesicus serotinus* (3%), *Pipistrellus nathusii, P. pipistrellus, P. pygmaeus, Myotis mystacinus, M.brandtii, Eptesicus nilsonii, Nyctalus leisleri, Plecotus austriacus, P. auritus, Barbastella barbastellus, Myotis daubentonii, M. naterreri* and *M. bechsteinii.*

Most findings of migratory bats such as *Pipistrellus nathusii* or *Vespertilio murinus* were situated along Vltava river, in particular during autumn and spring. This points out to the importance of Vltava as a migration route.

Systematic education and propagation increased number of notifications every year. Most of individual bats were found by public in their flats or streets during winter changes of temperature or during summer, when juveniles are fledged. Most winter colonies were found during warming rearrangements of blocks of flats in a countrywide project, and by cutting old hollow trees. Number of individuals in received winter colonies ranged from 14 to 600.

The most common injuries include torn wing membrane, fractures of fingers and arms, which were caused primarily by cat attacks. After recovery, handicapped bats are used in public display and education programs for children or adults.

Conservation of Bats in Slovakia



SON - Slovak Bat Conservation Group

since 1993 coordination platform of bat research and bat conservation in Slovakia

Forests

Due to forest practices in intensively managed forests, the loss of foraging habitats and suitable tree-hollows is an important influence on several bat species. The demands differ according to the individual species and habitat; also in the case of the indigenous Western Carpathian forests. Many of the stands are still composed of natural tree species and some of them are unique primeval forests. They are one of the most important but still heavily exploited central European ecosystems. European activity NATURA 2000 is one of the ways for protection of forest bats. Also the presence of bat species of European importance (e.g. horseshoe bats, mouse-eared bats, Bechstein's bat and barbastelle) was a background in definition of Special Protected Areas. The nature friendly forest management can provide sustainable conservation of bats and their habitats.

Colonies of Daubenton's bat (Myotis daubentonii) depends on suitable tree-hollows

Forest-dwelling brown long-eared bat (Plecotus auritus) gleans prey from foliage

People

Slovak Bat Conservation Group (SON)

Non-government organisation focused on the protection and research of bats and their habitats as well as public awareness activities in Slovakia. It has been established since 1993 and associates professional and amateur bat workers.

c/o: Institute of Forest Ecology SAS
Štúrova 2, SK–960 53 Zvolen, Slovakia
email: info@netopiere.sk
web: www.netopiere.sk

State Nature Conservancy of the Slovak Republic

Organisation of the Ministry of Environment of the Slovak Republic which provides habitat and species protection, coordinates research and monitoring, secures expertises, consultations and environmental education and participates in international cooperation in nature conservation.

State Nature Conservancy SR
Lazovná 10, SK–974 01 Banská Bystrica, Slovakia
email: sopsr@sopsr.sk
web: www.sopsr.sk

SNC SR – Muránska Planina National Park Office
J. Kráľa 12, Sk–050 01 Revúca, Slovakia
email: snpmp@sopsr.sk
web: www.muranska-planina.net

Published by © Slovak Bat Conservation Group & Muránska Planina National Park Office (2005)

Nurseries

More than 3000 buildings and their roof attics have been surveyed since 1996. Several house-dwelling bat species (mainly horseshoe bats, great mouse-eared bats, Geoffroy's bats, serotine bats and long-eared bats) occupied often church and other old attics as a nursery roosts. Cleaning bat guano from roof attics is an effective conservation measure for large colonies (commonly some hundreds females). In the case of roof reconstruction, the timing of works to minimise disturbance, creation of bat friendly entrances and limited access areas to protect bats are being advised on. Cooperation with house owners and use of bat guano in gardening by local people can raise public awareness.

Large nursery colonies produce a large amout of bat guano

Lesser horseshoe bat (Rhinolophus hipposideros) is still commonly breeding in roof attics

Hibernacula
Hibernacula

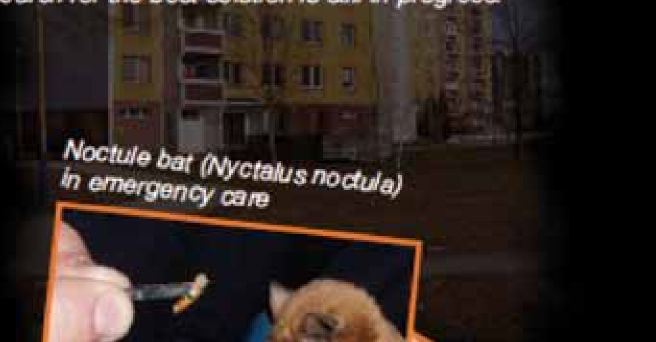
Greater mouse-eared bat (*Myotis myotis*) is one of the most frequent hibernating species in underground

Strict protection of the mass hibernacula demand our attention

More than 300 winter roosts (mainly caves and old mines) are monitored each year. Some underground hibernation sites are occupied by numerous assemblages for long-term periods. Mass winter roosts (even some thousand individuals) are known for common pipistrelle, barbastelle and Schreiber's bat. The majority of the conservation activities involve reconstruction (e.g. vegetation cutting) or gating of cave and mine entrances to provide suitable fly paths and to avoid human disturbance of bats (in cooperation with the Slovak Cave Administration). All caves are protected by law. Some of them are included in UNESCO natural heritage and other underground habitats (e.g. Dubnicke bane Mines) were established as specially protected natural monuments, due to important presence of bats.

Prefabs
Prefabs

The conflicts between bats and human dwellers in prefab houses are going to be a serious problem in the near future. During the last decade, occurrence of noctules (partly also pipistrelles and parti-coloured bats) considerably increased in prefab settlements in towns (especially in autumn and winter). Bats (sometimes in hundreds) occupy attics and crevices between panels. Noise disturbance, the presence of droppings and individual bats entering the living area causes problems for the occupants. Structure of prefab buildings (ventilation shafts) can be also an dangerous trap for bats. Also bats may be killed during reconstruction works (e.g. thermal insulation of walls). Several cases were successfully resolved through timing of works to minimise disturbance, translocation or evacuation of bats, and emergency care of exhausted bats but new cases are still appearing. A search for the best solution is still in progress.



Noctule bat (*Nyctalus noctula*) in emergency care

Prefab house-dwelling bats are also active during winter

long-term projects I

bat banding

Results of bat banding in the Czech and Slovak Republics, 1948-2000

by **Jiří Gaisler, Vladimír Hanák and Vladimír Hanzal**

Prior to the marking bats with forearm bands, Seidel (1928) published a paper describing his experiments with marking bats by perforating a number in their wing membranes. At least some of his 150 tattoed bats were released in northern Bohemia, on the territory of the present Czech Republic, but results of this experiment were never published. Bat banding (= ringing) in the then Czechoslovakia started in 1948. Ornithological rings designed for passerine birds, types M and N, were applied to bats in 1948-1957. Since 1958, special bat bands of two sizes have been used: larger bands, height 6 mm, outer diameter 5 mm, weight 0.105 g; and smaller bands, height 5.5 mm, outer diameter 4 mm, weight 0.082 g. Originally, the series of larger bands were denoted by Y, that of smaller bands by V, followed by a digital code. Later on the letters were replaced by X, alternatively the bands had only a number without any letter. The signature (address) of all bands was N. MUSEUM PRAHA (National Museum, Prague). All combinations of a letter with a number or of numbers only were mutually exclusive. In addition to bat bands, ornithological bird rings have been reintroduced to mark bats sometimes in 1995. Rings of the types N, S, T and Z were of similar sizes and weights as the bat bands and their address was the same. Since the bat bands proved to do more harm to bat wings than did the bird rings (Reiter 1998), bird rings were preferred during the last years of the period covered by this contribution, i.e. towards the end of the past century.

When bat banding started, there were no Czech and Slovak Republics but Czechoslovakia, and this situation existed within the greater part of the period of the organized catch-mark-recapture programme focussed on bats. Therefore all summary publications dealing with the results of marking bats concerned the combined territory of the present Czech and Slovak Republics (Hanák et al. 1962, Gaisler & Hanák 1969 a, b. c, Hanák 1989, Hanzal & Jarský 2000, Gaisler et al. 2003). Brief summary of these data with the emphasis on recorded movements was later submitted to a general publication on bat migrations in Europe (Hutterer et al. 2005). In addition to the summary papers, numerous (roughly 300) studies by Czech and Slovak authors were published concerning particular problems of bat distribution and biology and more or less based on marking and recapturing. They concerned the methodology (e.g. the use of coloured bands in investigating bats), autecology of selected species (*Rhinolophus hipposideros*, *Myotis myotis*, *Myotis emarginatus*, *Miniopterus schreibersii*, *Pipistrellus* and *Plecotus* species etc.), bat movements and life span and studies monitoring bat diversity and numbers in selected regions and/or localities. All such studies published until 2000 are listed in Gaisler et al. (2003), some of them also in Horáček (2001) and Uhrin et al. (2002). The paper by Horáček is an introduction to a series of 39 papers dealing with the results of long-term monitoring of bat populations in the Czech Republic, some of them partly related to banding. The paper by Uhrin et al. is an introduction to a series of 102 papers of similar content with respect to the Slovak Republic. End of the year 2000 represents the dead-line concerning the results of bat banding dealt with in the present paper. When discussing important problems, e.g. the maximum age, this dead-line is disregarded.

Material and methods

Within the years 1948-2000, 89,108 bats of 23 species were banded on the territory of the former Czechoslovakia. However, the two phonic species of pipistrelle bats, 45 kHz *P. pipistrellus* and 55 kHz *P. pygmaeus*, were not discriminated in the sample but lumped under the name *P. pipistrellus*, thus the real number of banded species could be 24. Additional three bat species, at present known from the combined Czech and Slovak territories, *Nyctalus lasiopterus*, *Hypsugo savii* and *Pipistrellus kuhlii*, were not banded during that time. The situation is obscure concerning *Myotis alcathoe*. While the possibility of banding some *M. alcathoe* in samples labelled *M. mystacinus* or *M. brandtii* cannot be excluded, it seems less probable than including *P. pygmaeus* into *P. pipistrellus*. The reason is in the very particular ecology of *M. alcathoe* (see Lučan et al. 2009).

For banding and recapturing, individual bats or bat clusters were mostly collected by hand, a pair of forceps, a hand net or mist-netted. During the early years, the rings to mark bats were distributed by the Czechoslovak Ornithological Society. In 1957, a Bat Banding Station was established, formally attached to the National Museum in Prague. For a short time, J. Gaisler was its first and J. Figala its second head. In 1960, V. Hanák became the head of the station. With him, the distribution of bands and the administration of the whole programme of bat banding in Czechoslovakia moved to the Department of Zoology, Faculty of Science, Charles' University in Prague. Hanák did the work for more than 30 years up to 1994 and created a large data base, at that time without any assistance of a computer. Since 1995, bat banding has been organized by the statutory nature conservation agency and the data base was computerised. The head became V. Hanzal and the Agency for Nature Conservation and Landscape Protection in Prague became the seat of the Bat Banding Office. This situation did not change, at least concerning the Czech Republic, until 2005.

Following persons, in alphabetical order, took part in banding and recapturing bats on the territory of the former Czechoslovakia up to the end of 2000: J. Andreska, Z. Bárta, T. Bartonička, Z. Bauerová, P. Benda, L. Bufka, P. Bürger, Z. Buřič, W. Černý, J. Červený, Š. Danko, L. Dvořák, P. Eleder, J. Figala, I. Flasar, J. Flousek, J. Gaisler, I. Grulich, P. Hanák, V. Hanák, V. Hanzal, D. Horáček, I. Horáček, V. Hrabě, L. Hůrka, J. Chytil, M. Jóža, M. Jurík, P. Kaňuch, T. Kašpar, M. Klíma, B. Král, J. Krátký, R. Lučan, I. Málková, B. Matoušek, F. Matoušek, B. Mikátová, P. Miles, A. Mošanský, M. Nevrlý, J. Palášthy, K. Petrželková, M. Pokorný, M. Průcha, A. Reiter, P. Rödl, Z. Rumler, Z. Řehák, J. Sklenář, B. Slavík, J. Souček, Z. Šebek, B. Urbánek, M. Uhrin, J. Vachold, M. Vlašín, K. Weidinger, J. Zejda, J. Zima, J. Zukal, J. Žalman.

Results and discussion

Following are the numbers of bats banded per species, with the number of recaptured individuals (in parentheses): *Rhinolophus ferrumequinum* 762 (136), *R. hipposideros* 6,172 (851), *R. euryale* 499 (5), *Myotis mystacinus* 2,493 (95), *M. brandtii* 1,334 (107), *M. emarginatus* 3,368 (276), *M. nattereri* 3,902 (256), *M. bechsteinii* 885 (31), *M. myotis* 24,595 (4,253), *M. blythii* 1,102 (122), *M. daubentonii* 9,193 (1,244), *M. dasycneme* 113 (10), *Pipistrellus pipistrellus* 7,978 (208), *P. nathusii* 90 (5), *Nyctalus leisleri* 192 (9), *N. noctula* 3,073 (240), *Eptesicus nilssonii* 1,723 (148), *E. serotinus* 710 (33), *Vespertilio murinus* 377 (27), *Barbastella barbastellus* 8,650 (973), *Plecotus auritus* 7,919 (518), *P. austriacus* 2,477 (184), and *Miniopterus schreibersii* 1,501 (111). In total 8,600 bats were recaptured what amounts to 9.65 % of those banded. Some of the individuals were recaptured several times and the total number of recaptures was 12,552 (14.08 %). The effectiveness of the method, as measured by the recovery rate, was highest in *M. daubentonii* (26.8 % of recaptures) and *R. ferrumequinum* (21.4 %). In some species, mainly those hibernating in caves and artificial underground spaces, total numbers of banded individuals may correlate with their real abundance. This is the case of a generally abundant *M. myotis* compared to a generally rare *M. dasycneme*. In many species their representation in the sample reflects differences in roosting behaviour and methods of search by ringers rather than differences in numbers. No correlation follows from the comparison of recovery rates among species.

In the following ten species, maximum known age was recorded by recapturing bats marked on the territory of the Czech or Slovak Republic: *R. hipposideros*, *M. emarginatus*, *M. nattereri*, *M. myotis*, *M. daubentonii*, *P. pipistrellus*, *E. nilssonii*, *V. murinus*, *P. austriacus* and *B. barbastellus* (tab. 1). In another species, *M. blythii*, its maximum age was recorded by recapturing in Slovakia a bat banded in Hungary. Maximum age found in *M. myotis*, 37 years and one month, was the second highest age recorded in a Palaearctic bat species, after *M. brandtii* from central Siberia. Considering the date of banding, the respective individual of *M. myotis*, marked as an adult male in the Harmanecká cave in Slovakia, could even be older, its potential maximum age was 37 years and 8 months, while that of Siberian *M. brandtii* was 38 years. All these data on longevity refer to the situation by the end of 2000, for details see Gaisler et al. (2003).

New data modified the above maximum known age records of some species. Steffens et al. (2004) published the maximum age of 30 years in *M. daubentonii* from Germany. Khritankov & Putincev (2004) recaptured the same Siberian *M. brandtii* mentioned above. The bat, a male with a ring X-147542, was this time recaptured at the age of no less than 41 years what is the new maximum age of a bat species wordwide. However, in *M. myotis* banded and recaptured in a hibernaculum in eastern Bohemia (Czech Republic), new longevity was recorded as well (Lemberk et al. 2008). A male marked with the ring V 23574 was at least 37 years and 10 months old, but since the individual was marked as an

adult, its potential maximum age was 38 years and 8 months. This is the maximum known longevity in a European bat species and the second maximum age recorded within the order Chiroptera.

In 19 bat species an age of more than 10 years was recorded on the territory of the former Czechoslovakia within the time span dealt with in this paper. The species with the numbers of individuals older than 10 years according to banding data (actual, not potential age) are: *R. ferrumequinum* 6, *R. hipposideros* 17, *M. mystacinus* 7, *M. brandtii* 20, *M. emarginatus* 6, *M. nattereri* 9, *M. bechsteinii* 2, *M. myotis* 89, *M. blythii* 6, *M. daubentonii* 27, *P. pipistrellus* 4, *P. nathusii* 1, *E. nilssonii* 9, *E. serotinus* 2, *V. murinus* 4, *B. barbastellus* 37, *P. auritus* 10, *P. austriacus* 8, *M. schreibersii* 1. No individuals older than 10 eyars were recorded in two rarely banded species, *R. euryale* and *M. dasycneme*, and in bats of the genus *Nyctalus*. Relatively low maximum age in *Nyctalus* species was reported by other authors as well. Our data correspond to certain predictions by Wilkinson & South (2002), namely that bat life span significantly increases with hibernation and cave use and decreases with reproductive rate, e.g. bearing twins. Life span is not influenced by diet or colony size.

In the former paper (Gaisler et al. 2003) bat movements were divided into the movements within the territory of the former Czechoslovakia, foreign records of our bats and records of bats banded abroad on the Czech and Slovak territory. All long-distance movements were documented in maps among other bat banding data from Europe in Hutterer et al. (2005)*.

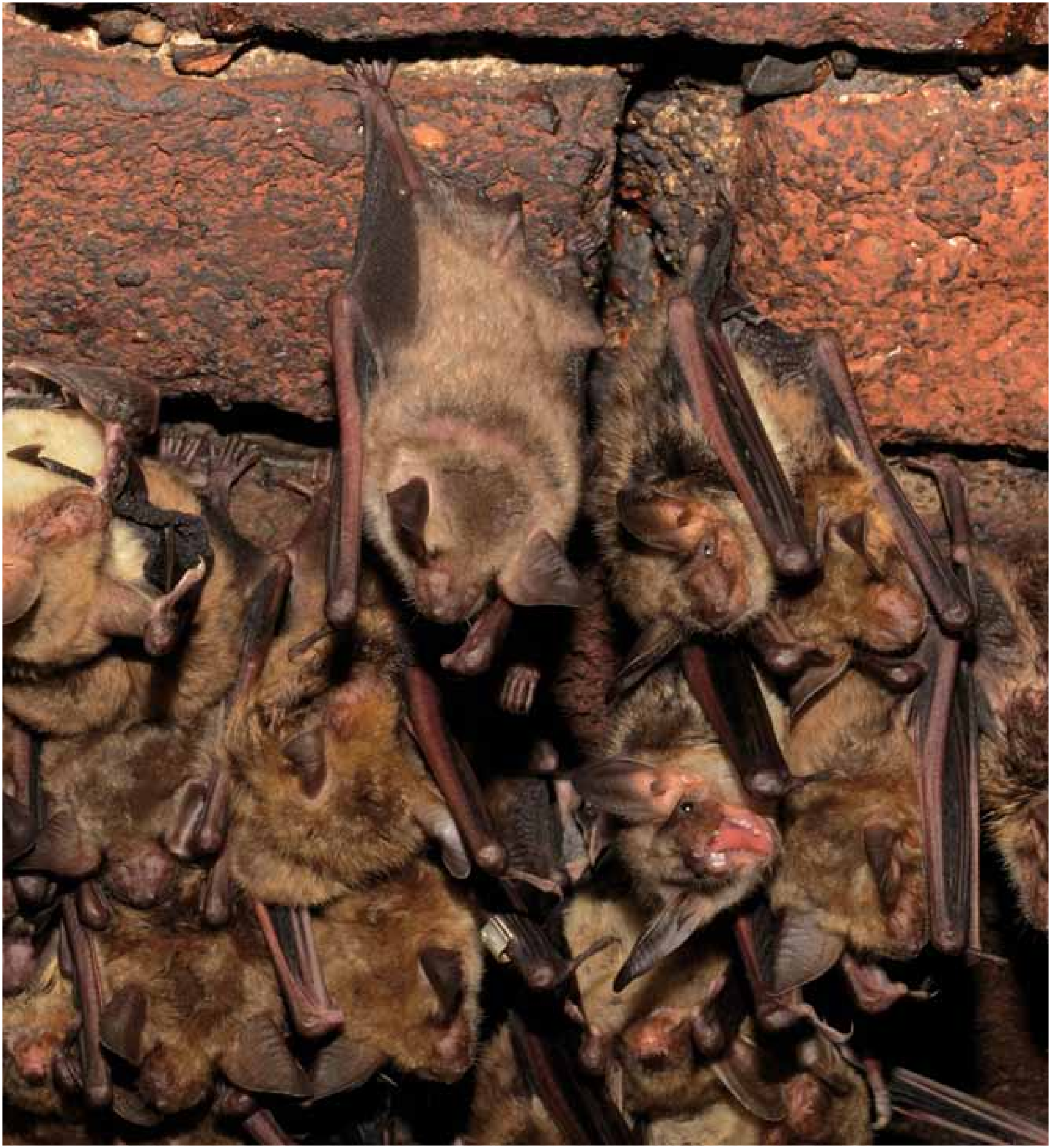
In the former paper (Gaisler et al. 2003) we wrote that in *E. nilssonii* and *P. auritus* the maximum recorded distances exceeded the longest movements recorded elsewhere. This statement resulted from a comparison with the data published by Schober & Grimmberger (1998). However, according to Hutterer et al. (2005), longer movements of the two species were recorded in other countries than the Czech and Slovak Republics. On the contrary, the Czech record of a 61 km long movement in *P. austriacus* was considered the longest movement known in Europe. There is a contradiction with Schober & Grimmberger (1998) who give 62 km as the longest movement of *P. austriacus* what was the reason why we did not consider 61 km a maximum. The authors, however, did not specify the country where from the record of 62 km came. Outside Europe a movement of 79 km was recorded in Armenia (Hutterer et al. 2005).

** The respective paper provided a table on banding totals in relation to country size and species diversity. The rank 1 was given to the Czech Republic for the relative number of bats banded per km^2 (1.132). This, unfortunately, was a mistake. The number of bats banded on the territory of the whole Czechoslovakia was applied to that of the Czech Republic only. When calculating the number of bats banded per km^2 of the former Czechoslovakian territory, we get 0.698. The correct rank is 4, after Germany, Belgium and Switzerland.*

In the present paper we arrange the movements primarily according to species, only when necessary regarding also the situation of banding and recapture localities. Eleven movements have been recorded in *R. ferrumequinum* in eastern Slovakia, 5-80 km long. One of them, 6 km long, was recorded 9 days after banding, others one or more years later. In *R. hipposideros* the sample consists of 243 records, with roughly a half < 10 km and one tenth > 30 km. Short movements prevail on the territory of both republics. The longest movement (112 km) of an adult female, banded in a summer roost in northern Moravia and recovered in another summer roost in southern Moravia, was recorded five years after banding and cannot be considered a migration. Only two movements between two caves (5 km) have been recorded in *R. euryale* in eastern Slovakia.

In *M. mystacinus* 12 movements have been recorded, more than a half of them < 20 km, the rest except one to 20-40 km. The longest movement (165 km) concerns a male who flew from a hibernaculum in Bohemia to a temporary roost in Moravia and the recapture was made in the year of banding. Only two movements have been recorded in *M. brandtii*, 0,2 and 21 km long, on the territory of Moravian Karst and southern Bohemia respectively. A correction was made of a published information (Ohlendorf 1990, Schober & Grimmberger 1998) about a movement from Lithuania to eastern Bohemia (700 km). The record did not concern this species but *P. nathusii* and its real length was 622 km. The information was finally withdrawn (Gaisler et al. 2003, Hutterer et al. 2005). The sample of *M. emarginatus* consists of 26 records, two thirds of them < 20 km. Summer and winter quarters have been shifted up to 12 km of distance as recorded in the years of banding. In contrast, three movements > 50 km (maximum 91 km) have been recorded after several years. In *M. nattereri* 17 movements have been recorded, nearly 90 % of them < 20 km. Two movements 34 km long document flights between hibernacula and summer roosts but the respective recaptures were made 10 years after banding. The sample of *M. daubentonii* consists of 58 records, more than two thirds of them are movements < 20 km, all records come from the territory of the Czech Republic only. One movement between two summer roosts (69 km) has been recorded two months after banding. The longest movement (229 km) concerns a male banded in Saxony and recovered 18 years later in southern Bohemia.

The largest sample consisting of 931 records is available in *M. myotis*. Short movements up to 20 km comprise more than two thirds of it, long movements, nevertheless, are well represented. Six movements about 100 km long from lowlands in Germany and Poland to Bohemia, Moravia and Slovakia were recorded half year or less after banding and can be considered seasonal migrations. Two movements from Bohemia (140 km) and Slovakia (103 km) into the caves of Moravian Karst were also recorded half year after banding. The longest movement



projects

from eastern Slovakia to central Moravia (355 km), however, was recorded seven years after banding and cannot be considered a seasonal migration. There are 39 records in *M. blythii*, more than a half of them < 20 km, a quarter between 20 and 50 km and 6 movements > 100 km, with a maximum of 145 km. Except three records in Moravia, all movements have been recorded in Slovakia and between Slovakia and Hungary. In none of the long distance movements the recapture was made in the year of banding.

There are 46 records labelled *P. pipistrellus*, very likely concerning each of the two cryptic species as mentioned above. More than one third of the sample are short movements < 20 km, more than a half of the sample movements 20-100 km long. Two movements of the latter category were recorded in Slovakia, all other in the Czech Republic. In addition to that, two long movements from abroad were recorded: a female banded in a hibernaculum in Austria was recaptured in a summer roost in southern Moravia (218 km) and an individual of unknown sex banded in a summer roost in Germany was recaptured in a hibernaculum in northern Moravia (411 km). Both bats were recaptured only half year after banding and their movements can be interpreted as seasonal migrations. Unfortunately we do not know if they concern the species *P. pipistrellus* or *P. pygmaeus*. In *P. nathusii* two short movements within southern Bohemia and four long movements (280-923 km) from Germany, Latvia and Lithuania to Bohemia have been recorded. Hibernacula can be the sites of recaptures but there is no unequivocal evidence of it considering the recapture months – October, November and March. Half year elapsed between banding and recapture in one case, more than a year in the remaining three. The sample of *N. noctula* consists of 19 records, nearly two thirds of them are movements > 100 km. A male was captured from a summer roost in southern Bohemia and recaptured in a winter roost in Prague (103 km) after less than half year. Five movements were recorded from Germany, Latvia and Lithuania to Bohemia, Moravia and Slovakia (333-937 km) and another five movements were recorded from Bohemia and Moravia to Austria, Germany, Poland and Slovenia (69-461 km). In two cases our localities definitely represented hibernacula (February and January records in buildings), and in another case a female captured in southern Bohemia (during migration?) moved to a hibernaculum in Ljubljana. The least time span recorded between banding and recapture was 19 days in a female who, within this time, covered a considerable distance of 709 km. The material obtained so far suggests that certain members of the northern populations of the species hibernate on the territory of the former Czechoslovakia while others migrate through it to the south. There is only one record in *N. leisleri*, a movement from Poland to Slovakia (403 km) documented by the recapture after nearly a year.

V. murinus is represented by one record only, a short movement (19 km) in southern Bohemia. Many records, mostly unpublished, of hibernating individuals found in buildings in cities and towns within the territories of the two republics, can tentatively be considered indirect evidence of migrations similar to that in *P. nathusii* and *N. noctula*. Nine movements have been recorded in *E. serotinus*, four of them are relatively long, 61-79 km. A female moved from her summer roost in Saxony to a hibernaculum in northern Bohemia (77 km) and was recaptured seven months after banding, the record thus seems to evidence seasonal migration. The sample in *E. nilssonii* consists of 13 records of which 11 are short movements < 20 km, mostly shifts of hibernacula. A movement 24 km long probably is from a temporary to a winter quarter and the longest movement (250 km) is from a hibernaculum in northern Bohemia to a temporary quarter in Bavaria. The recapture was made more than three years after banding thus not evidencing a seasonal migration. Large sample of 78 records exists in *B. barbastellus*, most movements are shifts of hibernacula. Short movements < 10 km represent roughly a half, movements to 10-40 km a quarter of the sample, the rest are movements 42-152 km long. In three cases the bats moved from a winter to a summer quarter and were recaptured after less than half year: a male within western Bohemia (64 km) and two females from eastern Slovakia to Poland (62 and 152 km).

In *P. auritus* 35 movements have been recorded, more than three quarters of them < 20 km. All short movements and four movements 43-61 km long were recorded on the territory of the Czech Republic, they concern shifts of all types of shelters. Three movements 77-88 km long approach the maximum distance of 90 km recorded in this species so far (Hutterer et al. 2005). Two of them were recorded within the territory of the Czech Republic, one in Slovakia, in all cases bats were recaptured several years after banding. In *P. austriacus* 36 movements have been recorded, roughly a half < 20 km, a half > 20 km, all within the territory of the Czech Republic. Nine movements up to 20 km have been recorded less than a year after banding, five of them are shifts of summer and winter quarters or vice versa. The longest movement (61 km) is a shift of summer roosts or a temporary and summer roost and has been recorded in a male less than a year after banding.

The sample of 151 records exists in *M. schreibersii*, the movements are 5-378 km long and concern southern Slovakia and neighbouring territories of Austria, Hungary and Ukraine. Movements between cave shelters of various type to 50-100 km represent the largest group (64 %), only one such movement has been recorded within the Slovak territory, all other are trans-frontier movements. Roughly a half of all recaptures have been made less than one year after banding, e.g. one and half month between the caves Čertova diera and István (61 km), three months between the caves Ludmila and Görömbölytapolca (63 km), three months between the caves St. Margarethen and Plavecká (89 km) and three and half months between the cave Jasovská and the town Uzhorod (98 km). Concerning their directions, most movements are cca north-south or vice versa between Slovakia and Hungary. Eight longest movements (> 300 km), however, were made (many years ago) between north-eastern Austria and eastern Slovakia.

Concerning the migrality in populations living on the territory of former Czechoslovakia, hibernating there and/or migrating through it, bat species can be divided into three groups: sedentary, facultatively (occasionally) migratory and migratory; the terms were adopted from Schober & Grimmberger (British edition, 1989). Sedentary species are: *R. ferrumequinum*, *R. hipposideros*, *R. euryale*, *M. emarginatus*, *M. nattereri*, *P. auritus* and *P. austriacus*. Facultatively migratory species are: *M. mystacinus*, *M. brandtii* (probably), *M. daubentonii*, *M. myotis*, *M. blythii*, *E. serotinus* and *B. barbastellus*. Migratory species are: *P. nathusii*, *N. noctula*, *N. leisleri* and *V. murinus* (only indirect evidence available). In *M. schreibersii* the migrality is pronounced as well but its movements differ from those in the seasonally migrating species. At present we are unable to classify *E. nilssonii* (sedentary or facultative migrant) and the species *P. pipistrellus* and *P. pygmaeus* which both can be facultative or true migrants or each of them belons to another group. Bats of the species *M. bechsteinii* and *M. dasycneme* were banded but we lack any data enabling to evaluate their movements. Similar classification was made by Hutterer et al. (2005). Long distance migrants concern the same species as our migratory bats. Regional migrants are nearly identical

Table 1. *The longevity reords in particular bat species by recapturing individuals banded on the territory of the Czech or Slovak Republic. Explanations: A - number of banded bats, B - number of recaptures, C - maximum age found, D - potential maximum age (y - years, m - months),* including Pipistrellus pygmaeus.*

Species	A	B	C	D
Myotis myotis	24,595	4,253	37 y, 1 m	37 y, 8 m
Rhinolophus hipposideros	6,172	1,115	29 y, 5 m	29 y,7 m
Myotis daubentonii	9,193	2,463	27 y, 11 m	28 y
Myotis nattereri	3,902	333	23 y, 8 m	24 y, 2 m
Myotis emarginatus	3,368	337	22 y	22 y, 8 m
Barbastella barbastellus	8,650	1,515	22 y	22 y, 6 m
Eptesicus nilssonii	1,723	220	20 y	20 y, 8 m
*Pipistrellus pipistrellus**	7,978	218	15 y, 11 m	16 y, 7 m
Vespertilio murinus	377	35	14 y, 6 m	14 y, 8 m

with our facultative migrants except for inclusion of *M. schreibersii* in this group. The group of sedentary or stationary bats concerns all species we included in, plus some that either do not occur in our country or for which we lack data.

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long-term projects II

Monitoring of Bat Populations: a brief outline of the Czech and Slovak monitoring scheme

The bat study in the Czech Republic and Slovakia during past decades has been in more respect focused to the elaborate system of monitoring of bat populations - a comprehensive program that most of the members of respective national organizations (CESON, SON) take part in. The monitoring projects currently include the controls of summer colonies, the monitoring of hunting grounds and hunting communities, as well as the monitoring of the conditions in urban localities, panel housing developments, etc. However, the central part of this comprehensive program is traditionally the monitoring in underground hibernacula that has been continuously taking place for over 40 years and thanks to amount of data, formalisation level and the observation duration, it ranks among the most elaborate programs of a similar nature in Europe. The first part of this chapter is naturaly focused just to it.


monitoring I

I. Monitoring bats in underground hibernacula

by **Ivan Horáček**

The bat populations are on a decline! This conclusion has basically become a standard message on bats in Europe during the 20th century. The unexpected population collapse of one of the most abundant European species, the Lesser Horseshoe Bat *(Rhinolophus hipposideros*) at the end of the 1960's and the beginning of the 1970's when this species practically became extinct in the majority of Western Europe, as well as in the Czech Republic, provided convincing confirmation of that statement. Unfortunately, like other vertebrates that recently experienced similar abundance changes (*Spermophilus citellus, Perdix perdix, Glaridae cristata, Athene noctua, Bombina variegata* a.o.) the mentioned trend was registered only in the final stage of the decline. It was not until then that adequate attention started to be paid to this phenomenon and various explanatory hypotheses were formulated. One of the factors discussed was for example the abundance drop due to a loss of roosts and hunting grounds, the impact of cold rainy periods during gravidity and lactation causing an increased juvenile mortality or decrease in fertility caused by chronic pesticide poisoning. Our analyses of that phenomenon (Horáček 1984) further demonstrated that disappearance of bats from traditional roosts and swarming places promote a strategy of the random search for a mate which under low population density dramatically reduce probability of mating success and causes a decrease in natality. It should be mentioned that especially with the *R. hipposideros*, a species hibernating strictly in well-known underground hibernacula, it was possible to accurately monitor the entire process from the very beginning. Unfortunately, it was not the case. This allarming fact became one of the impulses for establishing the project of a long-term monitoring in underground hibernacula which became a fundamental running platform of bat study in both Czech and Slovak Republics.

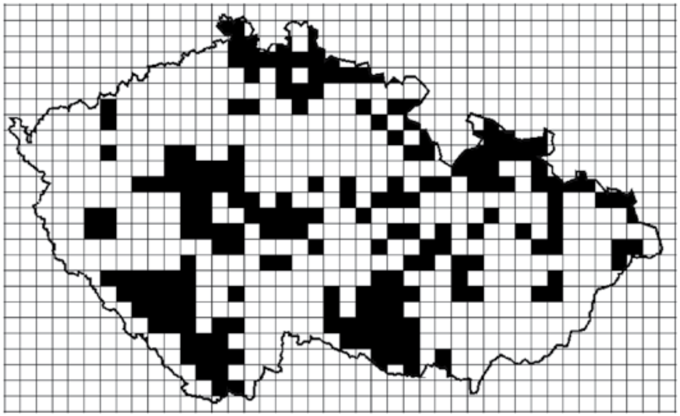
J. Gaisler and V. Hanák (1969) formulated the conceptual framework of the project with particular emphasizes to provide reliable data on population changes to answer objectivelly the questions like: Is the bat abundance really changing? Are there differences, in this respect, between individual species, individual regions and types of hibernacula? What is the dynamics of these changes? Which factors are included?

The project begun in the year 1969 with five participiants (Gaisler, Hanák, Horáček, Nevrlý, and Žalman) and 15 model localities representing the main traditionally monitored areas and types of hibernacula. The entry methodological census schedule was the following: limiting the visits of model hibernacula to **(a)** one single control during the winter (always at the end of January - beginning of February), including **(b)** an especially detailed inspection of the hibernaculum, performed each year in the same way, and **(c)** a record of all bats found. In the first phase of the census (1969 - 1975) the project expected the identification of all individuals and screening their body conditions (except for *R.hipposideros* which already then was not disturbed at all), and thus included manipulation of the bats (ringing, weighing) although done in the most gentle way, right at the roosting place and without any further transport, sampling or examinations.

Subsequently the number of localities monitored was expanded to 29 and already the first summary of the first five years of this project (Gaisler 1975) showed an exceptional value of the acquired data. For the first time, on the European scale, there was statistical evidence of an unexpected abundance rise of *Myotis daubentonii* and there was an indication of alternative population tendencies in other species. The next analysis was undertaken after ten years of the monitoring (Bárta et al. 1981, Gaisler et al. 1981) and provided detailed cenologic analyses, interegional comparisons and testing the abundance trends based on data from the Czech Republic (23 localities, 203 controls, 6855 records of 4643 individuals of 16 species). The abundance trends of the most abundant species were unequivocally demonstrated as the phenomena occurring synchronously in all the regions similarly as the well marked differences between particular species in these trends: positive population development in *M. daubentonii*, but further massive decline, however, in others - *M. myotis* (by 55% in 10 years) and *Plecotus austriacus*, resembling the population development of the *R. hipposideros* at the beginning of the 1970's. In connection to this we stated that the declining tendencies are in all these species much less evident in the eastern parts of the monitored area, including Moravia and Slovakia, and that evidently not by chance we find the same trend in exactly these three species that have appeared in our territory only in the historical period evidently connected to the post-Neolithic landscape changes.

The evaluation of the first decade of the census therefore led to (1) prediction of a drastic abundance drop (analogical extinction trends in the *R. hipposideros*) in several other species, primarily in the *M. myotis* and *P. austriacus*, in mass hibernacula, as well as in the *Barbastella barbastellus,* and (2) a conclusion that it is absolutely necessary for the next monitoring phase to completely exclude any disturbing effects, i.e. to stop ringing and any manipulation with hibernating bats.

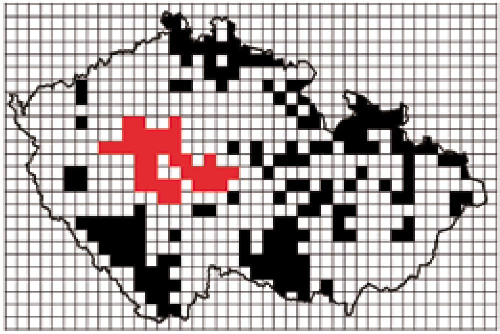
In the year 1981 we commenced a new census phase innovated by the exclusion of the disturbing effects of manipulation of the bats, resigning to have individual identification of the individual bodies and limiting the census control to visual species identification and counting numbers of particular species and cluster sizes and their dislocation within a hibernaculum. The project is being carried out according to this schedule until today. Thanks to the simplified methodology the individual controls are actually less time consuming and with attracting new generation of zoologists, speleologists and amateur naturalists we succeeded already during the first years of this census phase to enlarge the number and spectrum of monitored localities in a considerable way. Currently, over 800 underground hibernacula are covered by the project nad monitored annually. Since the year 1991 the program is coordinated by the Czech Bat Conservation Trust. The proximate results and data concerning the most imporant hibernacula (380 in total, over 200 000 registered bats) were summarized in 2001 (a monothematic issue of the journal Vespertilio: 5/2001). The following summary is based on this overview.



The grid map quadrats with the monitored bat hibernacula.

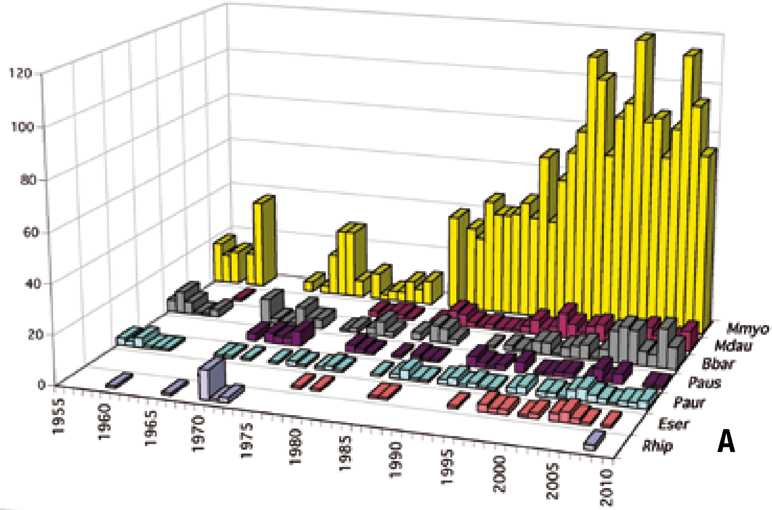
Some results

The hibernacula monitored over 20 years are situated in 206 squares of the standard mapping grid. Vast majority of them is concentrated in the traditionally long-term monitored areas such as Central Bohemia, Šumava (Bohemian Forest), Moravian Karst, Podyjí, Jeseníky and Oderské vrchy, Liberec area and Podkrkonoší; the majority of the monitored hibernacula has a character of abandoned mines (203) and karst caves (118), with a smaller part being cellars and similar places in human buildings (135). Despite differences among particular types of hibernacula and/or the regions in structure of their hibernating bat communities, the major signal concerning the long-term trends is surprisingly congruent. We will demonstate it in few examples.

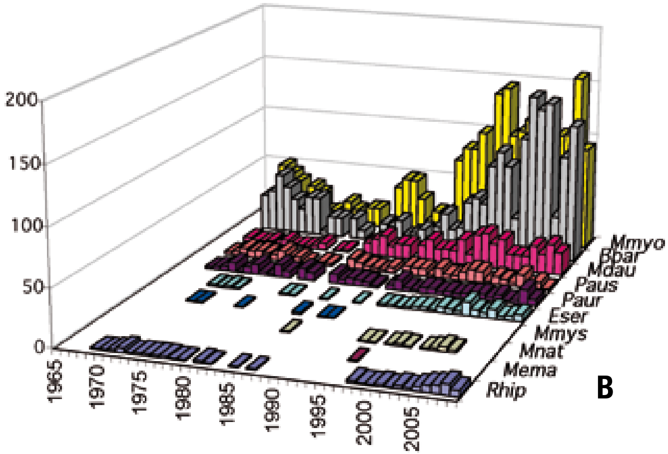


Central Bohemia - abandoned limestone mines (a.o.)

A total of 145 underground hibernacula are monitored in Central Bohemia, eight of them have been monitored for the entire census stage, in some of them there are comparable data available since the year 1955. The data from three such localities which well represent this area (galleries in Srbsko and near Mořina in the Bohemian Karst) are at the opposite page. As obvious, the records suggests that in contrast to the above-described trends in the first decade of the census (decline in *R. hipposideros, M. myotis,* and *P. austriacus,* abundance rise in *M. daubentoni*), since the beginning of 1980's the situation markedly changed. First we noted the consistent abundance increase of *M. myotis,* that attained nearly exponential slope since 1990, similarly as in *B. barbastellus.* The abundance drop in *R.hipposideros* was already a rarity at the beginning of the census and we excluded any disturbance to it at all. Despite that its abundance drop, continued until the mid 1980's when the winter record of the species in the region was restricted onto a few (3-5) bats in the main hibernaculum of this species in Koněpruske caves. Since the late 1980's, however, we have registered, not only in this area, a reversal of the abundance development which show then a slow but steady increase and subsequent recolonization of the hibernacula from which in 1970-1980's it disappearaed completely.



A



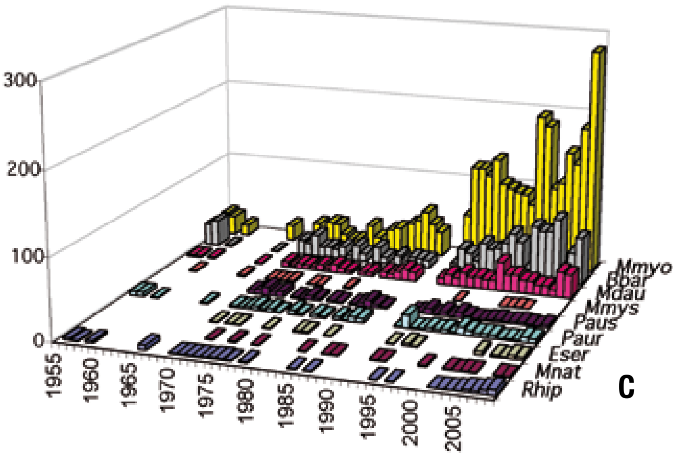
B

Abundance development in three abandoned limestone mines in central part of the Bohemain Karst:

A - Kozel (Alkazar) in Srbsko

B - Velká Amerika in Mořina

C - Malá Amerika in Mořina



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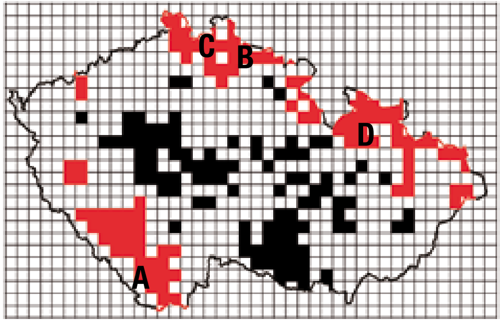
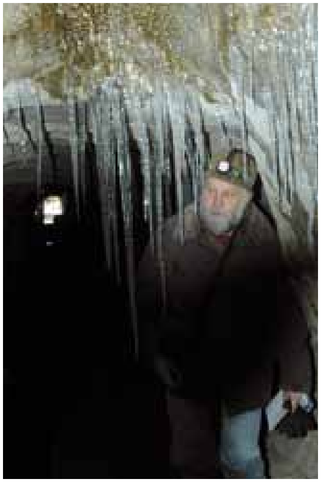
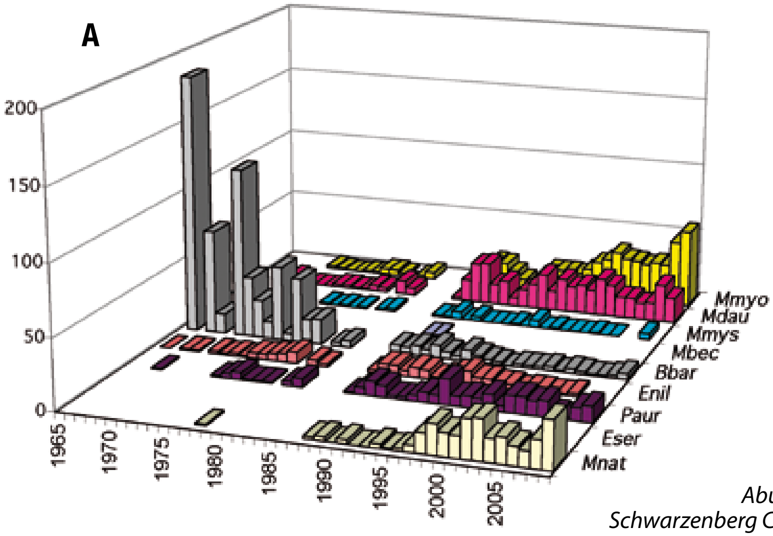


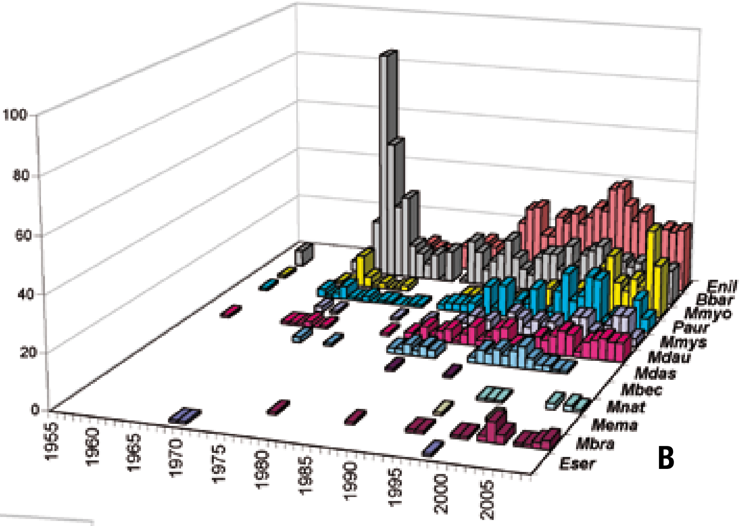


Hibernacula in mountain regions of Bohemia nad northern Moravia

Abandoned mines, often greatly variegated in their conditions, present the most frequent type of the hibernacula monitored in the mountain regions. At the beginning of the census these sites were the only localities with mass colonies of the Barbastelle and a regular occurrence of *Eptesicus nilssonii* in the Czech Republic. The records from four sites we choose as examples (the Schwarzenberg Canal in Šumava, Herlíkovice drifts in Krkonoše, Bílá Desná in Jizerske Mountains and Malá Morávka in Jeseníky Mts.) demonstrate both the considerable specificity in structure of hibernating bat community in each site but certain common trends recorded in all the regions. Among them one should note e.g. an instability of mass colonies of *B.barbastellus* which tend to disappear soon or latter (for different reasons, including occasional predation by a marten) and slow but steady increase in numbers of *M. daubentonii, Plecotus auritus* and locally also *E. nilssonii* since the beginning of the 1970's. In general, despite fluctuations in individuals localities, a continuous population increase since the end of the 1980's has been observed in *B. barbastellus,* and since the 1990's (i.e. with a certain delay compared to the lowland areas) also in the *M. myotis* and *R. hipposideros.*



Abundance development in gallery Schwarzenberg Canal near Lipno in Šumava Mts.



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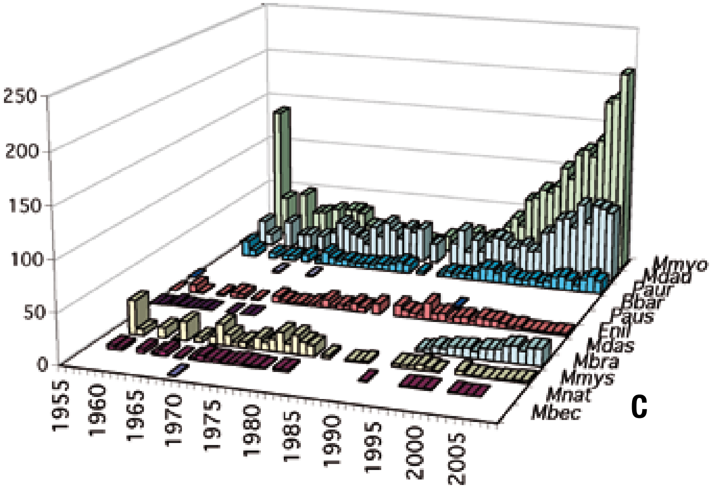


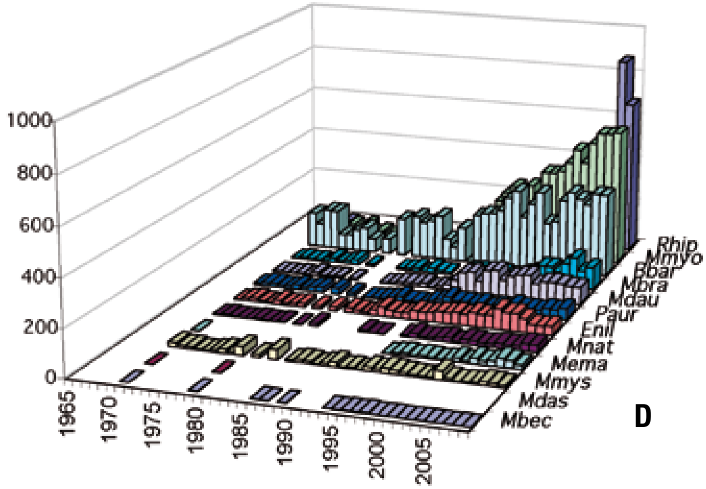
C

Abundance development in three hibernacula in northern mountains:

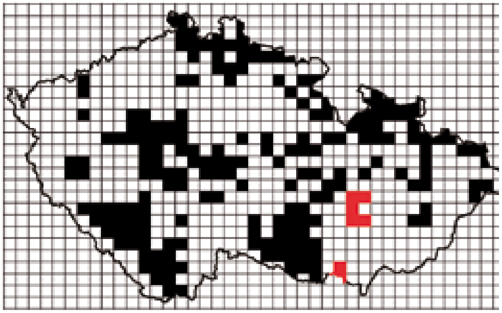
B - mine Herlikovice in Krkonoše Mts.

C - a gallery at Bílá Desná in Jizerské Mts.

D - mine Malá Morávka in Jeseníky Mts.

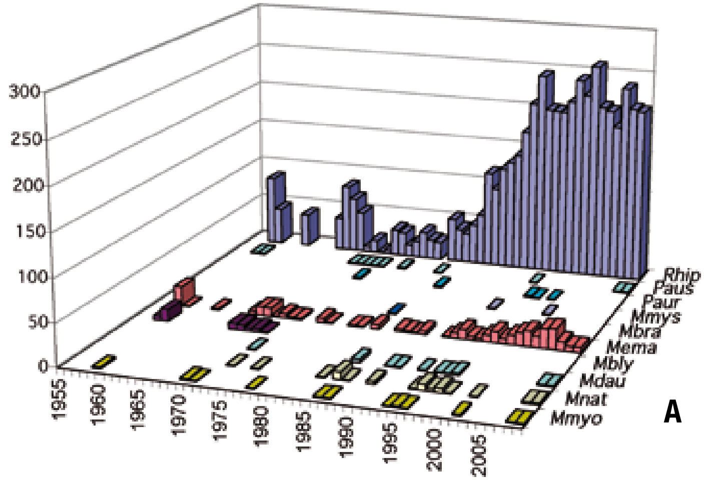


D

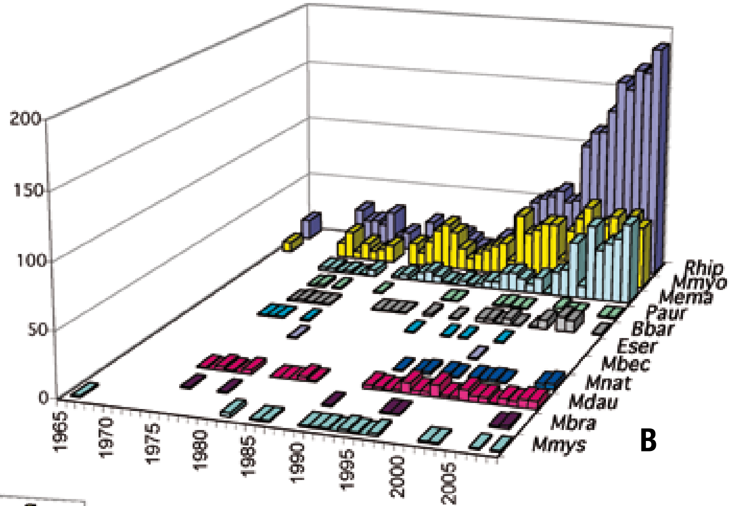


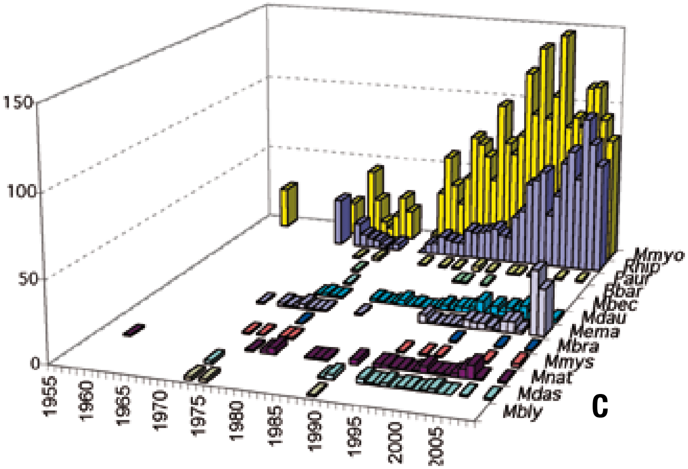
Caves of the Moravian Karst and South Moravia

While just a sole karstic cave is available in Southern Moravia (Na Turoldu in Mikulov), the Moravian Karst is enormously rich in caves (more that 4000). The bat communities of these hibernacula are characterized by predominance of thermophilous elements and/or those connected to caves in their roosting strategy, first of all *R. hipposideros*, *M. myotis* and *M. emarginatus.* For this it is the ideal region for monitoring just these species for which the most dramatic population decrease was predicted after the evaluation of the first census stage. Nevertheless, also here the reversed trends appeared and unequivocal abundance rise was registered with beginning at 1984. In comparison to other regions the slope of the abundance increase seems to have been here significantly higher. In this respect, it should be mentioned that the population decline of *R. hipposideros* and *M. myotis* in the 1970's was here (similarly to Slovakia) less dramatic that in Bohemia and Western Europe. In Moravian Karst the abundance of *M. myotis* since 1979 increased approximately by 600% (comparing it to state in 1979) similarly as in *R. hipposideros* (compared to minimum values in 1983-1985) which is absolutely highest values among all the regions. In *M. emarginatus,* quite a rare species at the beginning of census, we have registered an abrupt exponential abundance from 1995 accompanied also with its spread into the regions not colonized before (Bohemia).



Abundance development in the cave Na Turoldu near Mikulov in the southernmost Moravia



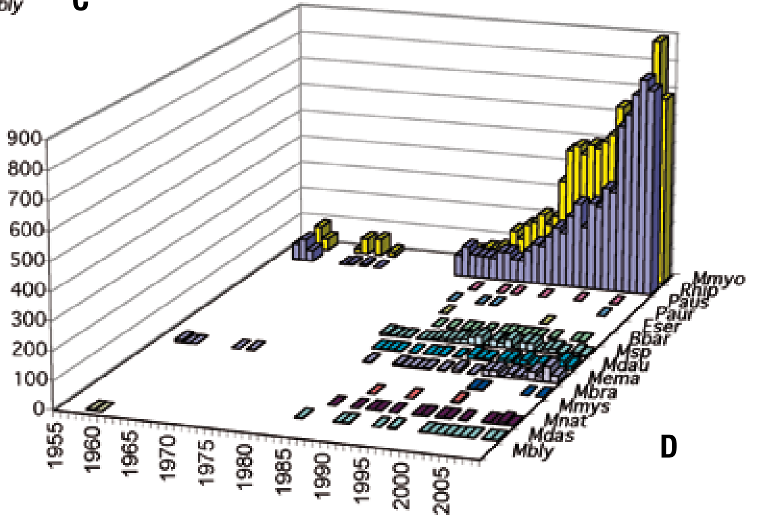


Abundance development in three hibernacula in Moravian Karst:

B - Ochozská cave in southern part of Moravian Karst

C - Kateřinská cave in central part

D - Sloupské cave in northern part of the Moravian Karst

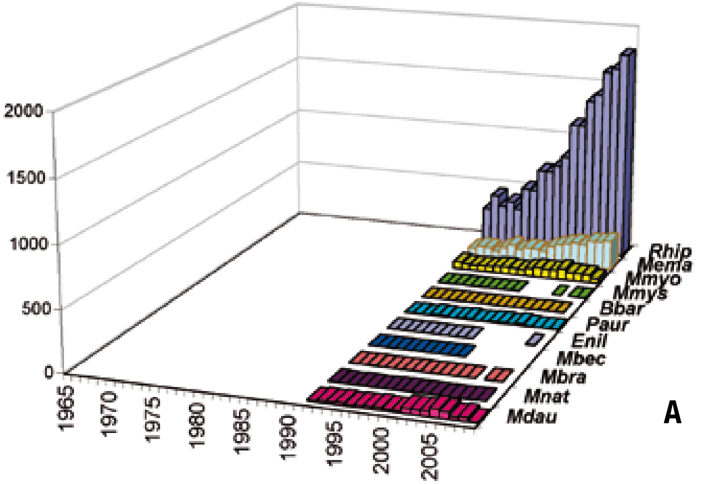


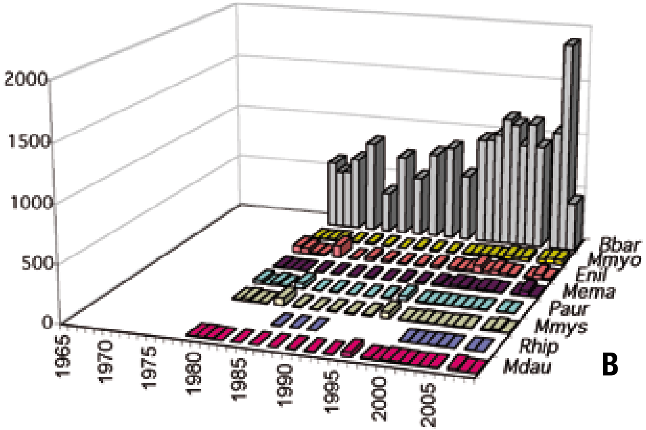
Are the documented trends real?

The results of the monitoring of the underground hibernacula showed that during the past 40 years unexpectedly extensive abundance changes have taken place and that particular species may differ in their abundance trends quite a much. As with any other monitoring programs, a question arises to what extent these trends are realistic and to what extent are their perceived results affected by methodical bias and reflect rather some of the nested background variables than the real abundance changes. In this case, an appropriate question to ask is: is not the increase of abundance of the species which were in decline during the first decade, mere a result of the recovery of local populations after the period of ringing? If this was true, then the appropriate question to ask would be whether the census results can actually be taken seriously? Do they have any use? In other words: How much do the registered data reflect real population trends and their causal associations?

In answer, it should be first remembered that only few localities were controlled during the first stage of monitoring so that the absolute impact of banding and disturbance upon whole local populations could hardly been the major factor of the abundance decline and, conversely, that exclusion of handling from the census technique was most probably not the major factor of the abundance increase observed from late 1980's. The facts that the abundance trends and their timing in the hibernacula not controlled in the first stage of the project (including those absolutely prevented from any disturbance such as the deep abandoned mines accessible only by advanced alpine technique) are almost exactly the same as those recorded in the hibernacula monitored throughout whole the 40 year period, suggests that role of methodical bias should not be overestimated.

In short, nearly in all hibernacula the cesus revealed roughly the same trends and, surprisingly, also similar rate of abundance changes, at least for the period of the last 15 years in *R. hipposideros, M. myotis* (by 200-600%) and *B. barbastellus* (nearly by 100%). Yet, in discussion of the reality of the respective slope of abundance increase, it should be remembered that considerable part of record comes from the large and densely populated hibernacula which occupancy is strongly supported by considerable social tradition. The social and behavioral aspect of hibernation may bias the relevance of monitoring data at least by (1) an extreme sensitivity of large clusters to any, even minimal disturbance and the rapid disappearance of mass colonies in a result of the cascade effect (well experienced with the mass colonies of *B. barbastellus* or *P. pipistrellus*), but also in that (2) the population in particularly advanced and undisturbed hibernacula may tend, at least theoretically, grow exponentially due to social learning, i.e. without being driven by the actual abundance increase.



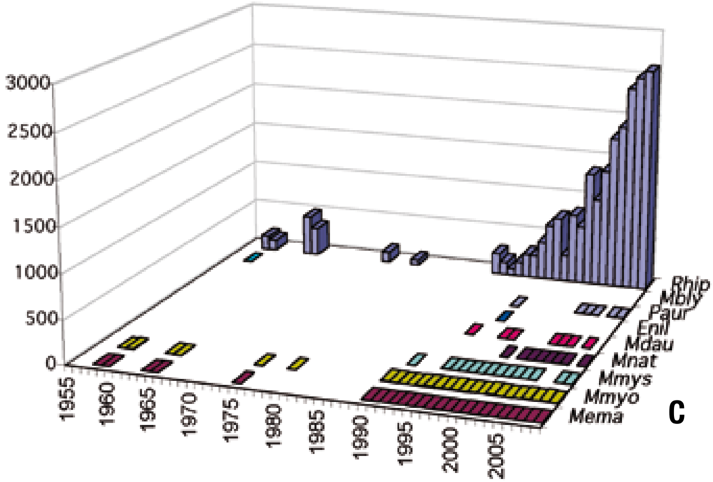


Abundance development in three north Moravian hibernacula where no banding and/or handling bats was performed:

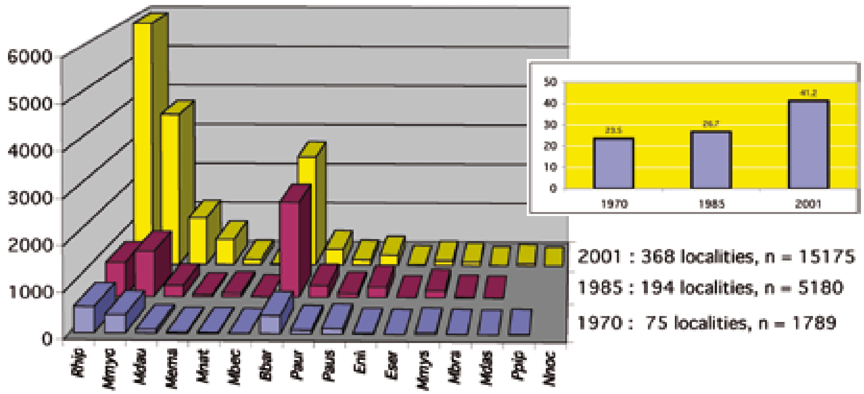
A - the abandoned mine Franz Franz

B - the abandoned mine Zaluzna

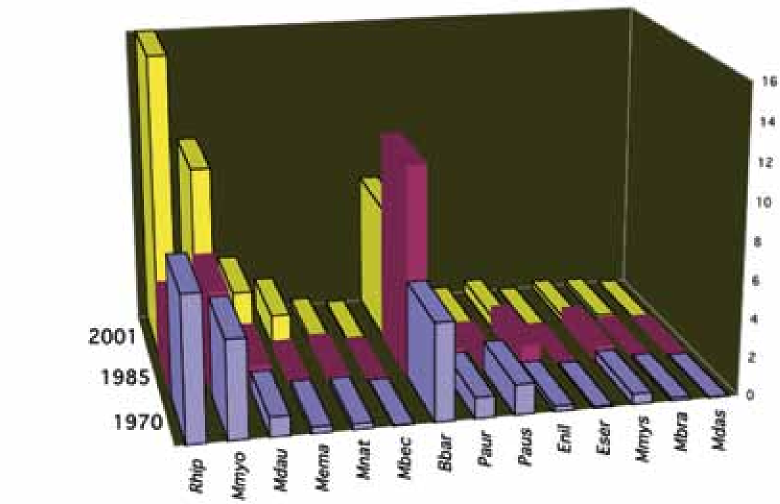
C - Javoříčské cave



For the above mentioned reasons the high amplitute abundance changes (both positive and negative) based on record from mass hibernacula can be overestimated, and, paradoxically, the apparently most valuable data from the richest hibernacula could be the most distorted. In that respect, the above mentioned data should be emended by the results from average and less populated hibernacula, which at first sight were not very important and attractive. Fortunately, considering the exceptional extent of the project after 1981 we also have a significant amount of these data available. A comparison responding to a situation in an „average“ hibernaculum show that the mean total population of an „average“ hibernaculum increased more than twice from 1970 and the respective values for individual species (obtained by multiplication of the species dominance in total sample by mean „average“ abundance) suggest for *M. myotis* the abundance increase by about 200 % similar as in *R. hipposideros* and *M. daubentonii*. Quite excessive values appear only during last decades for *M. emarginatus*. A clear population decline throughout whole the period was recorded just in one species, *P. austriacus*.

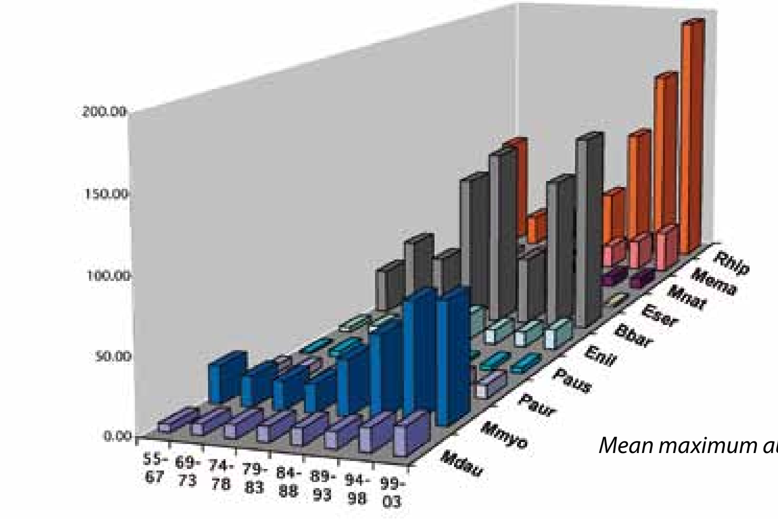


Total number of bats recorded in all hibernacula monitored in 1970, 1985 and 2001, and mean numbers per single hibernaculum in the respective years (upper right).



Mean abundances of individual species (in „average“ hibernaculum) corresponding to the data of the figure above.

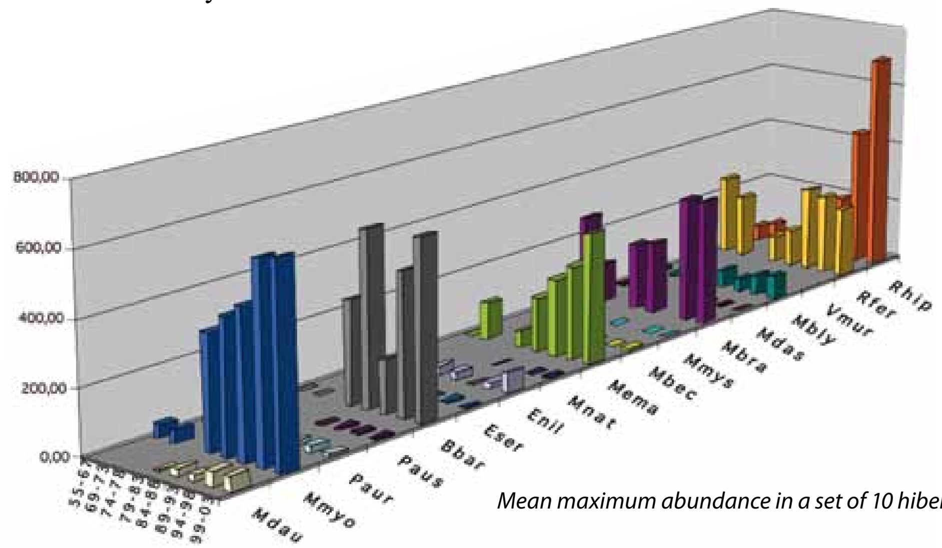
Worth mentioning is that quite similar values were obtained by comparison of the mean maximum abundances appearing in 5-year sections in 35 representative hibernacula controlled throughout the entire past half century and analogical trends appeared also selected hibernacula in Slovakia (using the data summarized in the Vespertilio 6 by Uhrin et al. 2002). Worth mentioning is that in Slovakia the positive abundance development seems to begin slighly earlier than in hibernacula of the Czech Republic.



Mean maximum abundance in a set of 35 hibernacula (Czech Republic) within particular 5-year periods from 1955 to 2005.

Summing up the rough results of the project we can conclude that:

- After an abundance drop of the *M. myotis* and *R. hipposideros* in the 1970's, there has been a steady abundance growth since the beginning of the 1980's - currently we are registering in practically all sites the highest abundance thus far (on average approximately twice as high as at the beginning of the program).
- The continuous increase of *M. daubentonii* since the 1970's has been less noticeable in the past decade, the current abundance, however is nearly triple the size in the year 1970.



Mean maximum abundance in a set of 10 hibernacula (Slovakia) within particular 5-year periods from 1955 to 2005.

projects


DEATH

- *M. emarginatus* have manifested an extraordinarily intense abundance growth and extensive continuous spread in Moravia since the beginning of the 1990's with a significant area extension into the area of Bohemia (particularly Eastern and Northern), uninhabited in the past. A similar trend manifested in Slovakia, only with a significantly earlier start.
- Also *E. nilssonii* have exhibited an abundance growth and an extensive continuous spread since the beginning of the 1980's and since the 1990's this species has been regularly appearing in areas of medium altitudes.
- From the overall figures a gradual population increase is also apparent in the *B. barbastellus.*
- The only species where there has been evident continuous abundance drop since the 1970's until the present is the *P. austriacus.*

Nevertheless, it should be remembered that the census of bats in underground hibernacula provides information on a smaller part of the Central European bat fauna. In the species that do not regularly hibernate in underground areas (particularly dendrophilous or lithophilous forms such as *Pipistrellus* spp., *Nyctalus* spp., *Eptesicus* spp., *Hypsugo*), only indirect or supplementary information is currently available that is being continuously supported by abundance data from other types of monitoring (including the standardized monitoring of dendrophilous species in the past decade). We have been finding evident changes in abundance trends and in the character of spreading at least in some of these forms. We should mention here particularly the massive increase in the number of findings in Pipistrellus nathusii and the areas where its steady occurrence is now documented. It appears that since the 1990's we have been witnesses to an expansion of this migrant dendrophilous species, which breeding range was formerly restricted to the lowland forests in the northern part of Central Europe. The spreading of *P. pygmaeus* and *P. pipistrellus* suggested both by abundance increase and appearance of these species in trhe regions not previously colonized, is evident in the same period as well. Significant shifting of the northern border territories of the thermophilic lithophilouos elements of Mediterranean fauna is taking place in the same area - the Savi's Pipistrelle (*Hypsugo savii*) and Kuhl's Pipistrelle (*Pipistrellus kuhlii*), which have been repeatedly documented since the 1990's also in the Czech Republic and Slovakia.

At first sight, the character of the mentioned changes in the structure of the mid-European bat fauna and the abundance trends of individual species is in unison with the dominant characteristic of the present climatic history - significant warming. The abundance rise is without a doubt the most obvious in the elements of a warm, open landscape (*Rhinolophus hipposideros, Myotis myotis, Pipistrellus*

pipistrellus, Hypsugo savii, Pipistrellus kuhlii) which ranges are centered in the Mediterranean region. Of course, it is more difficult to integrate in this scope of interpretation the radical abundance drop of the *P.austriacus*, and particularly the abundance growth and spatial spread of the species like *Eptesicus nilssoni, Myotis daubentoni, Plecotus auritus, B.barbastellus, Pipistrellus nathusii* demanding rather the mesophilic semi-opened habitats and/or the variegated woodland formations (i.e. the habitats characterising rather the more temperate regions and the transitional stages of the glacial/interglacial cycles). In search for the factors effecting the observed changes we should also mention the dramatic changes in the character of landscape management and agriculuture design which took place in our countries after the year 1989 (including a significantly decreased pesticide application), but also the fact that the respective changes in abundance trends apparently begun long time before this period. Simply, the abundance development in mid-European bats are in no way a simple unifactorial phenomenon but the subject worth of a detailed study and further research.

The basic prerequisite for it is the most reliable and comprehensive primary evidence. The 40 years of the monitoring program demonstrated that a careful large-scale and well designed study can provide for such analyses the substrate of quite an exceptional value. Regarding to that experience we extended the monitoring program with further approaches intended to refine information on abundance dynamic and to supplement the record with data on the species not covered by the hibernacula record.


monitoring II

II. Summer monitoring of bat populations

by **Tomáš Bartonička and Jiří Gaisler**

Monitoring bat populations has a long tradition in the Czech Republic (Horáček 1984) but in the past, it mostly concerned underground hibernacula only. Two species, *Rhinolophus hipposideros* and *Myotis myotis*, were monitored in their summer shelters as well, within the studies on their ecology and reproduction (Gaisler 1963, 1966, Horáček 1985). This research, however, comprised irregular (usually high) number of controls per season and locality, and it was completed many years ago. Systematic monitoring of bats in their summer stands is a relatively new approach in the Czech Republic, although it was sometimes preceded by a detailed survey. This survey concerned certain areas only and its frequency was not standardized. Since 2005, regular summer monitoring has been carried out every year comprising three main methodological approaches: i) revision of summer colonies, ii) bat-detectoring in 10 regions and iii) netting in 9 localities characterized by significant social activity of bats. The monitoring has been carried out mainly by members of the Czech Bat Conservation Trust (CBCT-CESON). The number of observers is correlated with the extent of observations and amounts to ca 20 persons engaged in the monitoring of summer colonies, 12 in bat-detectoring and ca 30 in netting the bats.

Monitoring of summer colonies

Material and methods

The program started simultaeously with the winter monitoring already in 1970 with focus on breeding colonies of *Myotis myotis.* Yet the study was irregularly combined with sampling and banding and/or identifying repeated records of banded bats. Although in some regions it continued to at least 1980, as its results were obviously biased by the methodological inconsistencies it was finished. The currect stage started with largerly improved methods in 2005. All summer colonies included in our monitoring programme are maternity (breeding) colonies consisting of numerous females that bear their young in the summer shelters. In most bat summer colonies known to exist on the territory of the Czech Republic, the census is taken yearly. Among bat species, the number of colonies differ. It is high in bats with high fidelity to shelters – *Rhinolophus hipposideros, Myotis myotis* and *M. emarginatus.* The samples are smaller in species with low philopatry in which the long-term monitoring is more difficult. Even in common species (e.g. *Pipistrellus pipistrellus, Nyctalus noctula*) it is difficult to locate

their summer colonies and, if found, they cannot be checked the following year due to liquidation of the shelter or moving of the bats to another one. Nevertheless, all localities declared as pSCI of Natura 2000 have been monitored. The shelters of summer colonies are monitored once a year, theoretically within the time from the end of pregnancy to the middle of lactation. Due to differences among species, the term of monitoring has been fixed to the time span from the beginning of June till the middle of July. Within this time, the young usually can be distingushed from the adult females. The census is taken visually without marking or otherwise disturbing the bats, digital photographs have been applied during the last years to minimize its duration, in particular when large colonies (clusters) are concerned. Within the last five years, in addition to the number of bats, young and old separately, air temperature and information about the shelter are recorded. In the case of a building the information contains data on its technical status, scheduled repairs, the size and situation of apertures and any threats to bats. If possible, the census of bats emerging at their evening departure was made if the shelter was inaccessible to humans. In particular localities and years, however, even the census from outside was impossible, mainly because of the obstructions by the owner or inhabitants of the building.

Table 1. *The number of summer colonies monitored per species and years in 2005-2009.*

Species/year	2005	2006	2007	2008	2009
R. hipposideros	52	35	38	40	42
M. myotis	112	73	75	83	99
M. emarginatus	15	10	10	9	9
M. brandtii	0	0	0	0	1
M. daubentonii	2	2	1	1	2
M. mystacinus	0	1	1	1	1
M. naterreri	2	2	1	1	1
V. murinus	0	0	1	1	2
E. nilssonii	0	2	2	3	8
E. serotinus	3	5	6	6	6
P. nathusii	2	2	3	4	2
P. pipistrellus/pygmaeus	4	1	1	2	2
N. noctula	10	2	2	2	2
P. auritus	1	6	4	3	4
P. austriacus	4	2	0	3	2
B. barbastellus	0	1	3	0	3
Total	207	144	148	159	186

Preliminary results

In total, maternity colonies of 15 species and one couple of species have been monitored within the years 2005-2009 (Tab. 1). Among the species and years, the number of colonies included into the census fluctuated heavily, wich had an impact to the total and average numbers of bats counted. One reason of this fluctuation was the shift of summer shelters by the bats themselves, another one the obstruction by the owner or manager of the property as mentioned above. The highest number of localities was checked in 2005, in particular in *M. myotis, R. hipposideros, M. emarginatus* and *N. noctula*, due to the collecting of data for the Natura 2000. It was technically impossible to census bats in all localities during the next years and some "less important" ones were left out. For all these reasons we refrain from giving the numbers estimated per years and species and refer to future when the sample will be greater.

Resuts of the monitoring and accompanying information on the shelters enabled to carry out necessary restauration works in several cases, without threatening the respective colonies.

Monitoring of bats at foraging grounds by ultrasound detectors

Material and methods

Bat detector monitoring has been made since 2005 in 10 regions that have been selected due to their well-preserved habitats and, accordingly, high diversity of bats. Following protected landscape areas (PLA), national parks (NP) and a biosphere reserve (BR) were selected: PLA Český ráj (CR), BR UNESCO Dolní Morava (DM), PLA Broumovsko (BR), PLA Český kras (CK), PLA Litovelské Pomoraví (LP), PLA Moravský kras (MK), PLA Poodří (PO), PLA Třeboňsko (TR), NP Podyjí (PD), and NP Šumava (SU). To avoid misunderstanding, we quote all regions by their Czech names only although some of them have English equivalents, e.g. Český kras = Czech Karst. The regions mentioned above were preferred over other regions also because bat research was performed there in the past, though with different methods. Since 2005, bat activity has been monitored by bat detectors with time expansion system (D240x, Pettersson Electonik AB, Uppsala, Sweden) and the signals have been recorded by minidisk walkmans SONY (MZ NH 900). Acoustic monitoring has been made only at nights without precipitations and strong wind. Bat echolocation signals have been recorded when walking, following a line transect selected in advance. In every region, six representative localities, each with three habitats have been chosen, resulting in 18 line transects per region. Only three localities have been monitored (9 transects) in the NP Podyjí due to limited space in the Dyje River canyon. To minimize the detection of the same bats, neighbouring transects are at least 100 m distant from each other. Following habitat types have been included into the monitoring: intravillan, forest, meadow, periphery of a growth (ecotone), field, rocks, stagnant and running water. Each monitoring starts 40 min after sunset and can last till midnight.

Bats recorded acousticly have been identified to species or to couples of species (in siblings *P. auritus/austriacus*, *M. brandtii/mystacinus*, and *M. emarginatus/alcathoe*). The number of bat positive minutes and type of actity, foraging or commuting flights, have been recorded. Such minutes have been considered bat positive at which at least two successive echolocation pulses were recorded, irrespective of their type (Thomas & West 1984). Foraging flights are characterized by the terminal feeding buzzes, as the bats approach their prey (Jones & Rayner 1988). If possible, both species and activity determination have been made in the field, only dubious sequences are analysed later by PC (BatSound Pro 3.3.1b). Records from different transects and dates are compared by the relative number of positive minutes (min+) (Bartonička & Zukal 2003) with respect to 1 h of monitoring (McAney & Fairley 1988). Per years, the total numbers of minutes of monitoring (and numbers of positive minutes) were as follows: 2005 – 4700 (1795), 2006 – 4950 (1797), 2007 – 5130 (1869), 2008 – 4590 (1821), and 2009 – 5615 (2144).

Results

Species diversity per regions. At least 17 species (or species couples) were recorded by bat detector monitoring in 2005-2009 (Tab. 2). *M. daubentonii*, *M. brandtii/mystacinus*, *N. noctula* and *P. pipistrellus* are the most abundant species that have been annually detected in almost every region. *M. daubentonii* was recorded every year, *M. brandtii/mystacinus* every year except 2007 in the PLA Moravský kras, *N. noctula* every year except 2006 in the PLA Český kras in and *P. pipistrellus* every year except 2005 in the NP Šumava and PLA Třeboňsko. *E. nilssonii*, in contrast, belongs among rare species and, together with *M. bechsteinii* and *R. hipposideros*, was only rarely recorded. Maximum changes in the composition of species were recorded in the PLA Litovelské Pomoraví where 47% of species were not annually recorded, followed by the PLA Moravský

Table 2. *Acousticly recorded species during the five years of monitoring in the following regions: CR-Český ráj, DM-Dolní Morava, BR-Broumovsko, CK-Český kras, LP-Litovelské Pomoraví, MK-Moravský kras, PO-Poodří, TR-Třeboňsko, PD Podyjí, SU-Šumava. Positive records are denoted by „+".*

Species / region	CR	DM	BR	CK	LP	MK	PO	TR	PD	SU
R. hipposideros	+	+			+	+				
M. bechsteinii	+	+	+	+	+	+	+			
M. brandtii/mystacinus	+	+	+	+	+	+	+	+	+	+
M. daubentonii	+	+	+	+	+	+	+	+	+	+
M. emarginatus/alcathoe	+	+	+	+	+	+				
M. myotis	+	+	+	+	+	+	+	+	+	+
M. naterreri	+	+	+	+	+	+	+	+	+	+
V. murinus			+	+				+		+
E. nilssonii	+		+	+	+	+		+		+
E. serotinus	+	+	+	+	+	+	+	+	+	+
P. nathusii	+	+	+	+	+		+	+	+	+
P. pipistrellus	+	+	+	+	+	+	+	+	+	+
P. pygmaeus	+	+	+	+	+	+	+	+		
N. leisleri	+	+	+	+	+	+	+	+		+
N. noctula	+	+	+	+	+	+	+	+	+	+
P. auritus/austriacus		+	+	+	+	+	+	+		+
B. barbastellus	+		+	+	+	+	+	+		+
Total	15	14	16	16	16	15	13	14	8	13

kras and PLA Český ráj (41% of species). In the BR Dolní Morava and NP Podyjí, in contrast, relatively constant species composition was recorded with 88% of species detected every year. The least number of species was recorded in the NP Podyjí, the greatest number, in contrast, in the PLA Broumovsko, PLA Český kras (with only *R. hipposideros* missing) and PLA Litovelské Pomoraví. *R. hipposideros* is a species difficult to record due to its very high frequency signals. Nevertheless, results from five years of acoustic monitoring tend to show that this period is long enough to record even rare species or species with very weak signals, thus reducing the selectivity of this method.

Species diversity per habitats. During the years, the use of habitats by species did not differ very much except in 2006, when the number of species increased in four habitats (intravillan, forest, stagnant and running water). The habitat stagnant water (G) has shown the greatest bat activity during the whole period although two species were never recorded there (Tab. 3). *M. daubentonii, P. nathusii,*

***Table 3.** Acousticly recorded species during the five years of monitoring in the following habitats: A-intravillan, B-forest, C-meadow, D-periphery of a growth, E-field, F-rocks, G-stagnant water, H-running water. Median values of relative activity are given in each species and habitat.*

Species / habitat	A	B	C	D	E	F	G	H
R. hipposideros	0.9	4.75	4.4	3.55	0	3.4	1.2	3.3
M. bechsteinii	0	0.1	0	0.05	0	0.25	0	0
M. brandtii/mystacinus	0.55	2.35	0.7	2.45	0	2	1.45	1
M. daubentonii	1.2	1.85	1.9	3.15	0.6	0.8	15.6	14.2
M. emarginatus/alcathoe	0	0.1	0.05	0.3	0	0.65	0.95	0.35
M. myotis	0.3	0.6	0.6	0.95	0.4	1.8	0.15	0.1
M. naterreri	0	0.7	0.15	1	0.55	0.2	1.2	0.15
V. murinus	0.2	0.2	0.25	0.15	0	0	0.5	0.15
E. nilssonii	0.5	0.65	0.35	0.15	0	0.3	0.75	0.7
E. serotinus	0.9	1.55	1.75	1.65	0.1	1.05	1.2	1.45
P. nathusii	1.35	1.25	0.3	3.15	0.75	0.6	6	3.35
P. pipistrellus	2.8	1.1	1.05	1.25	0.2	1.95	4.25	2.65
P. pygmaeus	2.1	3.35	0.75	4.5	0.1	0.35	6.9	3.8
N. leisleri	0.2	0.55	0.35	0.5	0.1	0.05	1.2	0.2
N. noctula	4.65	2.35	4.5	4.35	1.15	1.45	6.55	4.9
P. auritus/austriacus	0.55	0.55	0.15	0.75	0	0.45	0.4	0.1
B. barbastellus	0.1	0.35	0	0.45	0	0.8	0	0.3
Total	16.3	22.35	17.25	28.35	3.95	16.1	48.3	36.7

P. pygmaeus and *N. noctula* were the most common there and *M. daubentonii* was the overall most abundant species. In general, the spectrum of species was similar among all habitats. The maximum number of 17 species was recorded in forest habitats (B) and in the ecotones (D). Next come the habitats rocks (F) and running water (H) with 16 species each. The least number, only 9 species per year in average, was recorded in the habitat field. The highest activity was recorded over water, 48.3 min+/h in the habitat stangant and 36.7 min+/hod in that of running water. The lowest activity, 3.95 min+/h, was recorded over fields.

Netting at swarming sites

Material and methods

Monitoring of summer colonies and hunting grounds was completed by mist netting of bats. Such localities were selected that have been known as swarming sites or sites where the bats probably gather for social rather than foraging reasons.

Following nine localities have been chosen to monitor their bat assemblages by netting: (1) Ledové sluje Caves, NP Podyjí, (2) Na Turoldu Cave, PLA Pálava, (3) Soutěska beneath Mt. Děvín, PLA Pálava, (4) Cave on Mt. Bezděz, Dokeská pahorkatina, (5) entrances to caves in the National Nature Reserve Špraněk, Mladečsko-Javoříčský kras, (6) Hranická propast Chasm, Zbrašov Aragonit Caves, (7) Basa Cave, Ještěd ridge, (8) Kateřinská Cave, PLA Moravský kras, (9) Chýnovská Cave near Tábor. Although the netting was not standardized, valuable data on the composition of species and changes in numbers were obtained from all these localities prior to monitoring in 2006. Selected localities represent important hibernacula, places where bats meet at the time of migrations and mating or both. Very likely they are important to preserve or increase genetic variability of populations and to stimulate social learning. Previous netting at some of the localities revealed several species as abundant that are rarely found elsewhere or, although they form big colonies, their shelters are rarely found (*Myotis bechsteinii, M. brandtii*, *M. daubentonii, M. mystacinus*, *M. nattereri*, *M. emarginatus*, *P. pipistrellus* and *P. pygmaeus*). Netted samples can significantly contribute to the knowledge of population structure in these species.

In each of the nine localities, three netting nights have been performed at three seasons: (i) late April – early May (spring movements), (ii) first half of July (lactation, weaning – may be modified according to bat species and weather), (iii) late August – early September (autumn movements, mating). Every net-night must last from the time of sunset to that of sunrise. All netted bats have to be determined, their mass and standard measurements taken and they may be banded (voluntarily). The monitoring includes recording the number of species, their dominance and sex ratio as well as age structure in every species.

Results

Males of the species *R. hipposideros*, *M. emarginatus*, *M. bechsteinii*, *M. daubentonii*, *M naterreri*, *E. nilssonii*, *E. serotinus*, *P. auritus* and *B. barbastellus* were found to prevail in most localities (Tab. 4). A balanced sex ratio was recorded in *M. brandtii* and *M. alcathoe* in the localities Cave on Mt. Bezděz and Ledové sluje Caves although males prevailed in other species there. Although the males prevailed in *M. mystacinus*, the number of females was relatively high. More females than males were netted in *M. myotis* in the localities Hranická propast Chasm and Soutěska beneath Mt. Děvín, because of summer maternity colonies in proximity. In the former locality, more females than males were also netted in *P. pipistrellus*. The largest samples were obtained in the localities Ledové sluje Caves and Cave on Mt. Bezděz, the former locality also yielded the greatest species diversity (18 species). The smalest samples were obtained in the localities Na Turoldu Cave and Soutěska beneath Mt. Děvín, the lowest species diversity was recorded in the locality Chýnovská Cave (7 species).

Both numbers of individuals and numbers of species were similar in the remaining localities (Tab. 4).

Acknowledgments

It is with many thanks that the authors acknowledge the assistance of colleagues who submitted their own data to the CBCT data base. They were: M. Anděra, J. Barva, J. Bednářová, H. Berková, Z. Buřič, J. Červený, L. Dvořák, M. Gajdošík, V. Hanák, A. Hoffmannová, D. Horáček, P. Hrouzek, J. Chytil, H. Jahelková, M. Koudelka, M. Kutal, V. Lemberk, R. Lučan. J. Mach, P. Nová-Schnitzerová, J. Neckářová, M. Pokorný, A. Reiter, Z. Řehák, D. Weinfurtová, and J. Zukal. The project was financially supported by the Agency for Nature Conservation and Landscape Protection and the Ministry of Environment of the Czech Republic.

Table 4. *Results of netting bats in the following localities: (1) Ledové sluje Caves, (2) Na Turoldu Cave, (3) Soutěska beneath Mt. Děvín, (4) Cave on Mt. Bezděz, (5) entrances to caves in the National Nature Reserve Špraněk, (6) Hranická propast Chasm, (7) Basa Cave, (8) Kateřinská Cave, and (9) Chýnovská Cave. In each species, its per cent representations in the localities are given, with the number of males/females in parentheses.*

Species / locality	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
R. hipposideros	11.2 (23/2)	4.5 (8/2)		2.7 (4/2)	46.2 (77/26)			35.4 (69/10)	
R. ferrumequinum					100 (1/0)				
M. bechsteinii	36.4 (50/34)	7.8 (14/4)	4.7 (11/0)	9.1 (14/7)	18.2 (40/2)		2.2 (3/2)	16.9 (33/6)	4.7 (7/4)
M. brandtii	69.0 (205/55)			25.2 (47/48)	3.4 (12/1)		2.1 (7/1)	0.3 (3/2)	
M. mystacinus	20.9 (31/10)	1.5 (2/1)	1.0 (1/1)	64.8 (82/45)	7.1 (12/2)		4.1 (8/0)	0.5 (1/0)	
M. daubentonii	57.6 (472/178)	6.7 (70/6)	0.6 (5/2)	7.3 (65/17)	7.4 (73/11)	2.0 (18/5)	2.2 (21/4)	50.5 (50/7)	11.0 (90/34)
M. emarginatus	10.7 (26/9)	14.3 (39/8)	2.1 (3/4)	0.9 (2/1)	42.4 (116/23)	0.1 (1/1)	(1/0)	28.7 (72/22)	
M. alcathoe	91.4 (14/18)			2.9 (0/1)	5.7 (2/0)				
M. myotis	4.3 (13/12)	3.1 (9/9)	2.4 (1/13)	5.7 (23/10)	6.2 (18/18)	55.7 (63/262)	8.6 (25/25)	7.0 (25/16)	7.0 (22/19)
M. naterreri	38.9 (296/175)	2.8 (27/7)	1.7 (20/1)	29.9 (295/67)	5.1 (45/17)	0.1 (1/0)	2.6 (27/5)	13.0 (116/41)	5.9 (45/26)
M. dasycneme								100 (0/1)	
V. murinus	100 (1/0)								
E. nilssonii	75.4 (38/8)			14.8 (7/2)	9.8 (3/3)				
E. serotinus	50.9 (52/4)	24.5 (23/4)	1.8 (2/0)	2.7 (3/0)	1.8 (2/0)	16.4 (15/3)			1.8 (2/0)
P. nathusii		11.1 (0/1)	88.9 (6/2)						
P. pipistrellus	27.0 (24/17)			0.7 (0/1)		67.1 (36/66)	1.3 (2/0)	3.9 (1/5)	
P. pygmaeus	88.2 (8/7)		11.7 (2/0)						
N. noctula	4.6 (2/1)		23.1 (6/9)	12.3 (5/3)		58.5 (32/6)	1.5 (0/1)		
P. auritus	45.4 (422/86)	3.2 (23/13)	2.0 (15/7)	28.7 (281/40)	2.2 (19/6)	0.7 (7/1)	10.0 (94/18)	0.7 (6/2)	7.1 (61/18)
P. austriacus	35.5 (11/0)	54.8 (11/6)	6.5 (1/1)			3.2 (1/0)			
B. barbastellus	63.9 (128/60)	1.0 (1/2)	2.4 (3/4)		22.8 (49/18)	5.1 (9/6)	0.3 (1/0)		4.4 (10/3)
Total	2492	290	120	1072	596	533	245	488	341

monitoring III

III. Monitoring of swarming communities (in a case example)

Since the beginning of the 1970's, when mist netting was introduced as a routine method in the armamentarium of European bat research, the Czech bat students have given systematic attention to the phenomenon of net-revealed night visitations of underground spaces by bats (Horáček 1972, Gaisler 1973, Horáček and Zima 1978), currently termed swarming after the American authors (Davis 1964, Davis and Hitchcock 1965, Hall and Brenner 1968, Fenton 1969). A series of repeated mist nettings performed since 1970 in several cave sites in territory of former Czechoslovakia and abroad revealed already during the 1970's the fundamental traits of the phenomenon of swarming including remarkable temporal dynamics of swarming behavior and its essential role for comprehension to biology of temperate bats. The results of multi-annual monitoring of the phenomenon of swarming in entrances of underground hibernacula in various regions of Bohemia, Moravia and Slovakia (partly published in a series of separate papers, e.g. Anděra et al. 1992, Bauerová a Zima 1988, Červený 1982, Gaisler 1973, 2000, Gaisler and Bauerová 1977, Hanzal and Průcha 1988, Horáček D. 2007, Horáček and Zima 1978, Průcha 1989, Zukal and Řehák 1993, 2006, Zukal et al. 2005) further enabled the comparisons which resulted in the following conclusions:

(i) The annual course of swarming activity follows the same pattern each year: (a) none or a minor activity in late May and June, (b) a massive increase in number of swarming bats during the second half of July with peak abundance at late August or early September, (c) mass predominance of adult males during the first phases of the swarming period, with subsequenly increasing portion of adult females during August, (d) increase of relative portion of juveniles in the later part of the season (due to decrease in swarming activity of adult bats etc.), (e) a distinct peak in swarming activity in March and April, particularly in *Myotis nattereri* and *Plecotus auritus.*

(ii) In the peak of the swarming season the species diversity and often also abundance of a swarming community are significantly higher that respective characteristics of the community of batshibernating in the same site. Even the species which do not use underground spaces as hibernacula may frequently visit their entraces at the swarming period (*Hypsugo savii, Eptesicus* spp., *Pipistrellus* spp.). Thank to this, netting at cave entrances provides the most effective technique to reveal presence of rare species hardly accessible by other techniques.

Swarming in local bibliographic record

*9, 13, 14, 80, 85, 90, 105, 116, 122, 124, 127, **132 133,** 135 167, **197,** 798, 204, 207-209, 211, 217, 229, 231, 290,292, **351,** 353, 356, 366, 375, 415, 418, 449, 471-473, **476,** 479, 483, 486, 498, 502, 504, 505, 509, 510, 523, 530, 534, 550, 552, **567**, 570,-572, 578, 629, 631, 656, 686, 750, 752-753, 776, 801, 809, 913, 823, 824, 831, 857, 899, 96, 967, 994, 1002, 1006-1007, 1011, 1056, 1059, 1065, 1067, 1148, 1150, 1153, 1156, 1158, 1163,-1165, 1167, 1169-1170, 1170, 1172, 1176, 1172, 1185, **1251**, 1255, 1256, 1276, 1279, 1280, 1301-1305, 1308, 1312, 1316-1317, 1326, 1333-1335, 1337, 1360, 1371, 1406, 1407, 1444, 1446, 1454, 1459, 1460, 1501, 1502, 1504, **1511,** 1512, **1515, 1519,** 1550, 1553, 1564, 1572, 1581, 1582, 1594, 1598, 1615, 1632, -1672, 1689, 1691.*

(iii) There are apparent differences among particular species in their attitude to underground spaces and their use of them during the swarming period. As a rule, the forms representing cave-dwellers originally (Rhinolophidae, *Myotis myotis, Myotis emarginatus*) predominate the swarming communities.

(iv) Despite of the above mentioned common features, particular regions and even neigbhouring localities may considerably differ in abundance and composition of their swarming communities. The difference are believed to reflect the specificities of local bat fauna, differences in spatial characteristics of cave entrances and last but not least different social traditions of particular roosts.

(v) The phenomenon of swarming with its consequences for the gene flow dynamics, establishing and transferring social tradition of particular roosts, that is an essential component of the social system of temperate bats, is undoubtedly one of the most interesting phenomena in biology of European bats and as such it is steadily worth of a detailed study.

In the Czech Republic, the most detailed data concerning the phenomenon of swarming were obtained from a complex of pseudokarst spaces called Ledove sluje cave, which is, however, in more respect quite exceptional and differs (also in composition of the bat community) from most of other sites.

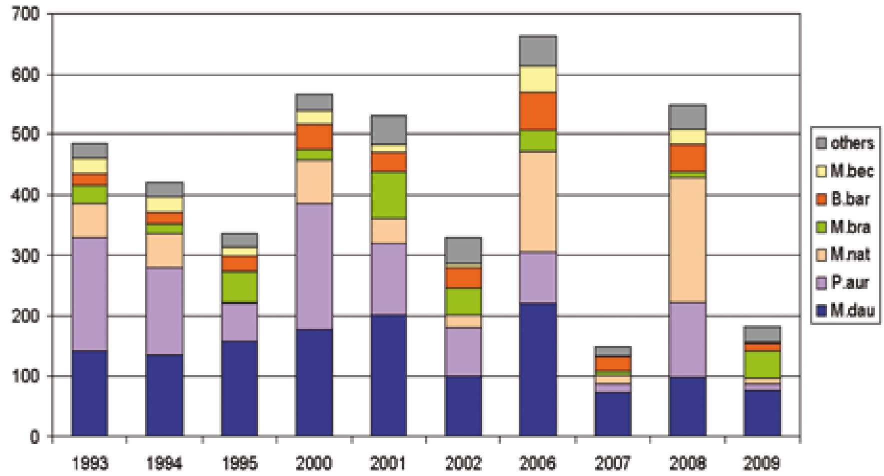
Project: Swarming bats in Ledové sluje

by **Antonín Reiter, Petr Benda, Anna Hofmannová and Michal Andreas**

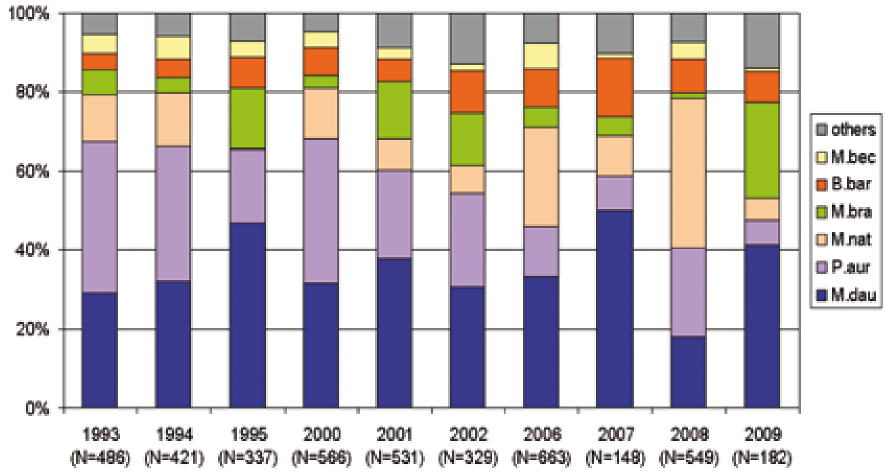
Ledove sluje is undoubtedly the site of an essential importance for study of swarming behavior and related aspects of behavioral ecology and various background effects modulating the phenomenon of swarming. Yet the site was long not available for a study. It is situated in vicinity of Vranov nad Dyjí (48°53´03´´N, 15°50´40´´E; 380 m a.s.l.) in the southeastern part of the Czech Republic, just at the border with Austria. Although the first incidental records of bats (*Myotis daubentonii* and *M. brandtii*) from there come from the year 1984 (Gaisler et al. 1989), until the year 1989 the site, situated in a guarded border zone, was absolutely inaccessible for systematic research. After the fall of the "Iron Curtain" in 1989 and in the context of the proclamation of the Podyjí National Park the locality immediately become investigated with aid of mist netting at various entrances of the underground labyrinth. The results demonstrating extraordinary rich community of swarming bats stimulated a large scale project of long-term study of bats in Ledove sluje that is continuing until present.

The site alone is due to its character an extraordinary natural phenomenon. It is an extensive system of pseudo-karst cavities originated by an large-scale collapse and gravitational displacement of a gneiss rock massive in the left undercut slope bank of the meander of the Dyje River. Only a smaller part of the cavities ranging from several tens to approximately 500 m in lenght with denivelation up to 40 m is accessible to speleological exploration, the actual extent of the labyrinth accessible to bats is unknown. In addition to underground spaces there are many rock walls, debrises of extensive rocky blocks, relief depressions with inverse microclimate and other phenomena. The name of the site "Ice Caves" points out formation of ice infill in some of the caves that in some years may last until the summer months. More detailed description and further references can be found in, for example, Demek & Kopecký (1999). This location alone as well as the wider surrounding area of the Dyje valley is covered with natural forest vegetation (mostly *Melampyro nemorosi-Carpinetum* and *Aceri-Carpinetum*) complemented with patches of wet meadows and river with riparian habitat (Chytrý & Vicherek 1995, Chytrý 1996), all (beacuse of the border zone) untouched by any exploitation for more that 50 years. The other habitats in the vicinity (5 km) are natural beech and oak forests, river and creek valleys, ponds, fields, dam reservoir and several villages.

Mist-netting repeated in regular terms mostly in the same standard positions was the basic method used in the project. For most of the time two nets placed in same two points were used and once in while they were complemented with other catching points. Intensive research took place particularly during the years 1993-1995 and 2000-2002 when the captures were done approximately in monthly intervals from March to November always during a one full night and the following night from dusk until midnight. Between the years 2003-2005 the research was discontinued and since 2006 the study is restricted to three full night monitoring captures per a year (April, June, and September). Between the years 1991-2009 a total of 75 full night captures and 116 shorter captures were realized. The bats have always been identified by species, sex, age and body condition, forearm length and weight were also recorded. Other methods were applied on a smaller scale or only in limited intervals. Ringing of most of the caught specimens was taking place until the year 1996. In addition to nettings, the accessible spaces of the locality are monitored also during hibernation period. Foraging habitat preferences of the bats were studies in this site during the years 1996 and 1997, including sampling for prey availability, observing foraging bats etc. During the years 1994-1998 faeces samples were taken from all netted bats for food analysis.



Number of individuals of the most common species netted during a single night in the late August term in Ledové sluje in particular years 1993-2009.



Percentage representation of the most common species in the late August sample of particular years 1993-2009.

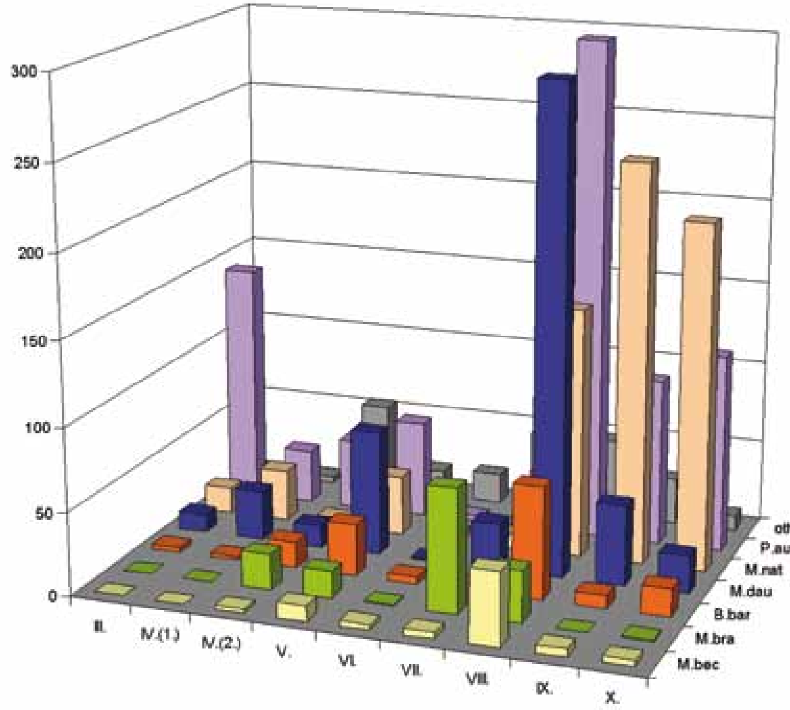
Structure of the swarming community

From 1991 to 2009, a total of 18 085 bats belonging to 19 species were netted (i.e. roughly a hundred bats per night on average, but about six to nine hundreds at peak of swarming season). Species composition of the sample and its dominance structure are characterized by vast predominace of the species typical for Central European deciduous forests, primarily *Plecotus auritus, Myotis daubentonii* and *Myotis nattereri*. Other more demanding forest specialists including *Myotis brandtii, Barbastella barbastellus* and *Myotis bechsteinii* also have abundant occurrence. The recently described *Myotis alcathoe* was distinguished here in the year 2007, and its determination was confirmed by a DNA analysis (Lučan et al. 2009). Its occurrence in the Podyjí/Thayatal National Park and in the surrounding

*Table 1: Total number of bats netted in Ledové sluje swarming site from 1991 to 2009 (including recaptures). *Myotis alcathoe is here recognized since 2007 (included either in M.mystacinus or M.brandtii previously), ** Pipistrellus pygmaeus was for sure identified first in 2008.*

Species	N	Dominance (%)
Plecotus auritus	5825	32.21
Myotis daubentonii	4060	22.45
Myotis nattereri	3710	20.51
Myotis brandtii	1135	6.28
Barbastella barbastellus	1082	5.98
Myotis bechsteinii	514	2.84
Myotis mystacinus	380	2.10
Myotis myotis	354	1.96
Eptesicus serotinus	253	1.40
Eptesicus nilssonii	161	0.89
Plecotus austriacus	145	0.80
Myotis emarginatus	142	0.79
Pipistrellus pipistrellus	122	0.67
Rhinolophus hipposideros	120	0.66
Nyctalus noctula	29	0.16
**Myotis alcathoe*	26	0.14
***Pipistrellus pygmaeus*	15	0.08
Nyctalus leisleri	11	0.06
Vespertilio murinus	1	0,01
Total	18085	100,00

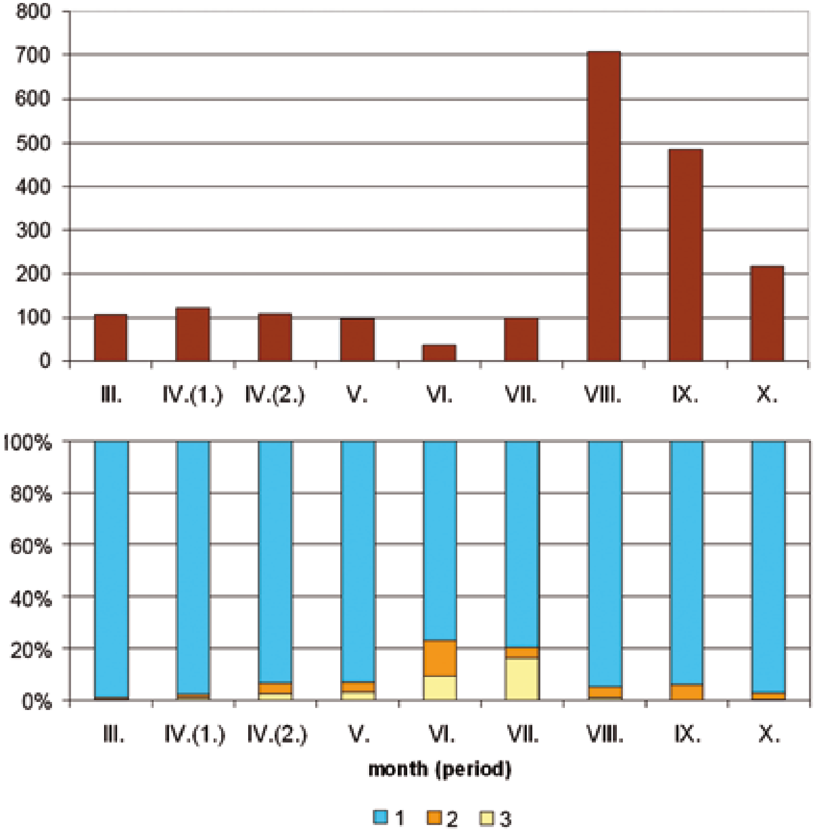
area was found in approximately 20 sites (Lučan et al. 2009, Hüttmeir et al. in press). It is therefore relatively commonly spread here which corresponds well to the presence of extensive areas of forest ecosystems that with their character correspond to the currently indicated ecological demands of this species (Lučan et al. 2009, Schorcht et al. 2009). The monitored location may have fundamental significance as a swarming place of this unstudied bat. Contrary to the forest species, the synanthropic and thermophilic species, e.g. *Rhinolophus hipposideros, Myotis emarginatus* and *Myotis myotis,* are rare in the netted sample, although their summer colonies are located in the surrounding region and at least two of the named species also belong to dominant species in neighbouring hibernacula (Reiter et al. 2001, 2003). The regular occurrence of *Eptesicus nilssonii* is noteworthy as the site is situated by the periphery of the regular range of the species in the higher altitudes of the Bohemian Massif. No records of this species are available both from the the warm eastern and south-eastern foothill of the Bohemian Massif, nor from the agricultural land of the South Moravian Lowland. In that respect the regular occurence in the studied locality presents the marginal point of its regional distribution and is indeed quite remarkable (cf. Anděra & Hanák 2007).



Abundances of the most common species in the netted samples from particular months of the year 2000.

Seasonal dynamics of swarming

One of the aspects that attracted attention from the beginning of the research was the seasonal dynamics of the occurrence of individual species. Already the first analysis of the results (Hanák et al. 1996) showed that correspondingly to experiences from other sites the seasonal dynamics of the swarming community has a notable late spring and early autumn peaks, while during the mid summer bats the number of netted bats is quite a low only. This course of seasonal

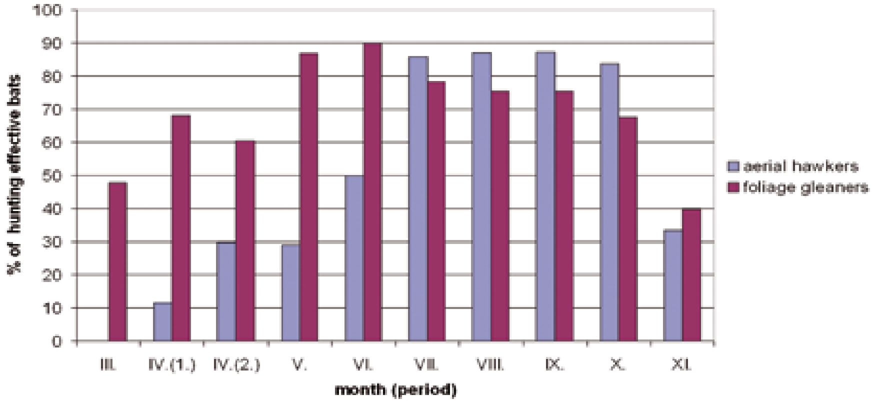


Mean abundances at single night nettings in particular months (upper) and contribution of the forest species (1), thermophilous (2) and anthropophilous species (3) to the total sample (lower).

dynamics was confirmed also in the following years. The spring peak during individual years appeared from the beginning of March until the second half of April, in average values the number of netted bats in these periods is approximately balanced. It should be stressed, however, that the site does not present a mass hibernaculum and not even during the periods with a maximum abundance of netted bats, most of them apparently do not use the site as a daily roost. Also in spring, only a minor part of the netted bats were netted on leaving the cave, and the maximum activity occured usually in the second quarter of the night. In general, the sex ratio in the netted sample is significantly shifted in the favour of males in the species with a distinct autumn maximum. All of these characteristics classify this site among typical swarming places and they coincide with the findings from other monitored European swarming locations with similar dominant species (cf. Parsons et al. 2003, Veith et al. 2004, Furmankiewicz & Altringham 2006, Rivers et al. 2006, Piksa 2008).

Banding data and spatial dispersal of swarming bats

In total 6500 bats were banded at the site, most of them until the year 1996. The banding was not selective, so the species percentages of the banded bats was similar to those in the total sample, with a considerable dominance of the non-synanthropic forest species previously only marginally appearing in banding studies. The extensive banding and recapture data were summarized by Reiter (1998) with particular respect to possible effects of banding upon health of bats: the health status examined in 449 recaptured bats revealed between species differences in the frequency of damages, effects of the time interval between ringing and recapture and a role of the type of the band used. The dominant forest bat species roosting in crevices and cooler hibernacula altogether appeared as quite sensitive, 20%-30% damaged specimens were found among them and in an extreme case (*Myotis daubentonii* with a combination of a less suitable type of ring) it was up to 50%. This finding immediately led to the stopping of ringing of the sensitive species in this site. The later findings of the ringed specimens also brought a number of valuable findings about spatial distribution of bats netted in Ice Caves. Directly in the same place more than 880 specimens were repeatedly netted (multiple re-captures were not included), which is about 13% of all the ringed specimens. In total 41 recaptures beyong nearest neighborhoos of the locality were obtained. The longest displacements were registered in the *Myotis myotis* - one to a materinity colony 59 km SE, the other to a hibernaculum 176 km NE. The migrations of the sedentary forest species - *Plecotus auritus, M. nattereri, M. bechsteini* or *B. barbastellus* (summarized in details by Reiter et al. 2003) demonstrated convincingly that the swarming site is regularly visited by bats from a region of at least 20 km in radius. Exceptionally long movement was recorded in *M. brandtii* - 73 km in the course of 42 days. In general, the direction NW-SE clearly prevailed in the movements, which corresponds to the direction of the Dyje River valley. Just one of them was perpendicular to that direction (it headed to the hibernacula in the Rokytná River valley which runs parallel to the Dyje River valley). The recaptures within the studied site are quite regular even recently including the individuals banded at the very beginning of the study period, so the data from the seasons to come are expected to provide valuable information on longevity (and other demographic parameters) of the the bat species dominating the sample.



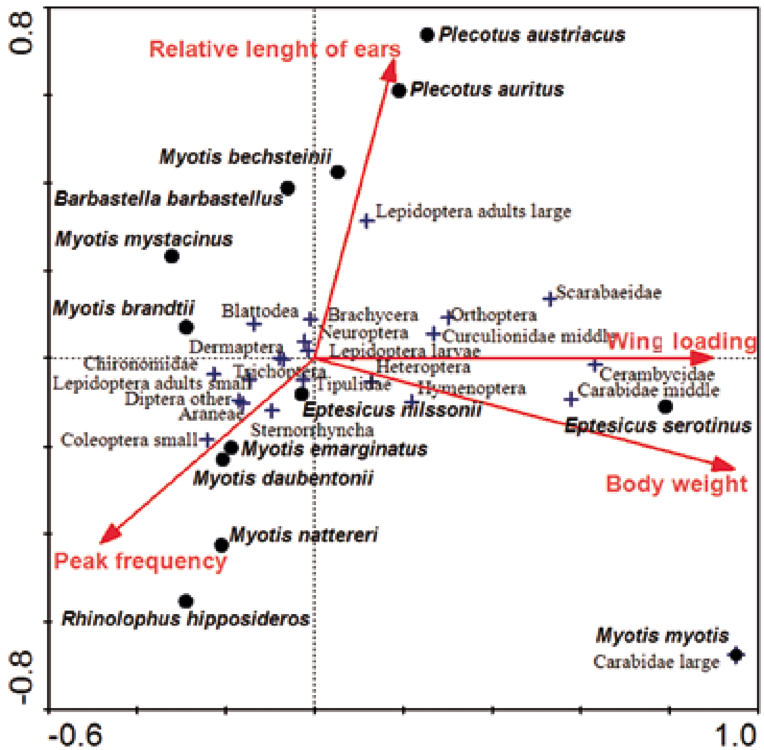
Mean hunting success in the aerial hawkers and foliage gleaners in particular months estimated based on feces dropings from netted bats.

Seasonal weight dynamics, efects of foraging strategy

Seasonal weight dynamics were evaluated in greater detail in six most abundant species in the site. The goal was for one the actual description of the course of weight changes, and reexamination possible relations between seasonal weight changes and the food ecology of the abundantly captured species. All the species exhibit a common general trend: increase of the body mass the lowest weight in the spring season after hibernation (March - May), to the highest in the autumn months (October - November). Also the findings that females are heavier than males and that the juvenile bats are throughout the period between August until October evidently lighter than adult specimens, are in agreement with expectations. Somewhat less trivial is the finding that the weight increase in females in the late summer period takes place evidently earlier than in males which may be related to increased activity (energy output) of males during swarming and the delayed beginning of accummulation of fat reserves for hibernation. Perhaps the most interesting output of the study is the observation that the aerial hawkers and foliage gleaners significantly differ in seasonal course of their weigth dynamics. While in the latters, i.e. *Plecotus auritus* or *M. nattereri*, the mean weight continuously increases during autumn with distinctly highest values in October and November, in the aerial hawkers, particularly in *M. daubentonii*, it attains the peak values already in August and September and since October it exhibits clear decrease. Besides that the gleaner *P.auritus* is capable of achieving the spring weight increase one month earlier than the aerial hawker *M. daubentonii.*

A greater effectivity of the foliage gleaners during the beginning and end of the season manifests also in their flying activity. As opposed to the aerial hawkers it is again higher in early spring and late autumn (March, April, October, November). The same phenomenon is evident in the hunting success of both compared hunting strategies, expressed by a percentage of specimens that defecated in the scope of the data collection for a diet analysis. The observed differences can be quite well explained by the accessibility of food supplies depending on the environment temperature. During the beginning and end parts of the season (i.e. early spring and late autumn) when the temperature is low the flying activity of small insects, hunted by aerial hawkers, is also very low or nil. This aerial prey, primarily the swarming nematocerans, is then obviously not available. The low flying activity of aerial hawkers in the respective period and significantly reduced hunting success of them are in good accord to that. As opposed to that, the supply of insects on surfaces of vegetation is unreduced even in relatively low temperatures and at cold spring and autumn nights it can be even enriched by imobile "aerial prey" what all promotes a higher foraging succes of the gleaner in these times. The resulting seasonal pattern showing hunting success clearly demonstrates that the period with a relatively higher hunting success is notably stretched to the beginning and end parts of the season in foliage gleaners, while in aerial hawkers it is more concentrated in the peak of summer and the beginning of autumn.

The enormous species diversity as well as relatively high numbers of particular species occurring at the studied site sparked off the research of trophic ecology of the community. Netted bats were kept individually in numbered cloth sacks and faecal pellets were collected for later analysis under a binocular microscope. The food supply was sampled using UV light and also by beating and sweeping vegetation. Thanks to syntopic occurrence of bats, the collected material made it possible to compare in detail trophic niche overlaps, differences in diet diversities and the entire prey compositions of the species with similar morphology and/or ecology (*Myotis emarginatus* vs. *M. nattereri, Plecotus auritus* vs. *P. austriacus*) or thoroughly evaluate some guilds (e.g. group of forest gleaners – *Plecotus auritus, Myotis nattereri, M. bechsteinii*). Results regarding the diet seasonal dynamics of some more abundant species occurring at the studied site within the most of the season is also worth mentioning.



Plot of the canonical correspondence scores for the diet composition in particular species, foot items and echo-morphological variables (based on results from whole season sampling in Ledové sluje).

Fig. 3 shows clustering of the bat species according to their diet composition and echomorphological variables characterizing the foraging capacities (cf. Norberg & Rayner 1987, Bogdanowicz & al. 1999, etc.). In a simplified way, we can observe species with large body size and high wing loading on the right side of the Fig. 3 (e.g. *Myotis myotis* and *Eptesicus serotinus*), bats with long ears in the upper part (*Barbastella barbastellus, Plecotus* spp., *Myotis bechsteinii*), species with high peak frequency in the lower part (e.g. *Rhinolophus hipposideros, Myotis nattereri*) and smaller bats on the left *(Myotis mystacinus, M. brandtii).* Positions of particular food items show that the prey of bigger bat species is especially composed of big representatives of Coleoptera or Hymenoptera, Heteroptera and Orthoptera. Bats with relatively longer ears *(Plecotus, Barbastella* and *Myotis bechsteinii)* feed predominantly on bigger Lepidoptera and bats with higher peak frequencies hunt mostly small Coleoptera, Sternorrhyncha, Chironomidae, etc. The projection of cannonical variable in Fig. 3 shows the same position of big Carabidae and *Myotis myotis* as its major diet component and no other species hunt this prey. Food items such as Chironomidae, Araneae and small Lepidoptera are placed among the species feeding mostly on them: *M. brandtii, M. mystacinus, M. emarginatus, M. daubentonii.*

Due to the syntopic and synchronous sampling, the presented results are for sure not biased by variation in local conditions as it often the case in other similar studies . Consequently, we can consider the between-species differecnces found in our material significant and referring to actual differences in their foraging biology of the respective species.

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projects

bats
of
czecho-slovakia

Bats of the Czech Republic and Slovakia: distributional status of individual species

by

Vladimír Hanák, Miloš Anděra, Marcel Uhrin, Štefan Danko and Ivan Horáček

The following chapter provides a brief summary of distributional status for all 26 species of bats recorded on the territory of Czech and Slovak Republic (including the recently distinguished sibling species Pipistrellus pygmaeus and Myotis alcathoe). The primary literary sources are indicated by numbers at the outer margins of the respective pages that refer to the record numbers in the Bibliography at the end of this book.

The grid maps illustrating current state of knowledge cover the data kindly provided by a large number of participants to the mapping and monitoring projects. For the Czech Republic the explicite account of all the primary mapping record is available at three volumes of the Atlas of the mammals of the Czech Republic by Hanák and Anděra / Anděra and Hanák – refer. 450, 451, 6).

In Slovakia, the corresponding data will be soon published in the book Mammals of Slovakia under editorial contribution by Krištofík, Danko, and others. Neither for Slovakia or Czech Republic the maps presented in the survey distinguish the origin, numbers and temporary characteristics of the record in particular grid quadrats - these data are available from the above mentioned special publications.

Vrápenec malý

Podkovár malý

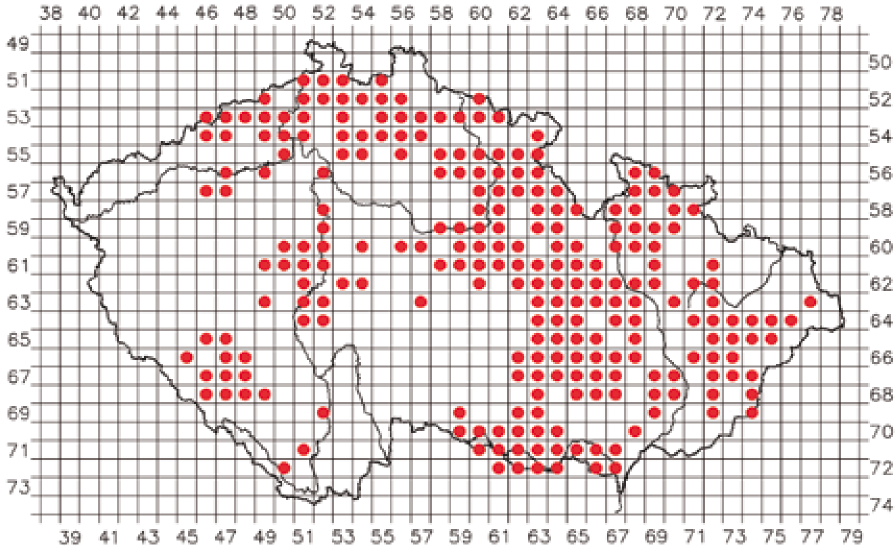
Lesser Horseshoe Bat

Rhinolophus hipposideros

Taxonomy, phylogeny

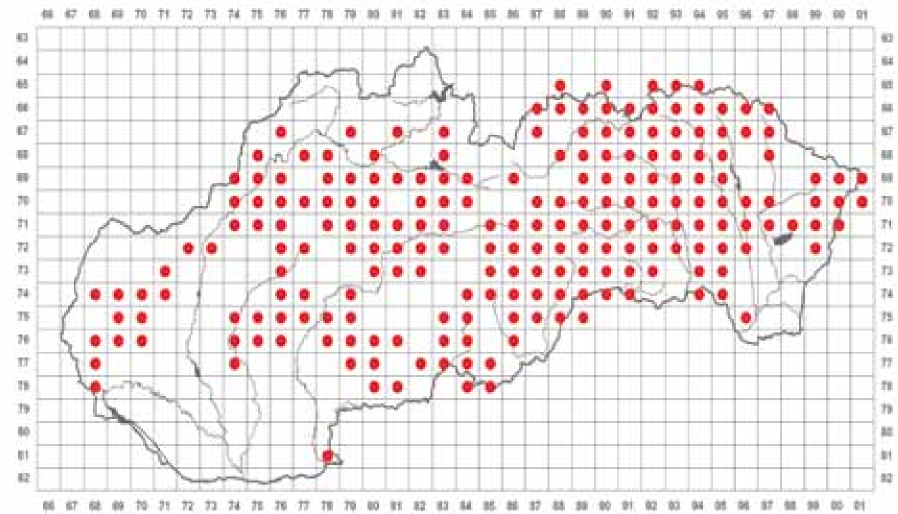
426, 745, 1235, 1246, 1340, 1665.

For the time being, the occurrence of *R. hipposideros* in the Czech Republic is documented by findings in over 730 localities covering a total of 240 quadrats of the mapping grid (38.2 % of the territory). Most of the records indicate occurrence in both summer and winter (112 quadrats, 17.8 % of the territory), winter occurrence is known from 80 quadrats (12.7 %), and summer occurrence from 35 quadrats (5.6 %). The species is fairly common also in Slovakia, its findings coming from 210 mapping quadrats (48.7 % of the territory). Since *R. hipposideros* is generally considered to be a resident species, the sum of the above data presents a fairly real picture of its permanent occurrence in Bohemia, Moravia, and Slovakia. This, after all, is confirmed by the winter findings fitting within or just slightly enlarging the range of its year-round occurrence. All this clearly indicates the long-time stability of the species' range in the territory of the two countries, even though its numbers were distinctly oscillating in the course of the 20th century, notably in Bohemia. *R. hipposideros* is distinctly more abundant in Moravia and Slovakia, practically in most of their territories, especially in their karstic regions in which, according to some of the indices (such as the representation in hibernacula) it is among the most abundant bat species. In Bohemia it occurs more coherently in its eastern and northern part, in islets of varying sizes in central Bohemia and the Šumava region. The distinct absence of records from some parts of Moravia and Silesia (above all, the industrial Ostrava region, the lowlands of southern Moravia with intense agriculture) can be explained by its less frequent occurrence, or (e.g. in the region of Bílé Karpaty Mts.), rather as the consequence of less intense research activity. Also sufficiently distinct is the gradual fading out of this thermophilous species on the south-facing slopes of the Bohemian-Moravian Uplands:



Local distribution

3, 30, 66, 167, 203, 208, 293, 309, 331, 360, 364, 402, 408, 410, 415, 442, 447, 571, 572, 576, 636, 754, 786, 813, 825, 1011, 1013, 1052, 1061, 1065, 1165, 1167, 1192, 1230, 1477.



Life history

51, 323, 333, 336, 337, 338, 339, 340, 342, 352, 382, 399, 407, 417, 469, 1051, 1059, 1098, 1265, 1511, 1548, 1620, 1680.

there the species is common due to the geomorphologically varied and wooded limit of the Pannonian and Hercynian regions. Deeper in the interior of the uplands it is only present in permanent populations (or at least hibernacula) in the valleys of the Moravian rivers (Dyje, Rokytná, Jevišovka, Jihlavka, Svratka, and Svitava r.) Into the eastern and later also northern and central Bohemia, *R. hipposideros* apparently advanced through the more open region along the Svitava River. Its further advancement in the S and SW direction to the Šumava region can logically be connected with its spreading along the Vltava R. valley and its tributaries, as indicated by the quite recent findings, e.g. in the Budějovická kotlina Depression. In Slovakia the species is obviously absent from the lowland regions (along the Danube and the Eastern Slovakian Lowland). On the contrary, its absence in the wider environs of the Štiavnické vrchy Hills rather reflects the less intense research intensity.

Most of the Czech findings of *R. hipposideros* in summer and winter come from elevations between 200 and 600 m. In contrast, the number of summer and winter records is equable at lower elevations below 400, whereas over 400 m the winter ones are distinctly more numerous. In Slovakia the overall hypsometric range of the species is 100 – 1488 m a.s.l., in summer 200 – 600 m a.s.l.

Against expectancy, the chorologic status of *R.hipposideros* is not completely clear. Relations of the Miocene and Pliocene small-sized horseshoe bats to the Recent species are doubtful. No record is available from the Early Pleistocene, the Middle Pleistocene records are limited to the interglacial assemblages of the Pannonian basin and only in some interglacials (Eemian for sure) it spread beyond its limits. Nevertheless, in the Holocene *R.hipposideros* is relatively common element of the fossil assemblages in our territory: 28 records (14 from continuous sedimentary sequences) are available - but no one from the Early Holocene (even in the Slovak karst). These data suggest that *R. hipposideros* is a species which appeared in Central Europe more or less exceptionally and its current distribution results probably from the late Holocene expansion, driven by synanthropic way of life.

Vrápenec velký

Podkovár velký

Greater Horseshoe Bat

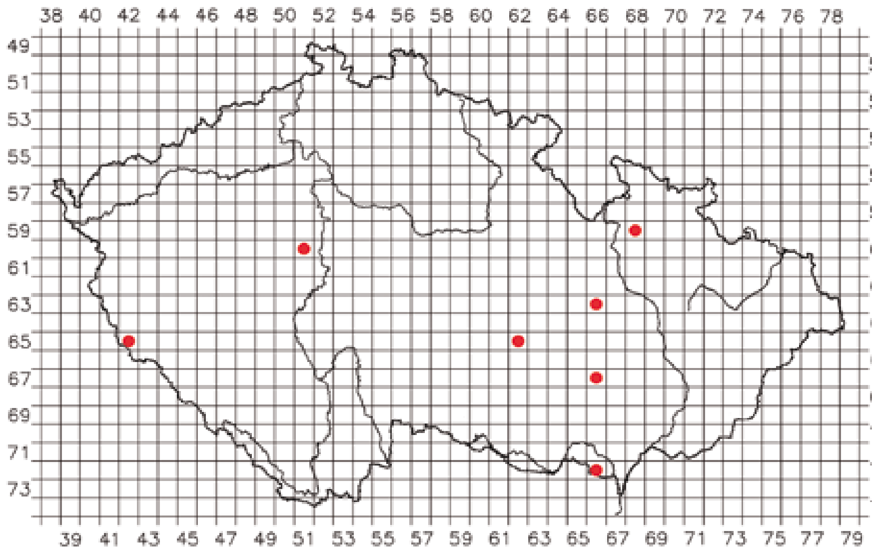
Rhinolophus ferrumequinum

Apparently, this species has never been among the permanent settlers in the territory of the Czech Republic Its occasional occurrence in this country is only documented by isolated records of hibernating bats, above all, in Moravia, and quite exceptionally even in Bohemia. In all, reliable records are available from 11 mapping quadrats (1.8 % of the territory); however, only old reports dating from the period before 1900 are available for 5 quadrats. After 1950, the species

Taxonomy, phylogeny

774, 1235, 1246,, 1475, 1665.

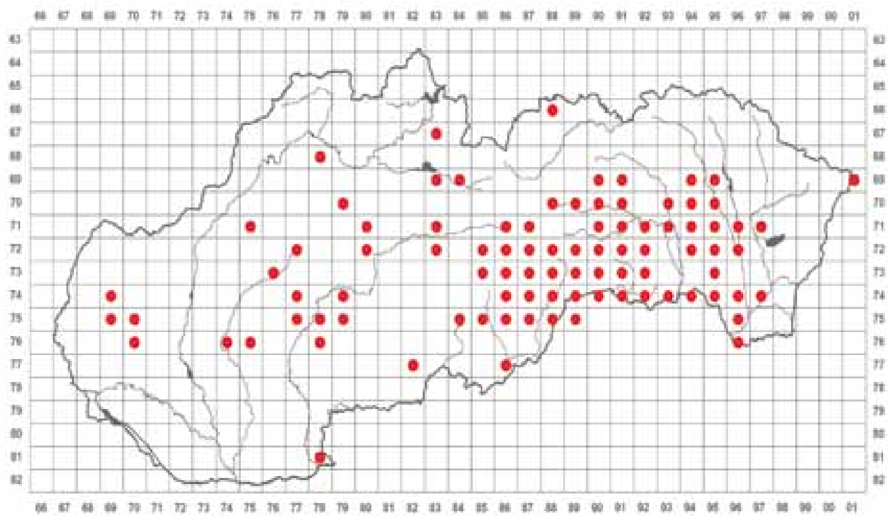
was recorded in 7 quadrats only (1 % of the territory) and for 8 mapping quadrats only uncertain and unreliable data are available, recorded here for completeness' sake.



The first concrete report on the finding of *R. ferrumequinum* in Bohemia (the Svatoprokopská Cave, lying at the outskirts of Prague) dates from 1848, and 10 years later the species was reported from the Moravian Karst. Its occurrence in this country has always been characterised by quite irregular records of individual hibernating males, more frequent in the second half of the 20th century and pertaining mainly to hibernacula in Moravia (the last occurrence reported in 1979). Only after a longish break, these data were joined by the finding of two individuals wintering in an abandoned gallery in the Český les Mts. on the Bavarian boundary. So far, nothing tends to suggest the presence of *R. ferrumequinum* in our country in summer, and even in the historical past this species apparently never was its permanent inhabitant. Evidently, this is a southern Palaearctic element the northern limit of whose range always passed south of our boundary. Thus the more frequent Moravian reports can be evaluated as occasional visits of individuals from permanent populations in the south-east (Slovakia, Hungary, Austria) and the findings in Bohemia may most probably be connected with the

Local distribution

138, 217, 296, 309, 3236, 331, 367, 402, 415, 435, 442, 450, 451, 454, 471, 476, 551, 571, 572, 786, 1026, 1067, 1026, 1121, 1131, 1165, 1192.



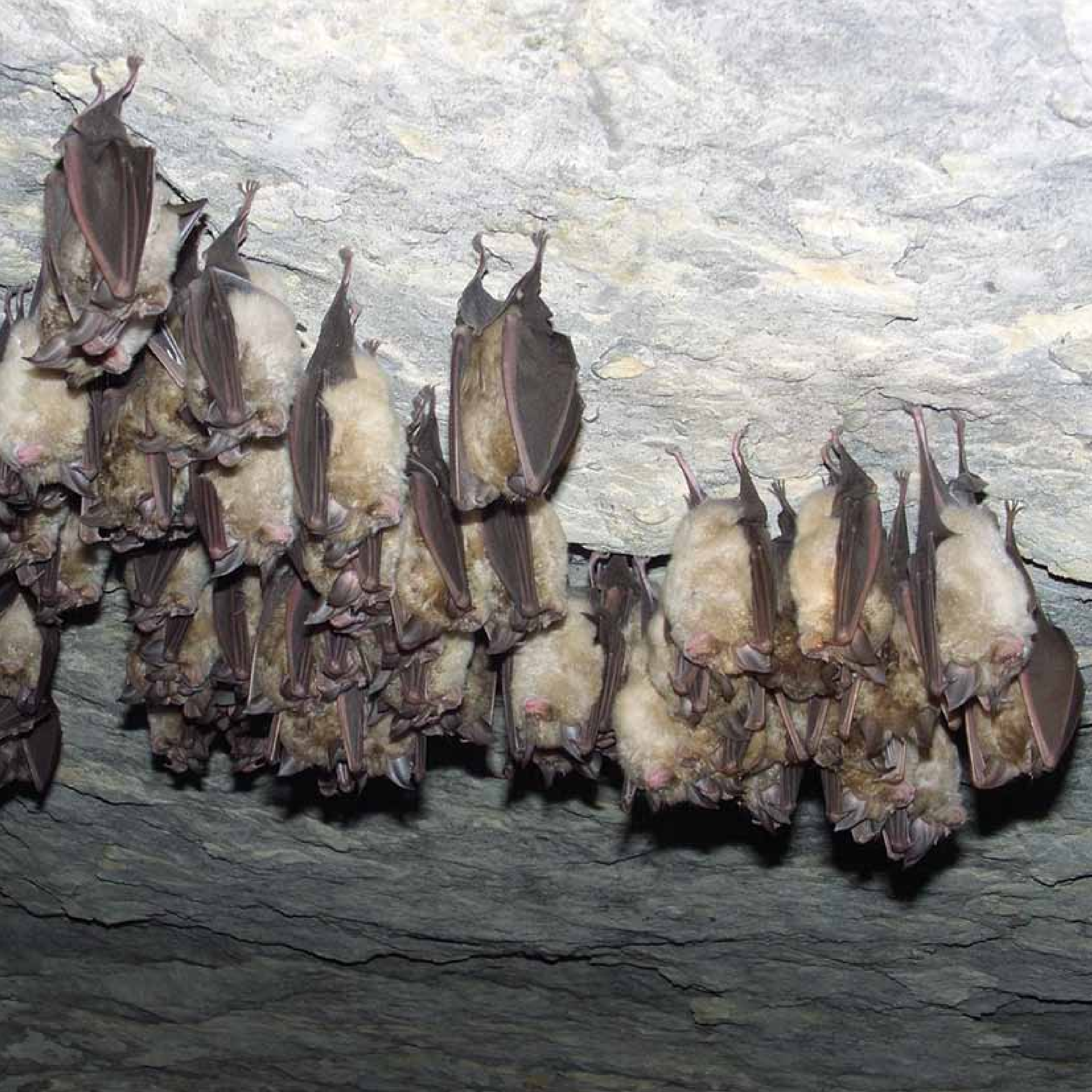
Life history

352, 382, 417, 469.

permanent occurrence of the species in southern Bavaria. For the time being, further development of this situation cannot be predicted, and it will depend on the development of *R. ferrumequinum* populations near the northern limit of its range both in the Pannonian region and in Bavaria.

The territory Slovakia lies in the northern part of the species' range (the northernmost localities lying in the south of Poland) and it occurs in Slovakia both in winter and during its mating season, demonstrably forming maternity colonies there. The recent occurrence (after 1960) of the species was reliably documented in 90 mapping quadrats, which is about 21 % of the territory of Slovakia. Its findings in the western part of the country are sporadic and rather resembling those in Moravia. Some of those data document its occurrence on the basis of osteological remains in the food of birds-of-prey or in caves. Their largest number is concentrated in mostly karstic regions in the southern part of central Slovakia (Slovakian Karst, Muránska planina Plateau, Revúcka vrchovina Hills) and the Slánske vrchy Hills and their environs. Except in the latter area, maternity colonies are known from 6 quadrats (1.4 % of the territory of Slovakia), found in the loft spaces of human buildings. The altitudes of the localities range from 100 to 960 m a.s.l., the bulk of them, however, lying at medium altitudes in the hilly country.

The phenotypical taxon *R.* cf. *ferrumequinum* presents a dominant element of the European fossil bat assemblages since Middle Miocene. Co-identified with the Recent species, it is an euconstant element also during the Pliocene and the lower part of the Early Pleistocene (when occurs in ca 70% of European bat assemblages). Since upper part of the Early Pleistocene it become less frequent (occurs in 18% of the European bat assemblages) and in the Middle Pleistocene it appears more frequently only in the interglacial communities of the Panonian basin. The fossil record from our territory, i.e. the zone of the northern margin of the species range, illustrates that history quite impressively. During the Middle Pleistocene, the northward expansion of the range margin from the Panonnian region took place probably just in some of the interglacials (for sure in Eemian). No Holocene record is available from Czech Republic, two (of the late Holocene age) come from the Slovak karst.



Vrápenec jižní

Podkovár južný

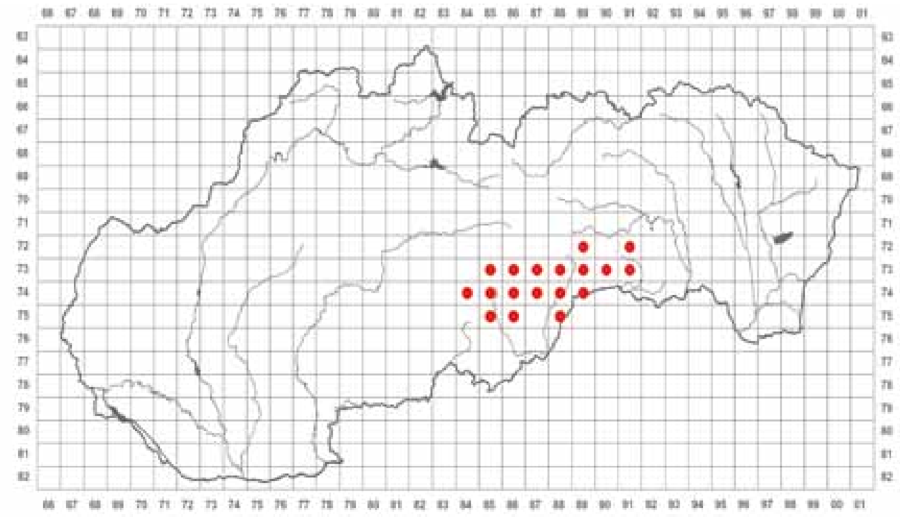
Mediterranean Horseshoe Bat

Rhinolophus euryale

In the south of Slovakia and the north of Hungary there lives a small population of this species, obviously separated by the Pannonian Lowland from its main range in the Mediterranean region. In Slovakia, summer and winter records of *R. euryale* limit its occurrence to a small area lying in only 18 quadrats of the mapping grid, i.e. a mere 4.2% of the territory of Slovakia. Thus, *R. euryale* occupies the least area in the country. So far, it has been found breeding in 7 quadrats (1.6 %). This area covers the southern parts of central and eastern Slovakia (Slovakian Karst, the S part of the Volovské vrchy Hills, the Rožňavská and Košická kotlina depressions, the Revúcka vrchovina Hills, the Rimavská kotlina Depression, the Revúcka vrchovina Uplands, the Rimavská kotlina Depression, the Muránska planina Uplands, and the Stolické vrchy Hills. Because of the association of the species with karstic areas and its caves, its known distribution in winter is almost identical with the summer one. Approximately since the 1970s, breeding colonies have also been found in the loft spaces of human buildings, a quite exceptional phenomenon in the previously almost strictly cave-dwelling species all over its range. The most important maternity colonies have been found in the monastery at Jasov, churches at Krásnohorské Podhradie and Silická Jablonica, curia in Drnava, the Liščia diera Cave, Drieňovská Cave, and the Domica-Baradla cave system in the wider region of the Slovenský Kras, the Veľká Drienčanská Cave, Chvalovská Cave, and the galleries near the village Nandraž in the Revúcka vrchovina Uplands. Despite the fragmentary data on the ecological requirements of this marginal population, one may state that the occurrence of *R. euryale* in Slovakia and the north of Hungary is limited by three major factor, (l) its high degree of association with karstic regions and minimum ability to occupy anthropogenic shelters, (2) climatic conditions in the occupied region, and (3) social structure preventing formation of stable isolated subpopulations. The occurrence of *R. euryale* in a geographically isolated region is also reflected in the hypsometric range of the known localities,

Local distribution

309, 352, 368, 402, 417, 442, 469, 551, 571, 572, 1147, 1151, 1192, 1235.



varying between 245 and 767 m a.s.l. and most of them lying between 200 and 400 m a.s.l.

R.euryale is a rare species in fossil record. Neither the Pliocene nor the later records exceed the range of its contemporary distribution. In total 6 records are available from Slovak karst but none beyond limits of that region.

Roosting on lofts of buildings (unique for the local population of the species) *R. euryale* often accompanies breeding colonies of *M. emarginatus*.

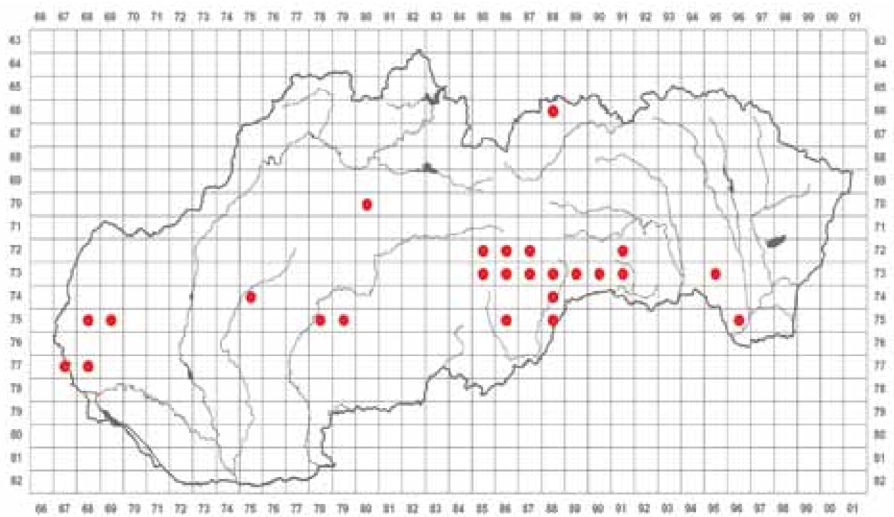
Létavec stěhovavý

Lietavec stahovavý

Schreibers's Bat

Miniopterus schreibersii

Together with *Rhinolophus euryale, M. schreibersii* is one of the two bat species occurring only in the territory of Slovakia, not recorded in the Czech Republic so far. Its occurrence in Slovakia in the summer and winter season is documented by records in 34 quadrats of the mapping grid (7.9 % of the territory of Slovakia). In general, two regions of occurrence of this species can be distinguished: the smaller one, lying in the western part of the country and unstable at present (the Malé Karpaty Mts. and adjacent localities), and the larger one in the eastern part, harbouring a stable population (Slovakian Karst, the Muránska planina Plateau, the Revúcka vrchovina Uplands and adjacent localities). The hitherto ringing results indicate that these two regions probably harbour two different populations. The region of the Malé Karpaty Mts. is inhabited by a western Pannonian population connected with that in the north of Austria. The wider region of the Slovakian Karst is inhabited by an eastern population related to the adjacent populations in the north of Hungary. Records as well as osteological evidence are available from between these two regions, pertaining to individuals or smaller colonies. However, the record most probably pertain to the occurrence of migrating individuals, as indicated by the distribution of such localities along



Local distribution

77, 230, 309, 331, 352, 382, 402, 442, 469, 795, 864, 961, 1112, 1150, 1168, 1192, 1481, 1667.

major rivers (the Hron, Nitra, and Váh rivers) flowing in the north-south direction, which is also characteristic of the migrations of the species. In Slovakia, *M. schreibersi* occurs in localities lying predominantly in lower mountain ranges at elevations between 200 and 400 m a.s.l. A majority of the known summer colonies and hibernacula are situated in that zone. The highest elevated hibernaculum is the Čertova diera Cave on Horný vrch Hill in the Slovakian Karst at 767 m above sea-level.

The oldest representative of the genus, *M. fossilis* Zapfe, 1950 (described from Devinska Nova Ves n. Bratislava, Slovakia) indicates occurrence of the genus already in the Early Miocene. *M. schreibersii* is recorded in our territory (both Czech Republic and Slovakia) from about 20 sites of the Pliocene and Pleistocene age, all of exclusivelly interglacial contexts. The Holocene records in Slovak karst are from the Late Boreal, a single Holocene record from the Czech Republic comes of the Late Holocene in Moravian karst.

Netopýr velkouchý

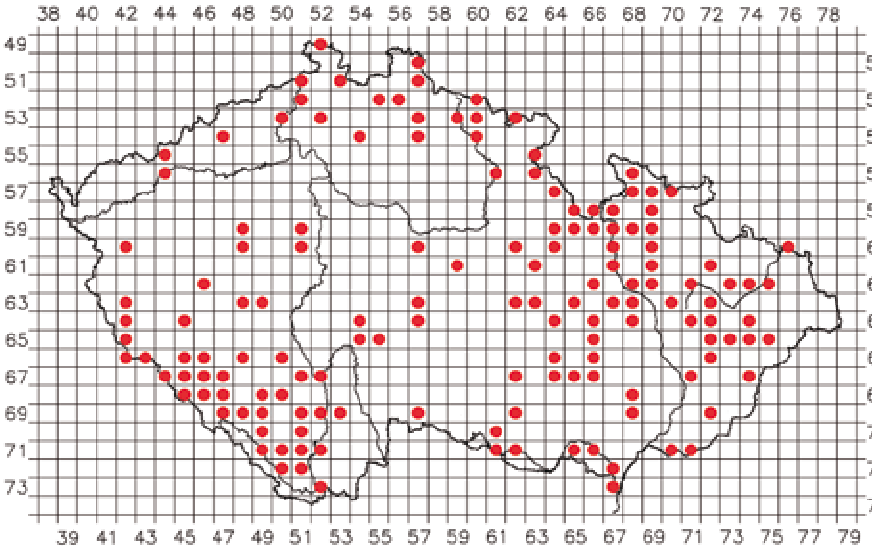
Netopier velkouchý

Bechstein's Bat

Myotis bechsteinii

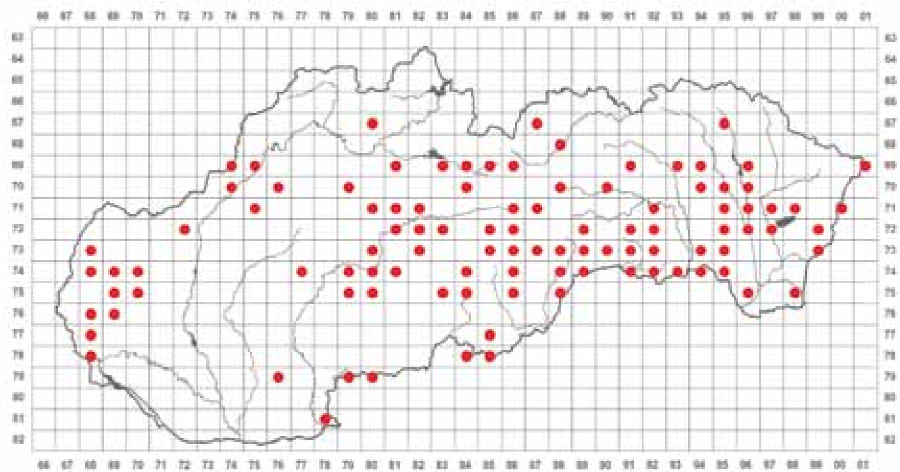
The data obtained so far after 1950 on the occurrence of *M. bechsteinii* in the Czech Republic pertain to roughly 230 localities in which the bat was recorded in winter (97 localities), summer (107 localities) or in both seasons (26 localities), all these findings covering 135 quadrats of the mapping grid, i.e. 21.5 % of the territory of the Czech Republic A similar percentage of the territory of Slovakia (23.1 %) is covered by the findings of this species in altogether 100 quadrats.

Thus, *M. bechsteinii* is among the least abundant bat species with distinctly mosaic distribution pattern. Beyond doubt, the data obtained suggest that it is distributed all over the territories of the two countries, yet the mapping picture obtained so far is considerably fragmented (due to the low numbers of individuals difficult to discover in their tree roosts and, as usual, to different research intensity in different regions). The species is more abundant in Moravia, above all, in warmer and wooded hilly country, such regions offering sufficient numbers of shelters in old tree holes as well as sufficient supply of suitable hibernacula in karstic regions or in abandoned mine galleries. In Slovakia, its more frequent occurrence has been reported from various wooded regions, such as the Poľana, Slánské vrchy Hills and Vihorlat Hills. In Bohemia, its rather more abundant and coherent occurrence has been recorded so far only at lower elevations of the Pošumaví Region; the sparse findings in the remaining regions (more frequent in winter) tend to suggest its more numerous and stabilised occurrence in eastern, north-eastern and probably also central Bohemia. The overall range of altitudes of its localities is 140 – 1150 m a.s.l. in the Czech Republic, and 100 – 1390 m a.s.l. in Slovakia. However, the absolute majority of winter



Local distribution

3, 51, 66, 90, 130, 167, 203, 204, 293, 309, 402, 415, 442, 451, 464, 475, 476, 571, 572, 636, 786, 813, 829, 866, 1011, 1013, 1040, 1052, 1061, 1067, 1103, 1192, 1230.



Life history

51, 352, 417, 476, 576, 1515.

and summer records are rather equitably concentrated between 200 and 800 m a.s.l. (90.8 and 91.1 % respectively). Sporadic records of maternity colonies of this species in the Czech Republic come from elevation ranging between 430 and 580 m a.s.l. (averaging 456 m a.s.l.). In Slovakia the species has been found breeding in 24 quadrats (5.6 % of the territory). On the whole, the picture of the distribution of *M. bechsteinii* should be considered preliminary, due to the different intensity and methods of investigation, and apparently underestimated.

The forms phenotypically very close to the Recent species, present the euconstant element of the mid-European fossil assemblages since the end of Miocene. In the Czech Republic, *M.bechsteinii* was recorded in 20 Pleistocene sites, all from interglacial context, and (combined with Slovakia) in 55 assemblages of the Holocene age, from the Late Vistulian (in S-Slovakia) or early Boreal in Bohemian karst when its abundace clearly increased until middle and late Holocene. The massive drop of abundance and disappearance from cave roosts where until then it was an eudominant species took place probably as late as in the historical time.

Netopýr ostrouchý

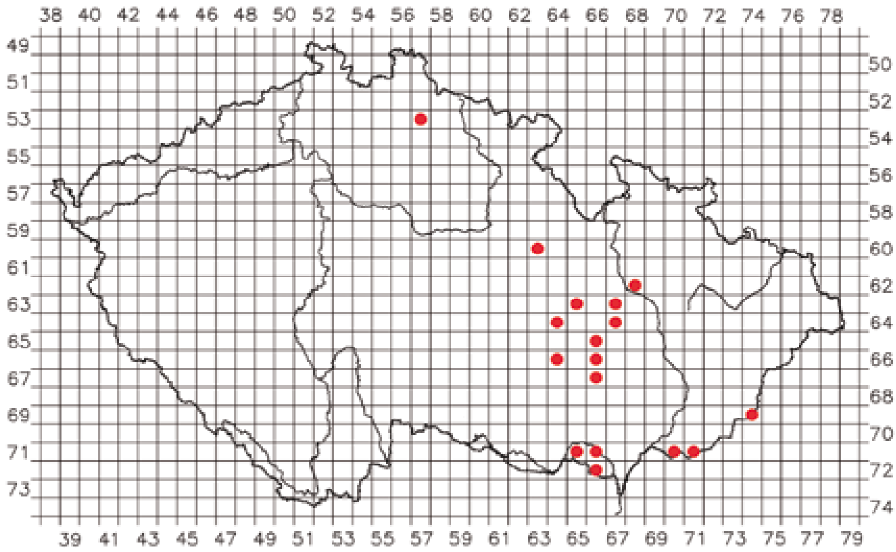
Netopier východný

Lesser Mouse-eared Bat

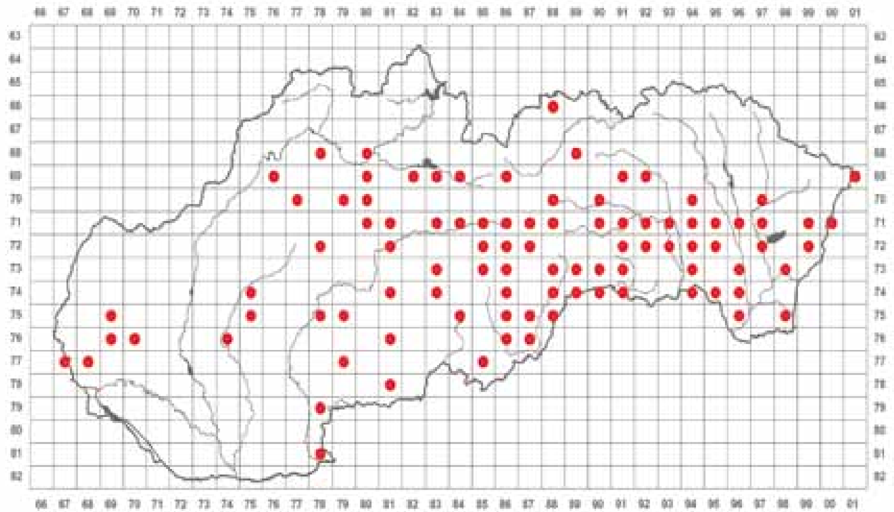
Myotis blythii (*Myotis oxygnathus*)

In the Czech Republic, this species was recorded so far in localities lying in 16 mapping quadrats (i.e. 2.5 % of the territory), mostly during hibernation or on spring and autumn migrations. The distribution of these records outlines the rather coherent region of potential hibernacula of the species in the south of Moravia, with a gravity centre in the Moravian Karst, karstic areas near Mladeč and Javoříčko, and the traditional hibernaculum in Turold Cave at Mikulov.

Occasional hibernacula are found on Květnice Hill near Tišnov and in the Hornosvratecká and Svitavská vrchovina Hills in the borderland between Bohemia and Moravia. Quite separated are the hibernacula in the North Moravian Karst and particularly the isolated locality in NE Bohemia (Jičínská pahorkatina Hills). Only seven of the southern Moravian records plus another two in the more northern areas of southern Moravia may be considered to evidence the species' summer occurrence. For the time being, they only suggest the possible breeding of the species in the southernmost part of our territory. Thus, the species appears to prefer only a small region in the SE of the Czech Republic for regular or occasional hibernation. Apparently, this pertains to individuals from colonies near the northern limit of the permanent range of *M. blythii* in the eastern part of Austria and in Hungary and/or western Slovakia. In that region, individual female *M. blythii* may occasionally breed in maternity colonies of *M. myotis*. However, no evidence of a maternity colony in our territory has been presented so far.



The occurrence of *M. blythii* in Slovakia is different. While its findings in its western part are sporadic like in Moravia, in central and eastern Slovakia it is rather frequently found in suitable hibernacula and regularly forms mixed breeding colonies with *M. myotis*,



typically in the lofts of churches. Just a single cave colony is known in the present (in Drienovecká Cave, Slovakian Karst, occupied also by a maternity colony of *M. myotis, R. euryale* and *Miniopterus schreibersii).* The records of *M. blythii* are distributed over about a fourth of the Slovak territory (21.8% of mapping quadrats), their elevations lying between 100 and 1280 m a.s.l.

Due to the small number of records from 1958-2000 it is impossible to estimate to what extent this picture corresponds to the permanent status or is a mere manifestation of oscillations in the parts of populations near the northern limit of the range of *M. blythii.* Such oscillations are also apparent in the trend of the numbers of *M. blythii* hibernating in the abandoned mines at Dubník in the Slánske vrchy Hills. The largest numbers of winter records in the Czech Republic came from the late 1970s, becoming distinctly irregular later on, and their gradual drop is apparent until present. The occurrence of *M. blythii* in the Czech Republic and Slovakia presents the northernmost projection of the range of this thermophilous species in central Europe. The northernmost known maternity colony of *M. blythii* was recorded in the area of Turčianská kotlina basin in Slovakia.

Local distribution

22, 101, 309, 331, 335, 379, 402, 408, 415, 442, 451, 571, 572, 786, 813, 832, 1052, 1067, 177, 1177, 1192.

Taxonomy, phylogeny

21, 94, 103, 1283

Life history

51, 222, 382, 417, 469, 553, 1177, 1379.

In contrast to its sibling species, *M. blythii* (or exactly: the remains which for their smaller size correspond rather to this species than to *M.myotis*) appears in fossil records from Central Europe since middle Pliocene. There are several records from the late Early Pleistocene and Middle Pleistocene (Turold n. Mikulov) as well as Holocene. Eight Holocene records from Slovakia and two from S-Moravia suggest that *M. blythii* colonized the region at least since Boreal.

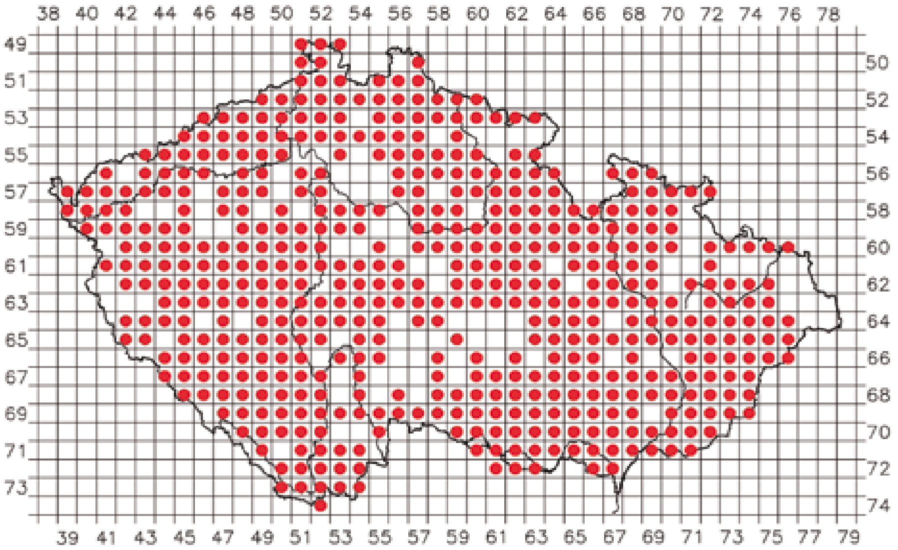
Netopýr velký

Netopier obyčajný

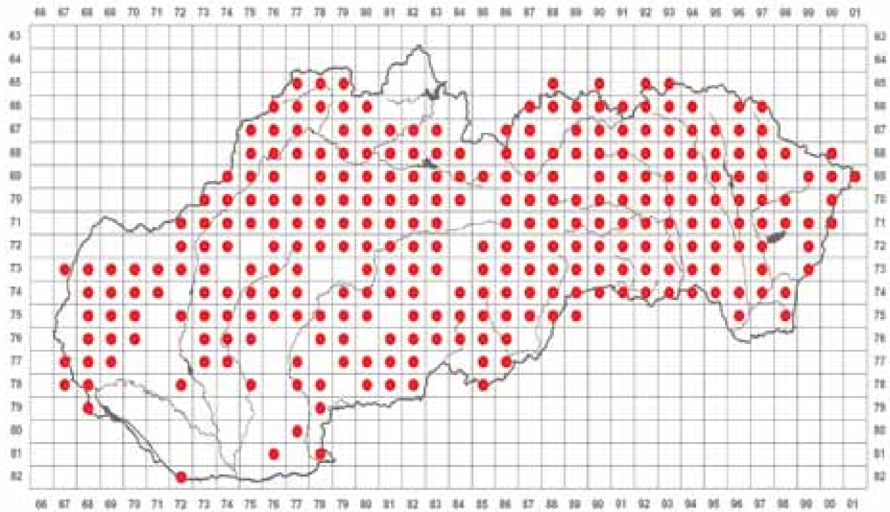
Greater Mouse-eared Bat

Myotis myotis

The occurrence of *Myotis myotis* in the territory of the Czech Republic is documented by almost 1500 localities in which the species was recorded either in winter (about 510 localities), in summer (860 localities) or in both seasons (about 60 localities). In all, these localities fill in 484 quadrats of the mapping grid, i.e. 77.1 % of the territory of the Czech Republic. In Slovakia, too, *M. myotis* is among the most frequent species, recorded in 287 quadrats of the mapping grid (66.6 %). In both countries, the above records also pertain to numerous known maternity colonies. By the number of occupied mapping quadrats and their more or less regular distribution over the territories of the two countries, *M. myotis* is among the most abundant bat species at all. It occurs from lowlands and hilly country up to warmer places in mountain regions. While the gravity centre of its summer occurrence lies in the varied and wooded lowlands and hills, for hibernation it regularly utilises hibernacula with



suitable temperature condi-tions even at higher elevations. The distribution of records and most maternity colonies indicates the greatest abundance of *M. myotis* in central, western and eastern Bohemia and in southern and central Moravia, and it has permanently populated most submontane regions. In Slovakia, breeding *M. myotis* have been recorded in 143 quadrats (33.3 %), above all, in the submontane parts of larger orographic units, e.g. in the Malé Karpaty Mts., Kysuce Mts., the valleys of northern Slovakia, the limestone areas in central and southern Slovakia, as well as in almost all of the hilly eastern Slovakia. The species finds optimum conditions for survival in varied regions with lowlands passing into hilly country; it is less abundant in intensely utilised agricultural landscape. As to summer habitats, it is almost exclusively tied to human settlements incl. small and medium-sized towns with varied surroundings but is absent from large city



agglomerations. Only three underground maternity colonies have been found in the territory of the Czech Republic and Slovakia, viz., in the Hranická propast Abyss in Moravia, the Plavecká Cave in the Malé Karpaty Mts., and the Drienovská Cave in the Slovakian Karst. A coherent evaluation of the sub-area of *M. myotis* is complicated by the fact that in a number of regions, apparently not populated by this species, have not been subject to systematic chiropterological research (most of such regions comprising lowland regions less attractive in respect of natural science). After all, a similar problem is encountered in the case of all bat species commented below.

Life history

51, 222, 352, 382, 407, 417, 469, 476, 530, 576, 645, 763, 777, 980, 1051, 1099, 1100, 1192, 1281, 1288, 1306, 1307, 1308, 1309, 1359, 1363, 1472, 1562, 1564, 1596, 1597, 1681.

Long-time monitoring in important hibernacula and summer colonies of *M. myotis* confirm a significant decrease in abundance in the 1970s and a subsequent increase in the early 1980s to a roughly twice higher numbers than those at the beginning of the investigations. Apparently, the present numbers are the highest over the whole period under study. The hypsometric analysis of localities inhabited by *M. myotis* tends to confirm the above description of its occurrence. While the overall range of summer and winter records lies between 100 and 1180 m a.s.l. in the Czech Republic, in Slovakia it is between 100 and 1622 m a.s.l. Most of the records in the Czech Republic come from elevations between 200 and 600 m a.s.l.; more marked seasonal differences becoming apparent in marginal zones (summer records being relatively more frequent below

200 m a.s.l., winter ones on the contrary over 600 m a.s.l.) This hypsometric distribution depends, to a considerable degree, on the varying landscape geomorphology with predominant climatically favourable medium elevations with the greatest offer of natural roosts. Of much greater informative value is the hypsometric analysis of the occurrence of maternity colonies and other summer aggregations, their predominant percentage (almost 90 %) being found in the medium altitudinal zone between 200 and 600 m a.s.l. The low percentage of colonies recorded below 200 m a.s.l. is surprising, apparently connected with the already mentioned small woodland area and intense agriculture in that zone. The highest situated colonies are known from the Šumava Mts. region where the species ascends up to 680-750 m a.s.l along river valleys (Horní Planá, Kundratice).

The detailed population study undertaken in Central Bohemia in seventies provided reliable data on demographic parameters of the species and its population density which then was estimated to 3.5-3.x ind. per km^2. In regard to abundance

Local distribution

3, 66, 94, 103, 167, 203, 293, 309, 402, 408, 410, 415, 442, 475, 571, 572,, 6336, 645, 762, 786, 813, 1011, 1013, 1052, 1067, 1093, 1192, 1281, 1283, 1288, 1517.

increase during last decades the current density can thus be estimated to ca 5 to 12 ind. per km^2, at least in the medium altitude regions where *M. myotis* is for sure the most common local species.

Despite bone remains of *M. myotis* are frequently found in a large number of cave localities and in some of them they even form the major component of subfossil thanatocenoses (e.g. Belanská cave in High Tatras Mts.), no record is available from any assemblage of either early Holocene or Pleistocene age, both in Czech Republic and Slovakia. Consequently, it seems that *M. myotis* is the species which spread to our territory appeared just recently, supposedly in historical time and due to roosting in lofts of buildings.

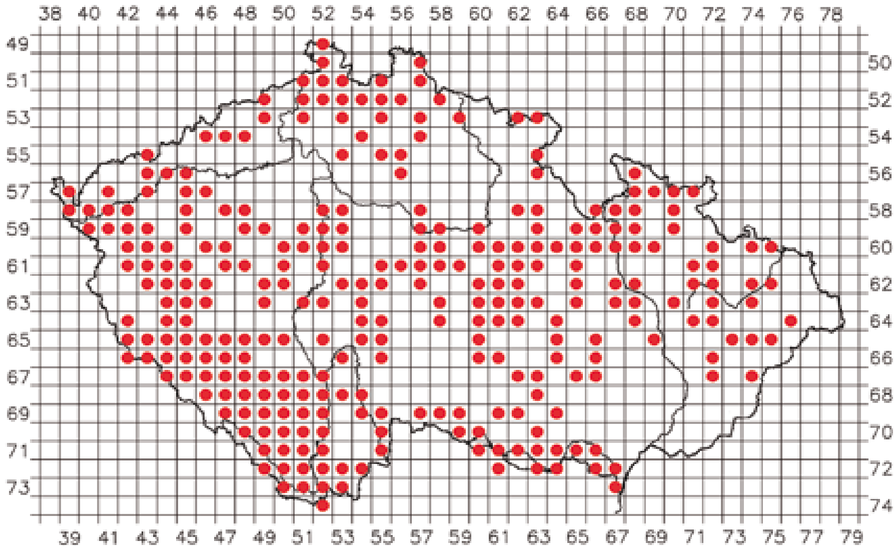
Netopýr řasnatý

Netopier riasnatý

Natterer's Bat

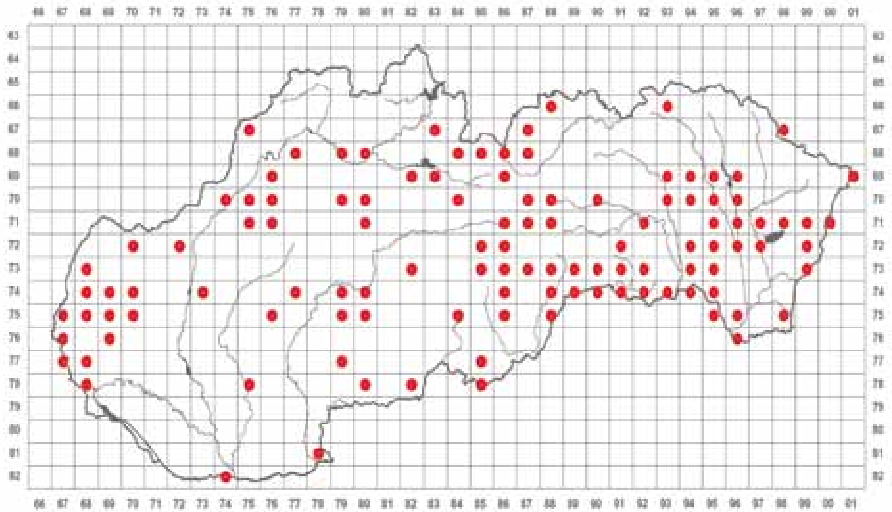
Myotis nattereri

Investigations implemented after 1950 until present have recorded over 550 localities of occurrence of this species in winter (270 localities), summer (230 localities), or both (52 localities). The records cover 255 quadrats of the mapping grid (i.e. roughly 40.6 % of the territory of the Czech Republic). This is a significant increase in faunal data against the period before 1950 when its occurrence was documented in only 15 mapping quadrats and the species was considered rare. It is still considered rare in the territory of Slovakia. All records in that country cover 114 mapping quadrats, which is only about a fourth part (26 %) of the territory. Since *M. nattereri* is a distinctly resident species, the records of its summer and winter occurrence is roughly the same as regards their information value for faunal evaluation. Thus the species can be considered as permanently populating practically the whole territory of the Czech Republic and Slovakia even if the present picture of its distribution is still discontinuous and distorted. By the number of records, it is among the medium frequent species of our bat fauna. In winter and summer alike, it can mainly be observed in submontane woodland and in varied park-like landscapes with abundant water bodies from lowlands to medium altitudes (almost 80 % localities lying between 200 and 600 m a.s.l.). Certain seasonal differences occur only in the marginal altitudinal zones (summer localities being relatively more frequent in lowlands in contrast to the winter ones which are more frequent over 600 m a.s.l.). In Slovakia the overall range of records is between 102 and 1600 m a.s.l. In the periods of autumn migrations and during swarming, large numbers of *M. nattereri* can even be recorded above the timber line (e.g. in the Alabastrová Cave in the Belianske Tatry Mts., 1390 m a.s.l.). It is necessary to note, however, that due to our hitherto



Local distribution

3, 66, 167, 203, 293, 309, 331, 402, 409, 410, 415, 442, 451, 475, 571, 572, 786, 813, 1011, 1013, 1052, 1061, 1067, 1192, 1230.



Taxonomy, phylogeny

554, 575, 1380

Life history

51, 83, 209, 352, 382, 424, 475, 636, 1051, 1412.

knowledge of this fissure bat species with incompletely clarified ecological requirements, this evaluation is rather based on occasional captures obtained by means of various methods and can thus present only preliminary information on its overall distribution and especially on the frequency of its occurrence in the territories under study. This is indicated by the considerable disproportion between the numbers of summer and winter records in regions studied in greater detail and the still insufficient knowledge of its maternity colonies. It can only be stated on the basis of the available field data that it is a fissure bat species showing special requirements as to habitat and little known roosting strategy. The hitherto picture of its distribution in our territories is still based on occasional data obtained from hibernacula and netting results, and its actual numbers are apparently underestimated.

M. nattereri is a plesioochoric element of mid-European bat communities well represented in fossil record (55 sites of the Pleistocene age). At least 46 Holocene records are available from Czech Republic and Slovakia. Repeated records in Slovakian karst indicate its appearance already during the late Vistulian, since Boreal and also during Atlantic and late Holocene it was a common element of bat communities. Throughout whole Quaternary its abundance in fossil assemblages clearly correlates to that of *Plecotus auritus*.

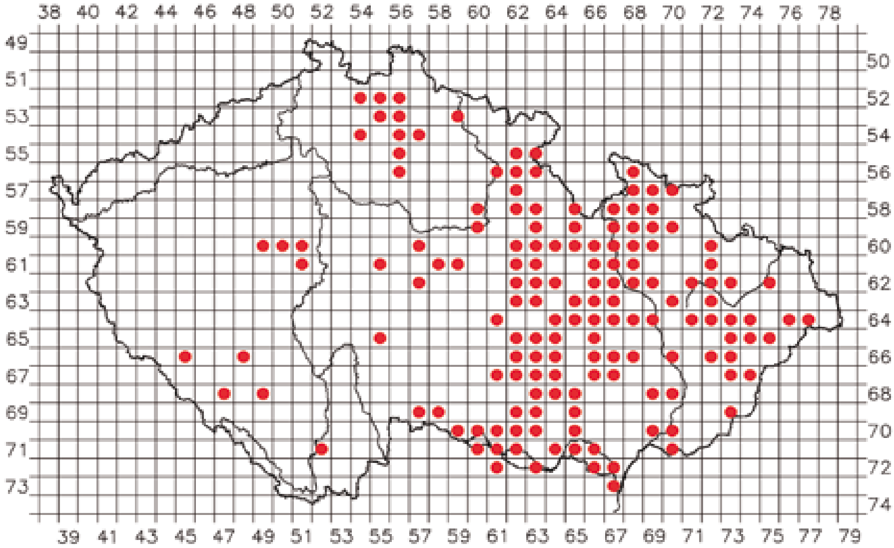
Netopýr brvitý

Netopier brvitý

Geoffroy's Bat

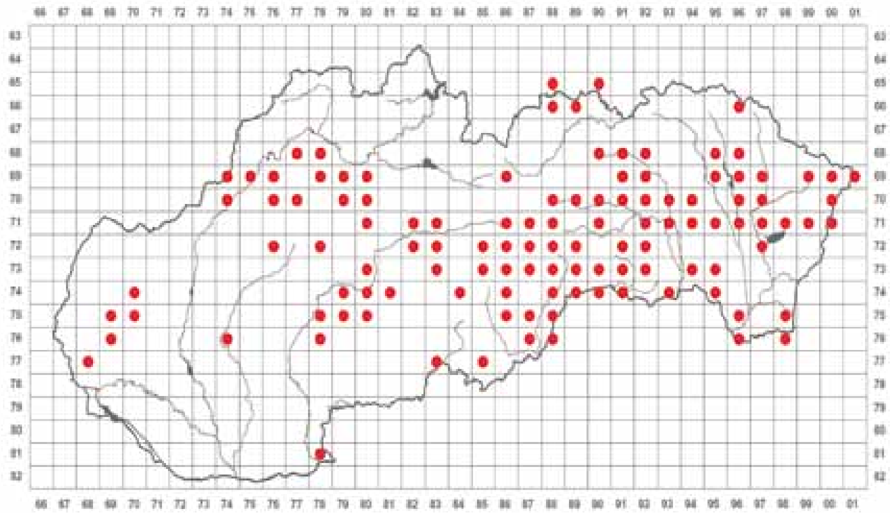
Myotis emarginatus

The distribution of *M. emarginatus* in the Czech Republic before 2006 is documented by findings in some 260 localities in which it was recorded in winter (95 localities) or summer (132 localities incl. autumn migrations) or both seasons (33 localities), covering a total of 138 quadrats of the mapping grid (roughly 30 % of the territory of the Czech Republic. Compared to the historic findings before 1950 (13 quadrats), the present data not only reflect the substantial precision of our observations but, above all, the distinct enlargement of the range of this species after 1950, particularly in the Czech part of the territory under study. A submediterra-nean species by origin, *M. emarginatus* is at present a permanent inhabitant of a substantial part of Moravia and a large part of eastern Bohemia from which it apparently spread, only during the several past decades, into NE Bohemia (from which now records are available of its winter and summer occurrence, and even breeding in places). From this altogether continuous range are geographically isolated (temporarily for the time being) regular (and increasingly frequent in recent years) findings of this species in central Bohemia and especially in southern and SW Bohemia (the Posázaví, Táborsko, Jindřichohradecko, Českokrumlovsko, and Posázaví regions), suggesting the species successfully spreading and perhaps even producing permanent populations in those parts even though direct evidence of its breeding in them is not yet available. In the development of its present range in the Czech Republic, *M. emarginatus* resembles another submediterranean bat species, *R. hipposideros*: both these thermophilous species having apparently spread from the SE into our space along identical pathways, and even the picture of their present distribution is alike. However, *R. hipposideros* appears to be more progressive, having spread into Bohemia some time earlier than *M. emarginatus*



Local distribution

3, 13, 66, 102, 167, 207, 290, 309, 314, 331, 402, 409, 410, 415, 442, 451, 454, 509, 571, 572, 786, 813, 962, 1011, 1013, 1016, 1033, 1052, 1061, 1067, 1097, 1192, 1230, 1282.



Life history

51, 78, 348, 352, 382, 417, 469, 475, 576, 1051, 1504, 1505, 1691.

and having occupied there a more extensive and apparently more stabilised range. In Moravia, *M. emarginatus* prefers mainly the climatically more favourable wooded regions, its summer colonies being mostly found in open landscape with mixed and broadleaved enclaves or park-like landscapes, especially in regions offering suitable hibernacula in karstic areas (the Moravian Karst and North Moravian Karst) or in abandoned mine galleries (the Svratka River valley, The Jeseníky Mts., etc.)

In the territory of Slovakia, the localities of *M. emarginatus* are mainly concentrated in karstic regions (the Strážovské vrchy Hills, Malá Fatra and Velká Fatra Mts. Muránska planina Uplands, the Slovakian Karst, the Revúcka vrchovina Uplands) and several other mountain ranges. Of particular importance are the localities in the Slánske vrchy Hills in eastern Slovakia with the greatest hibernaculum of the species in Slovakia (in the Libanka and Malá Šimonka mines), harbouring over 900 hibernating individuals. The species was recorded in 113 quadrats of the mapping grid (26.2 % of the country‘s territory), its maternity colonies being found predominantly in the southern part of its known range.

Hypsometric analyses of the data have indicated a relatively wide range of elevations between 165 and 1050 m a.s.l. in Bohemia, and between 100 and 1150 m a.s.l. in Slovakia, as regards hibernating and active individuals, which is relatively surprising in a thermophilous species of submediterranean origin. It should be added, however, that its localities lying below 200 m and above 800 m a.s.l. are rather exceptional, most of the records coming from medium altitudes between 200 and 600 m a.s.l.

Long-time monitoring of some of the hibernacula in Moravia, NE Bohemia, the Slovakian Karst and the Slánske vrchy Hills has confirmed the exceptionally intense and steady increase in the numbers of this species, which correlates with recent findings beyond the known range of this species in the Czech region and the adjacent Poland. Thus even this thermophilous element appears to stabilise its populations and shows a distinct spreading trend in our space.

M. emarginatus is a plesiochoric element characterizing the interglacial bat communities, typical in association with *R. ferrumequinum*. It is recorded from 25 mid-European Pleistocene sites including those from our territory. The Holocene records are quite exceptional, of course, and are limited to the localites in Slovak karst only. It cannot be excluded that colonization of its current range appeared just in the historical time in response to roosting of maternity colonies on lofts of buildings.

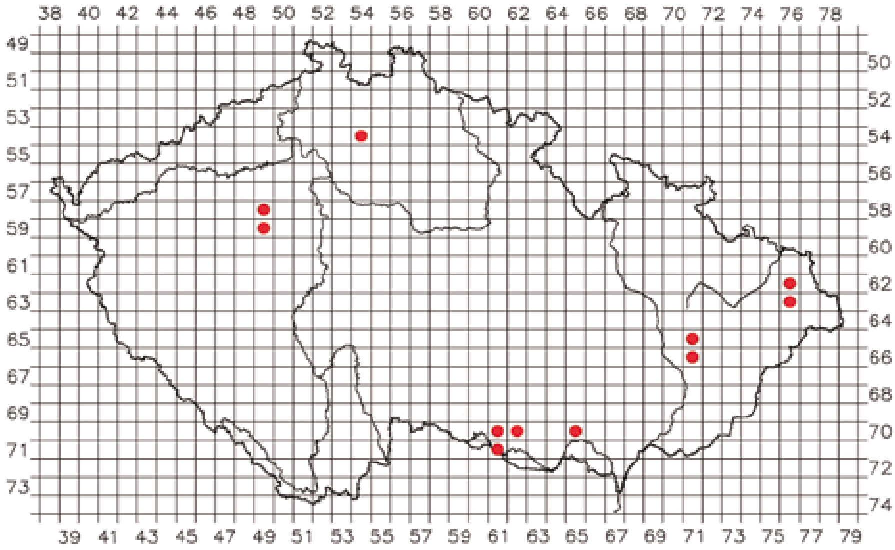
Netopýr Alcathoe

Netopier nymfin

Alcathoe's Bat

Myotis alcathoe

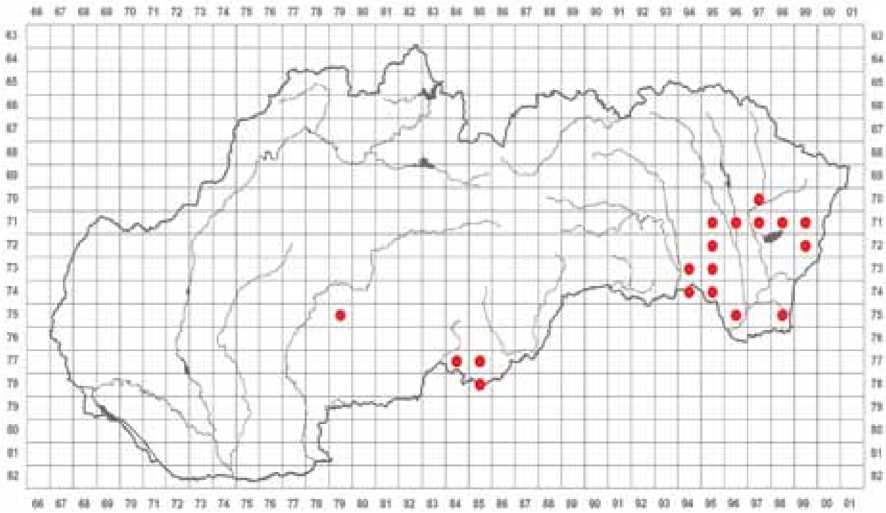
The first occurrence of this species in the territory of Slovakia was recorded in 2001 in the Cerová vrchovina Uplands in the environment of oak forests. Additional findings were later reported from the same upland range as well as in the Štiavnicke vrchy Hills and, above all, in eastern Slovakia (the Vihorlatské, Slanské, and Zemplínské vrchy Hills, the hilly country of the Východoslovenská pahorkatina Hills and flatland, the S part of the Ondavska vrchovina Uplands). The data available so far should be considered to be very fragmentary, documenting the occurrence of *M. alcathoe* in 18 mapping quadrats, i.e. 4.2% of the territory of Slovakia, and the localities lying at 100 – 500 m a.s.l.



Soon the species was recorded also in the Czech Republic. In three regions where it was found locally abundant (woodland complexes in Křivoklátsko in central Bohemia, southern Moravia and piedmonts of Hostýnské hills in central Moravia) a detailed study of the species was undertaken with aid of radiotracking, monitoring of roosting habits and sesonal dynamics and/or diet analyses. The species was found to be extremelly stenoecic - it inhabits old full-grown oak-hornbeam forests,with numerous large trees in advanced stages of decay, typical with smaller water bodies and/ or patches of riparian vegetation surrounded by the forest. It is a typical canopy dweller roosting high in tree fissures and foraging in the upper canopy level inside the forest stands. Until now it was recorded in 11 quadrats of the mapping grid (1.8% of the territory) and although this is for sure not the complete picture of its distribution, its habitat specialisation suggests that the islet-like mosaic occurrence restricted to patches of old full grown oak stands presents most probably the basic pattern of its distribution throughout its European range. For obvious reasons no information from fossil record is available.

Local distribution

6, 100, 117, 416, 833, 1068, 1427.



Netopýr vousatý

Netopier fúzatý

Whiskered Bat

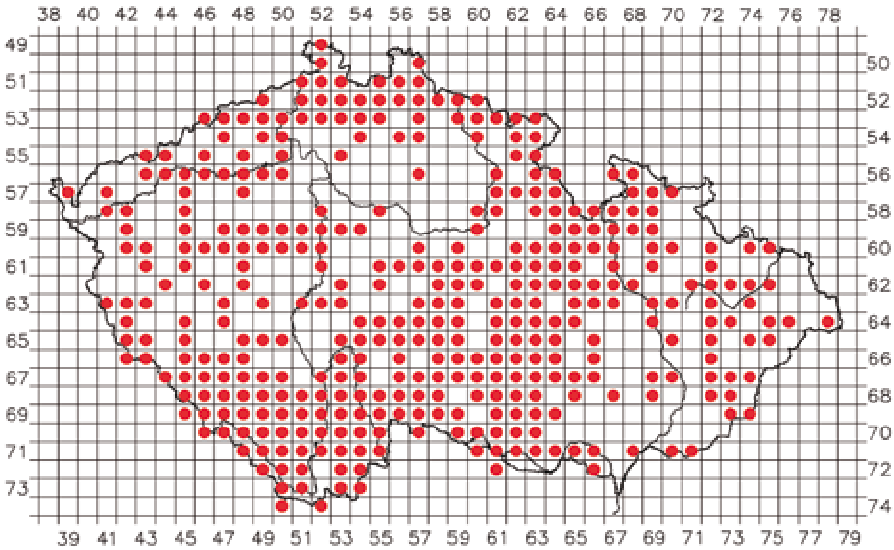
Myotis mystacinus

Taxonomy, phylogeny

113, 439, 445, 576, 766, 982, 1041, 1231.

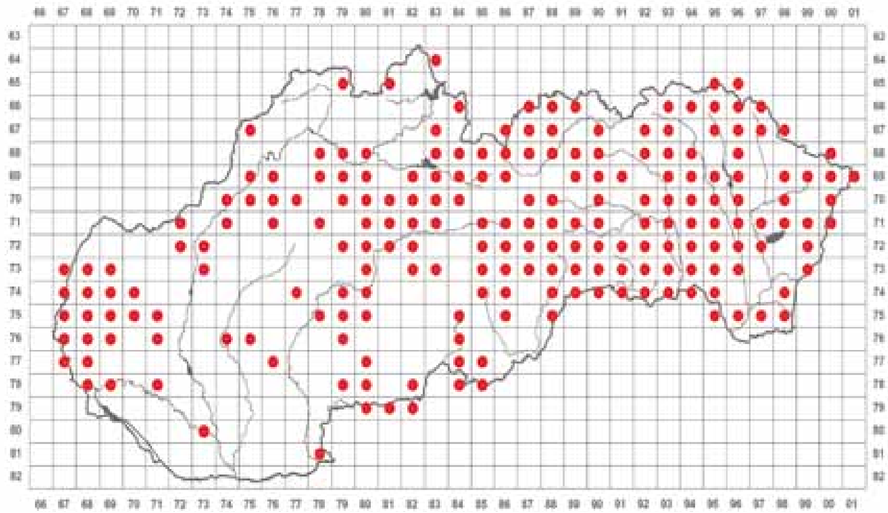
By the number of available records, this species is among the most abundant bat species (together with *M. daubentonii, M. myotis* and both *Plecotus* spp.). In the Czech Republic, its occurrence has been documented in almost 880 localities, the records of its occurrence in summer coming from round 600 localities, in winter from around 240, and in 40 localities its occurrence has been evidenced in both seasons. As a whole, this corresponds to 321 quadrats of the mapping grid (51.1 % of the territory,). In Slovakia the occurrence of bats of the „*mystacinus*“

morphological group have been recorded in 206 quadrats (47.8 %), reliably determined findings of *M. mystacinus* s.str. coming from only 15 quadrats (3.5 %). The list of localities contains only reliably determined finds. Since *M. mystacinus* is considered a resident species or one performing short migrations only, all data on its occurrence (i.e. in winter and summer) are of the same information value and evidence the permanent occurrence of the species incl. its possible breeding. The overall character of its distribution suggests that this fissure species, rather sporadically discovered until recently, is distributed all-year round practically all over the Czech Republic and Slovakia, with the gravity centre of its occurrence lying in varied woodlands at medium and higher elevations. The species prefers environments in the vicinity of water bodies and is even present in human habitations. Most of the localities in the Czech Republic (88.1 %) are found between 200 and 800 m a.s.l. (or even 1000 m a.s.l., 93.4 – 94.6 %), which is logical in view of the predominating hilly country. The overall range of winter records is 140 – 1180 m a.s.l. The upper limit for its summer occurrence is markedly higher as the species has been recorded on top of the ridge of the Krkonoše Mts. (Vosecká bouda Chalet, the top of Mt. Sněžka, 1250 and 1600 m a.s.l. respectively). Evaluating only the localities with maternity colonies, their overall range



Local distribution

3, 66, 167, 203, 293, 309, 402, 409, 415, 439, 442, 451, 475, 476, 571, 636, 786, 813, 1011, 1013, 1052, 1061, 1067, 1192, 1230.



decreases to 150 – 1100 m a.s.l. (with only two colonies, lying over 800 m a.s.l, having been reported from the Šumava Mts.) and a distinct maximum (61.4 %) of colonies are found between 400 and 600 m a.s.l. The hypsometric range of all findings of *M. mystacinus* in Slovakia is 98 – 1622 m a.s.l., most of its hibernacula lying between 300 and 1200 m a.s.l.

Life history

51, 352, 382, 407, 417, 469.

Despite obvious increase in number of new records due to intensive investigations in recent years which refine knowledge of local distribution of the species, the extensive changes in its abundance do not seem probable. More likely, its populations appear to have been stable for long periods, showing no visible oscillations.

Small forms of *Myotis* closely resembling Recent *M.mystacinus* and its siblings were an euconstant component of mid-European bat communities throughout whole Pliocene and Pleistocene. They were recorded in at least 45 Pleistocene sites in Central Europe, and correspondingly frequent is the species also in the mass cave thanatocenoses, particularly in Slovakian mountains. Besides them, the reliably determined and well dated Holocene records are, of course, relatively rare. Nevertheless, it seems quite probable that this plesioochoric element colonize Central Europe since the early Holocene and records of single individual in few Vistulian assemblages sugest even a possible residence of the species during the last glacial stage.

Netopýr Brandtův

Netopier Brandtov

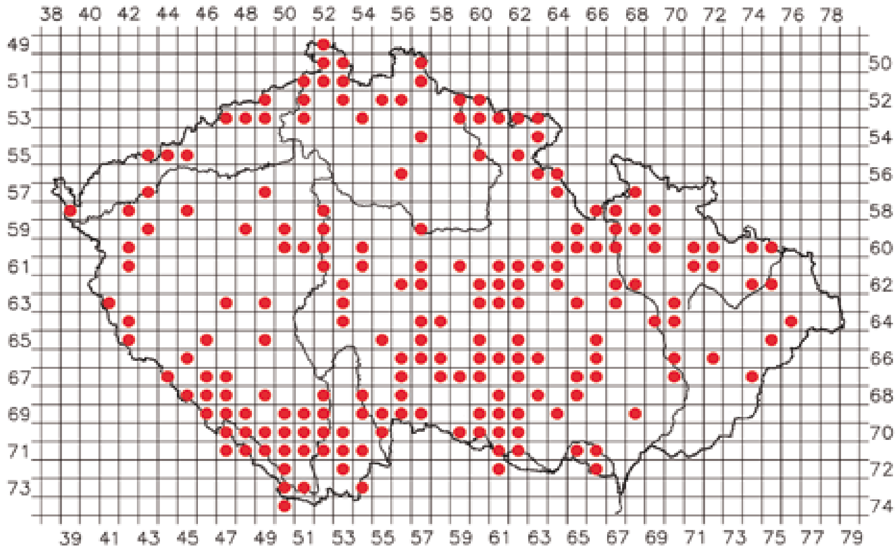
Brandt's Bat

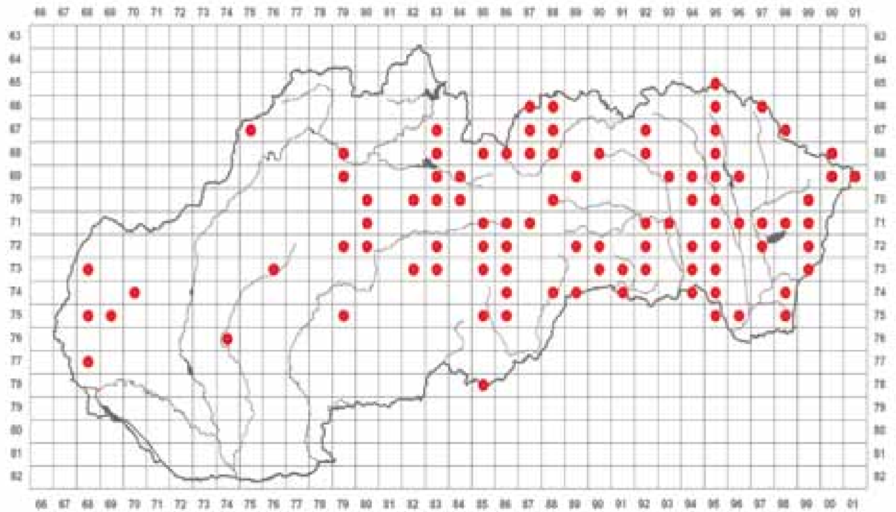
Myotis brandtii

Taxonomy, phylogeny

66, 96, 439, 445, 446, 744, 1041, 1109, 1231.

Identified relatively recently, this species was recorded in the Czech Republic in over 260 localities, of which about 170 pertain to summer findings, 75 to discoveries in hibernacula, and in 22 localities it was registered in both seasons of the year. The findings cover 162 quadrats of the mapping grid (i.e. 25.8 % of the territory). In Slovakia the knowledge of this species are still fragmentary, the species occurring in 94 localities, i.e only 21.8 % of the territory of this country. Even though the data reflect, to a considerable extent, the different status of investigations in different regions, it is possible to state that the species is distributed all over the territory, from lowlands up to uplands, even though its occurrence may be rarer in the lowlands along the Danube in Slovakia. The number of findings and their overall character classify the species among medium rare ones. It is assumed that the present data rather underestimate the actual status. Comparing the findings, however, indicates that the species is at least two to three times less abundant than *Myotis mystacinus*. The hypsometric evaluation of the data does not confirm the general opinion that the occurrence of *M. brandti* should be predominantly confined to wooded lowlands. Rather than by elevation, it is affected by the overall landscape character (extent of wooded areas, presence of water bodies). The known localities are situated between 98 and 1433 m a.s.l., in Slovakia most frequently between 100 and 800 m a.s.l., and there are no substantial differences between the summer and winter distribution. Most maternity colonies of *M. brandtii* in the Czech Republic are distributed from lowlands up to the hilly country (200 – 600 m a.s.l., i.e. 84.6 %), the overall hypsometric range being 210 – 920 m a.s.l. Disregarding minor differences, even the hypsometric analysis of the occurrence of maternity colonies indicates that the





Local distribution

3, 167, 293, 309, 409, 415, 451, 475, 476, 571, 636, 786, 813, 1011, 1013, 1052, 1061, 1067, 1230.

altitudinal preferences of *M. brandtiii* and *M. mystacinus* are more or less identical.

Life history

51, 352, 417, 576, 1060.

M.mystacinus phenotypical group (and/or the forms phenotypically closely related to them) is fairly common in fossil record since Pliocene. Although onl few Pleistocene records were co-identified with *M. brandtii* explicitely, it seems probable that the species is plesiochoric to central Europe. It forms a regular component of the cave thanatocenoses, particularly in mountain caves in Carpathians, and sprase records from sedimentary series indicate that it occured here at least from the beginning of Holocene.

Netopýr pobřežní

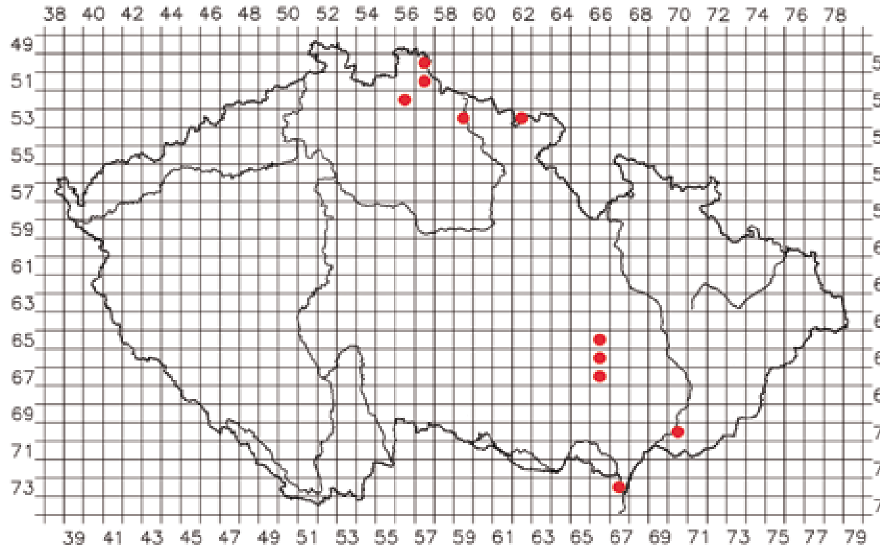
Netopier pobrežný

Pond Bat

Myotis dasycneme

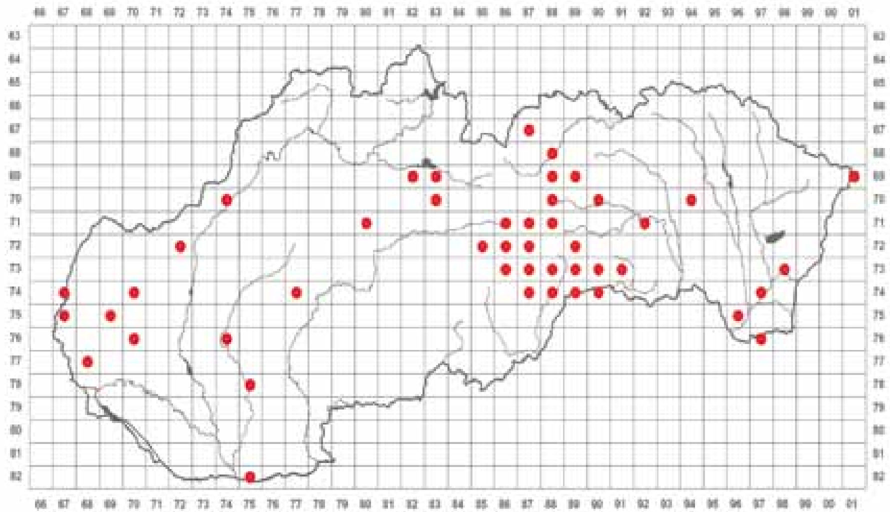
Compared to *M. daubentonii, M. dasycneme* is still one of the rarest bat species. In the Czech Republic its presence has been reliably demonstrated in only 15 localities (comprising altogether around 200 individuals) lying in 12 mapping quadrats (1.6 % of the territory) in spatially limited regions of northern Bohemia (the Jizerské hory Mts., the Krkonoše Mts., the Broumovsko region) and northern Moravia (the Jesenicko region), the Moravian Karst, and the floodplain forests in the southernmost tip of Moravia.

In all cases individuals during hibernation were recorded (88.7 %) or during autumn and spring flights (9.7 %) near potential hibernacula. The only two documented cases of these bats occurring in the park-like landscape along the lower reaches of the Dyje and Morava River (about 40 km apart) suggest, by the captured juvenile individuals and one pregnant female, that the species very probably breeds in the territory of the Czech Republic However, no unequivocal evidence of a maternity colony is available. Thus, the regular occurrence of *M. dasycneme* in this country has been repeatedly demonstrated in only a few traditional hibernacula in the northern borderland of Bohemia, the Jesenicko region of Moravia, and the Moravian Karst. Quite recently, this evidence has been supplemented by the above-mentioned summer findings in the area of the lower reaches of the Dyje River in the southernmost part of Moravia. The hibernacula near the northern boundary of Bohemia and Moravia seem to be regularly visited by individuals from the summer colonies in the lowlands of Germany and Poland, whereas the summer and winter findings in southern Moravia belong to the sphere of the isolated Carpathian-Pannonian population (Slovakia, Hungary). This evaluation is supported namely by the increasing numbers of individuals hibernating in Slovakian and Moravian



Local distribution

309, 314, 331, 376, 402, 415, 417, 442, 451, 456, 475, 556, 571, 572, 673, 674, 786, 813, 832, 854, 898, 899, 1066, 1067, 1159, 1162, 1259.



caves in the past 10 – 15 years. All the available documents of the occurrence of *M. dasycneme* (incl. skeletal remains from owl pellets) come from 46 quadrats of the mapping grid (10.7 % of Slovakia‘s territory) from altitudes between 101 and 1390 m a.s.l., which tends to suggest the species preferring hilly country with slowly flowing and rather broad streams, and lakes. In summer the species is more frequent e.g. in the Slovakian Karst and the Eastern Slovakian Lowland, and it regularly hibernates in some of the hibernacula on the Muránska planina Upland, in the Slovenský raj region, the Veľká Fatra Mts., and the Slanské vrchy Hills (Haska, Marincova jaskyňa Cave, Dobšinská Ice Cave, Libanka, Harmanecká Cave). The only document so far of the roost of a breeding colony in a loft in the Východoslovenská Plain dates from the 1980s.

M. dasycneme is a plesiochoric element of Central Europe. Together with its ancestor, *M. delicatus,* it is recorded in 24 site of the late Pliocene to middle Pleistocene age (6 from Czech Republic) and 33 sites of the Holocene age. In contrast to Slovakia, no Holocene record is available from Czech Republic.

Netopýr vodní

Netopier vodný

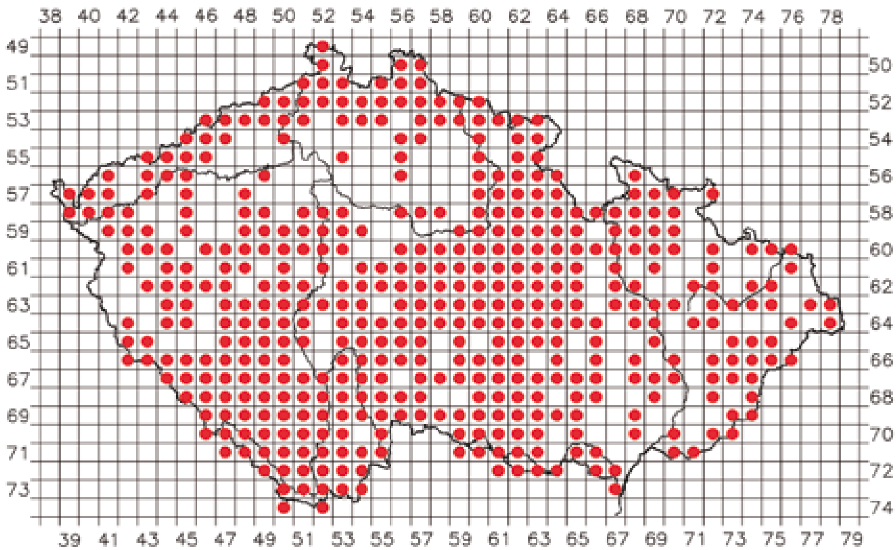
Daubenton's Bat

Myotis daubentonii

Taxonomy, phylogeny

401, 407, 417, 465, 469, 765, 826, 982, 1348.

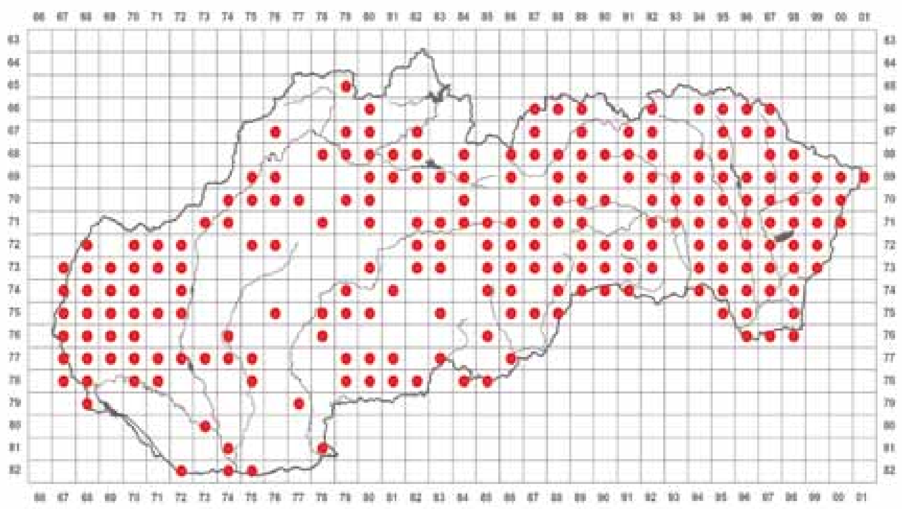
The list of localities in which *M. daubentonii* has been recorded in the Czech Republic so far comprises almost 1100 evidenced localities covering 393 quadrats of the mapping grid, i.e. about 62.6 % of the territory; summer occurrence (maternity colonies and nettings during migrations) was documented in 616 localities, winter occurrence in 387 localities, and all-year round occurrence in 91 localities. In the territory of Slovakia the occurrence of *M. daubentonii* was recorded in 222 quadrats (51.5 % of the territory). The dense mapping grid and the more or less evenly distributed findings document the all-area distribution of *M. daubentonii* over the Czech Republic and Slovakia. Considering additional reported circumstances of the findings (high abundance and large number of summer colonies in optimum habitat types), one may state that at present, *M. daubentonii* is among the most abundant bat



species in the two countries. While it is common from lowlands up to rather high mountain elevations, the gravity centre of its occurrence lies in wooded and varied landscapes with plenty of water bodies (the southern Bohemian depressions, the Bohemian-Moravian Uplands, submontane regions in Bohemia and Moravia as well as the Moravian floodplain forests; in Slovakia e.g. the Eastern Slovakian Lowlands, depressions, and western Slovakia). In the Czech Republic the large majority (around 90 %) of localities. are found between 200 and 800 m a.s.l., certain differences between summer and winter records being apparent in the marginal zones only. The overall altitudinal range in the Czech Republic is 130 – 1160 m a.s.l., in Slovakia 95 – 1494 m a.s.l. The upper limit of the hypsometric distribution of maternity colonies is distinctly lower (150 - 690 m a.s.l.). Long-time monitoring of populations of *M. dauben-*

Local distribution

3, 66, 167, 203, 293, 309, 331, 402, 409, 415, 442, 451, 475, 476, 571, 636, 786, 813, 1011, 1013, 1052, 1061, 1067, 1162, 1230.



tonii (mainly in their hibernacula) has demonstrated a markedly positive all-area increase in the numbers of this species in the past five decades so that its present populations are about three times as numerous as in 1970.

Life history

51, 352, 382, 407, 417, 469, 576, 824, 826, 828, 1051, 1412, 1422, 1423, 1424, 1425, 1531, 1597, 1608, 1609.

M. daubentonii is reported from 22 Late Pliocene and Pleistocene localities in Central Europe (8 from our territory), most of which come from relatively short stage of the Middle Pleistocene (13 sites in Europe, 5 in Czechoslovakia). Otherwise, it is a rare element, typically represented just with single or few individuals often contrasting to mass appearance of *M. bechsteinii*, *M. nattererii* or *Plecotus auritus.* This is also valid for its sparse Holocene fossil record which suggests its presence in the region at least from the early Boreal. In regard to its fossil record, *M. daubentonii* can be looked upon as a plesiochoric element in Central Europe which current abundance increase seems to be quite unusual.

Netopýr severní

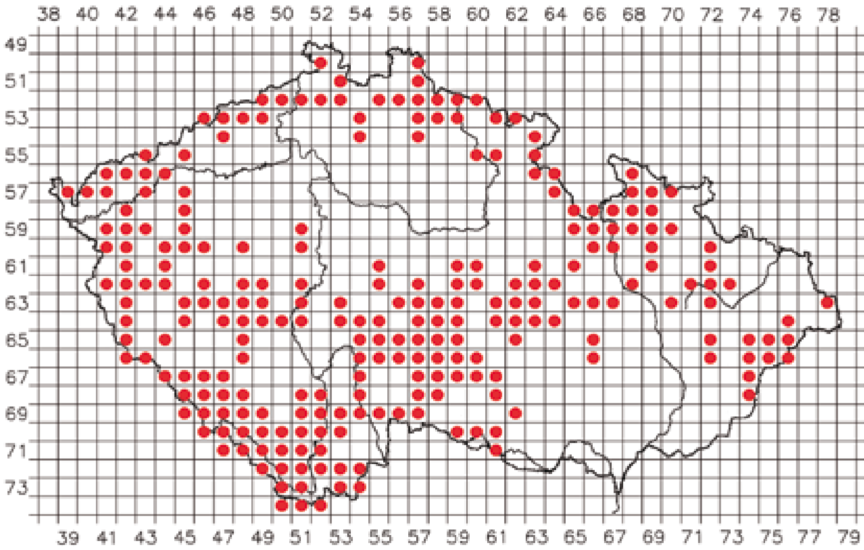
Večernica severná

Northern Bat

Eptesicus nilssonii

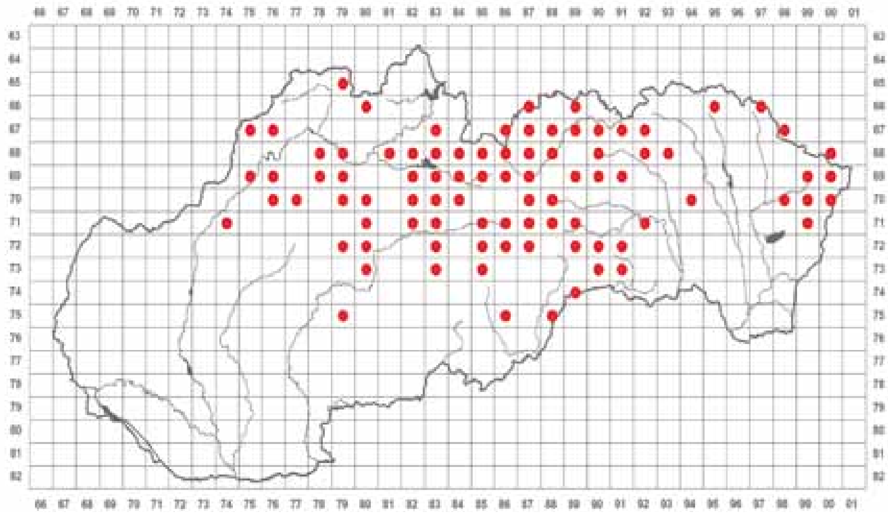
Until present, the Northern Bat was found in the Czech Republic in over 580 localities recorded after 1950, most of them pertaining to the summer season (398 localities), including evidence of maternity colonies (60 localities in 48 mapping quadrats), and only one third of the findings come from the hibernation period (31.9 %). In the mapping grid, the species occupies 231 quadrats (36.8 %

of the territory of the Czech Republic, and 94 quadrats (21.8 % of that of Slovakia). Data obtained mainly in recent years indicate that the Northern Bat can be included among the rather common species permanently occupying large parts of the territories under study. This typically Boreo-montane element is mainly tied to wooded hilly countries and submontane regions, from which it reaches even the more varied hilly countries in the interior of Bohemia and Moravia. In Slovakia, its occurrence is more clear-cut. With the exception of repeated findings in the Slovakian Karst, its occurrence is limited to higher mountain ranges of the Western Carpathians incl. the higher elevation in the Tatra Mts. Its absence can be considered proven in lowland regions. The boundaries between its occupied range in hilly countries and non-occupied lowlands appear to be quite sharp apparently stable, even though there are indications that its traditional range is slowly enlarging. The distinct preference of the above described landscape types, occurring at medium and higher elevations, is also apparent from hypsometric analyses of its localities. Most of its summer localities (almost 81 %) lie in the altitudinal range between 400 and 1000 m a.s.l. (the overall range being 250 – 1320 m a.s.l., averaging 657.2 m a.s.l.). In the case of maternity colonies the percentage is up



Local distribution

3, 6, 30, 167, 293, 309, 376, 402, 433, 442, 466, 475, 476, 571, 572, 955, 1011, 1013, 1038, 1052, 1102, 1199, 1217, 1250, 1353.



to 90 % (582.8 m a.s.l. on average). The winter findings basically copy the altitudinal distribution of the summer localities even if their average elevations are slightly lower (598.3 m a.s.l. on average). In Slovakia all localities of *E. nilssonii* fall within the altitudinal range of 220 – 1494 m a.s.l.

Life history

51, 353, 417, 469, 576, 630, 636, 1051, 1552, 1598.

Long-time monitoring of important hibernacula as well as more detailed investigation on summer roosts of bats has evidenced, particularly in the Czech Republic, a marked increase in the number of hibernating Northern Bats in the traditional and newer hibernacula, as well as a spreading of maternity colonies to lower elevations.

This species is a plesiochoric element, recorded since the Upper Pliocene (MN17 Plešivec) and Early Pleistocene (Chlum 4, Koněprusy C718 a.o.). It was relatively common in Middle Pleistocene (14 localities including 4 from Czech Republic) and with records in 6 sites from Czech Republic and Slovakia it is the most common bat in the Vistulian glacial assemblages. Six Holocene records come mostly from early Holocene and from highland localities.

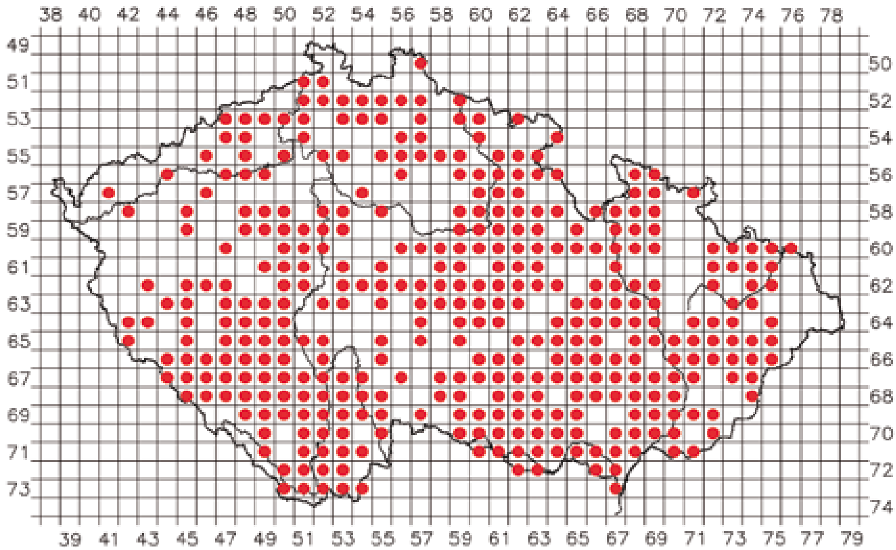
Netopýr večerní

Večernica pozdná

Serotine

Eptesicus serotinus

The synopsis of findings of *E. serotinus* in the Czech Republic documented after 1950 numbers almost 1000 localities covering 359 quadrats of the mapping grid (roughly 57 % of the territory). In Slovakia, the species was found in 264 mapping quadrats, covering 61.3 % of the territory. It is a common species showing almost all-area distribution and strong synanthropic linkage (incl. urban environments) and preferring varied and more densely populated lowland and hilly country landscapes (including agrocoenoses avoided by most bat species). On the other hand, its occurrence at higher elevations (e.g. in the central part of the Bohemian-Moravian Uplands, in the Low and High Tatra Mts., and the top parts of the borderland mountain ranges) is rather sporadic. This situation is relatively well reflected by the results of hypsometric analyses. The fact that most

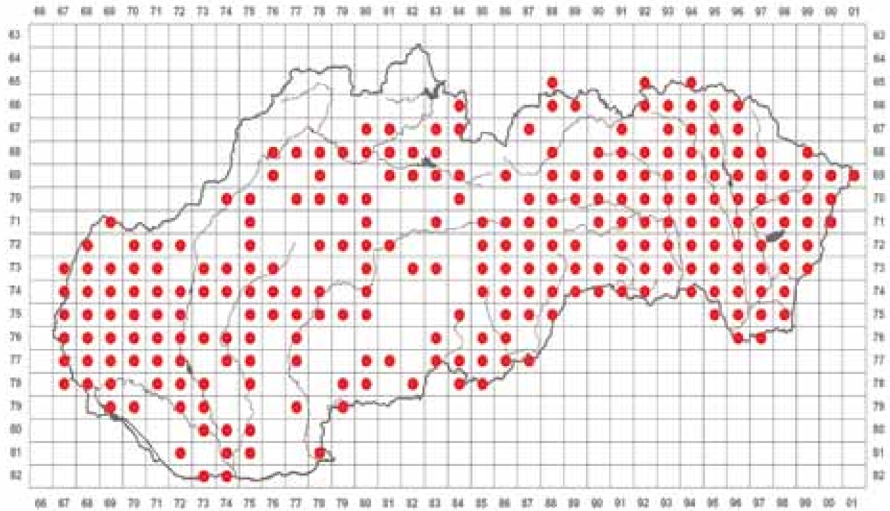


of the localities, both summer and winter ones, are situated at elevations between 200 and 600 m with indistinct overshoots (of mainly the summer findings) over this limit is more than predicative. The affinity of *E. serotinus* to lower and warmer elevations is demonstrated by the hypsometry of its maternity colonies: in their case, almost 84 % of findings fall below 400 m. The overall range of elevations at which the Serotine was found in the Czech Republic is 140 – 1090 m a.s.l. (averaging 367.6 m a.s.l.), the range in Slovakia being 100 – 1090 m a.s.l.

Local distribution

3, 6, 66, 167, 203, 293309, 331, 402, 410, 442, 475, 476, 571, 572, 576, 786, 813, 1011, 1012, 1038, 1052, 1061, 1097, 1192, 1356.

E. serotinus is a plesiochoric element in Central Europe recorded since the Early Pliocene and from at least 14 sites of the Early and Middle Pleistocene age (including 5 from Czech Republic). There are 29 records of the Late Pleistocene and Holocene age from our territory concentrated to either to the Late Vistulian to Boreal or the Post-Neolithic stages what suggests its retreat during woodland stage in Middle Holocene.



Life history

51, 352, 382, 417, 419, 469, 508, 576, 636, 978, 1439, 1442, 1507, 1551, 1552, 1623, 1630, 1637.

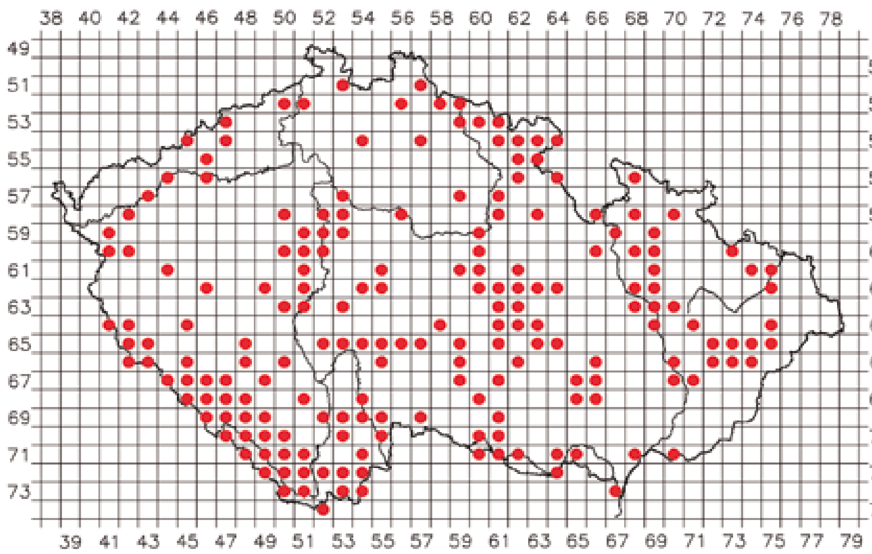
Netopýr pestrý

Večernica pestrá

Parti-coloured Bat

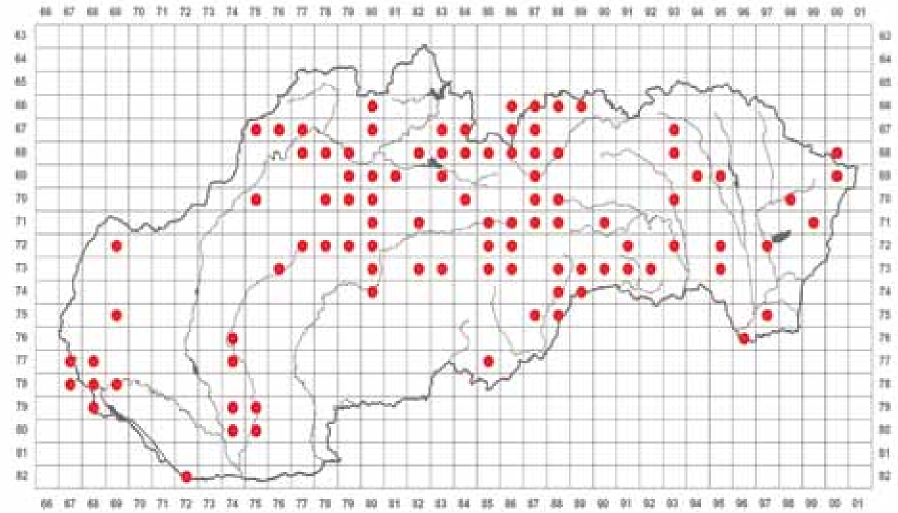
Vespertilio murinus

The occurrence of *V. murinus* in the territory of the Czech Republic after 1950 is documented in 357 localities in which it was found in summer (219 localities) or winter (136 localities or both seasons of the year (3 localities). These records cover a total of 178 quadrats of the mapping grid, i.e. 28.7-4 % of the territory. Of a similar character are the findings in Slovakia. After 1960, evidence was obtained from 104 quadrats, i.e. from about 24.1 % of the territory. The obtained mosaic of faunal data is preliminary for the time being, and it is evidently due to the different research activities in different regions (this being the case with most of our bat species). Nevertheless, it tends to suggest that the centre of the range of *V. murinus* lies in wooded hilly country and submontane regions where it produces stable breeding populations. However, evidence has been obtained of the sporadic occurrence of *V. murinus* in summer in lower elevations of the central Polabí Region and southern Moravia in the Czech Republic, and in the Podunajská rovina Plain and the Eastern Slovakian Lowland. Characteristic are the rather numerous and, in a number of places, repeated findings of this species in the temporary transition period in urban environments, incl. evidence from cities (such as Prague, Bartislava, Banská Bystrica, Košice, etc.). Such findings are evaluated as migrating and hibernating members of more northern populations, although unequivocal evidence of such behaviour has not been presented for the time being. The altitudes of the localities in the Czech Republic range from 170 to 1130 m a.s.l., most of the summer findings falling in the 200 – 1000 m zone (averaging 533.8 m a.s.l.). While the winter findings show an



Local distribution

3, 6, 66, 167, 203, 205, 309, 402, 410, 415, 442, 475, 476, 501, 571, 572, 576, 786, 813, 814, 815, 845, 1011, 1052, 1084, 1146, 1192, 1322.



identical altitudinal range, they are distinctly more frequent at lower elevations (about 82.4 % of all findings reported from below 600 m a.s.l., averaging 417.3 m a.s.l.). The altitudinal range is similar in Slovakia: in summer the species was found between 102 and 2200 m a.s.l., the winter records ranging between 115 and 1000 m a.s.l. These data may suggest a different situation in the altitudinal distribution of members of this species in summer and winter, or a participation of migrating individuals in the winter population.

Life history

84, 205, 1031.

V. murinus is a plesichoric element in Central Europe. As it is not a cave dweller only 6 Pliocene and Pleistocene record are available. It is quite rich, of course, in the debris series under rocky walls or in deposits in rocky fissures. The Late Pleistocene and Holocene sites of such a type revealed its appearance in 34 assemblages (12 in Czech Republic, 22 in Slovakia) covering evenly the period from the late Vistulian to Recent. It is proabbly one of few bat species that survived even LGM in our territory.

Netopýr Saviuv

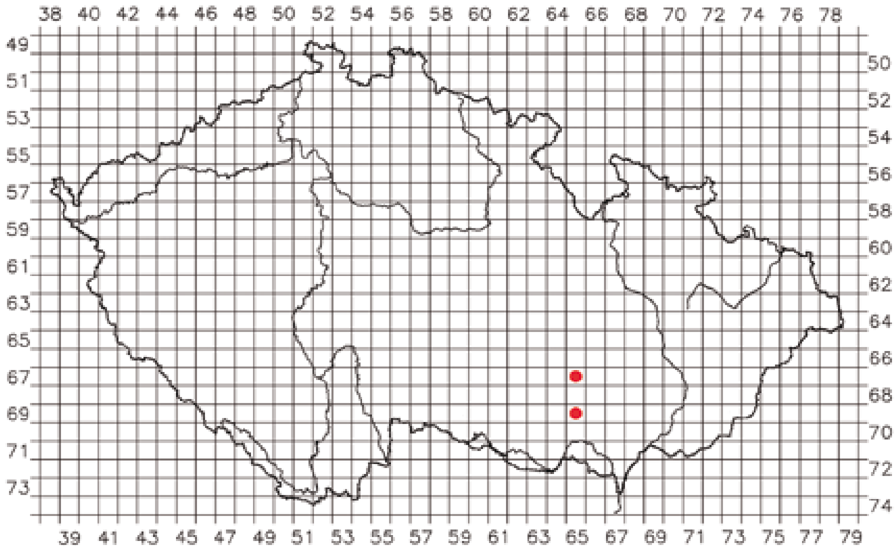
Večernica Saviova

Savi's Pipistrelle

Hypsugo savii

This species is relatively new to the faunae of the Czech Republic and Slovakia. The species has apparently spread to central Europe only in the course of the recent decades from its previously stabilised Mediterranean range with the northern limits lying in the foothills of the Alps and in the Balkan. So far, the species has been registered in two localities in southern Moravia (mapping quadrats 6765 and 6965).

From the repeated capture of the species in one of the localities (Brno) it is possible to judge on permanent occurrence (the captured individual, a female showing post-lactation signs, is sufficient evidence of breeding). In the territory of Slovakia, the findings come from three quadrats (7868, 7674, and 7297, i.e. 0.7 % of the territory). All this evidence was obtained in the housing estates of large towns. In eastern Slovakia (Michalovce) evidence has been obtained of breeding *H. savii,* which is in agreement with the traditional assumption that central Europe is invaded by synanthropic populations from the northern limit of the original range in Italy and the Balkan. Almost for sure it is the species apochoric to central Europe.



Local distribution

60, 226, 370, 400, 547, 792, 807, 1381.

No fossil record is available except for the Miocene genus *Miostrellus* supposedly related to the Recent genus (with *Miostrellus egeriensis* described from MN4 site Citice near Sokolov).

Taxonomy, phylogeny

547, 555.

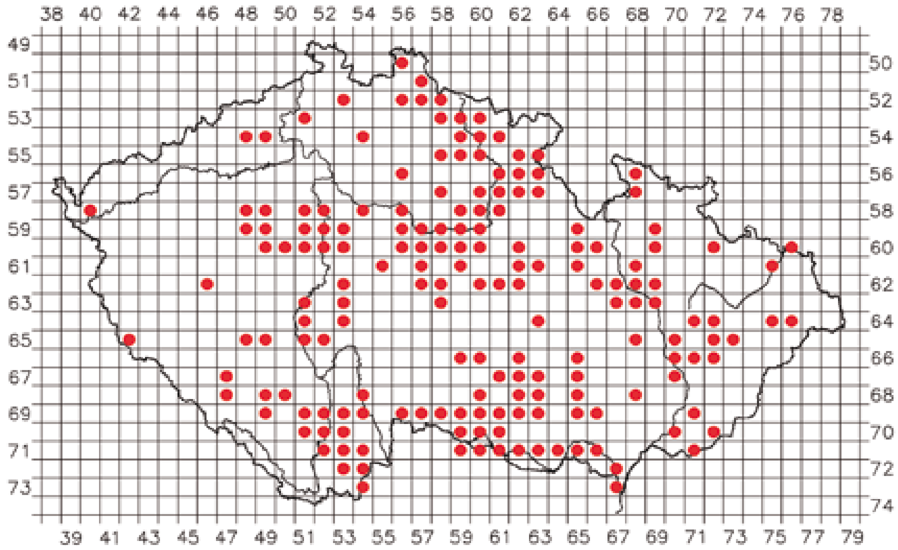
Netopýr hvízdavý

Večernica malá

Common Pipistrelle

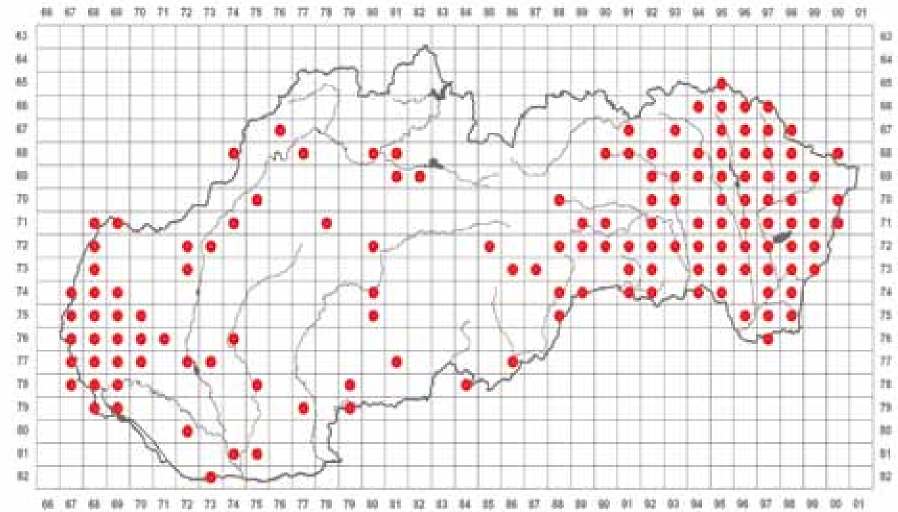
Pipistrellus pipistrellus

The faunal a 7nd zoogeographic evaluation of the occurrence of the Pipistrelle is complicated by the recent division into two morphologically similar species, *P. pipistrellus* and *P. pygmaeus.* In our literature, the separation of the two species was gradually accepted since 2000, and thus the present range of *P. pipistrellus* in the Czech Republic can only be based on correctly determined data obtained after that time. In the Czech Republic the database of correctly defined findings of *P. pipistrellus* s. str. comprises 309 localities lying in 151 mapping quadrats, i.e. about 24 % of the territory of the Czech Republic. In Slovakia, correctly determined findings of *P. pipistrellus* were reported from 137 mapping quadrats (31.8 % of the territory). The number and distribution of these reports, as well as the incomplete data make it possible to evaluate *P. pipistrellus* s. str. as a relatively common species, the gravity centre of which lies chiefly in varied wooded and watery hilly country and uplands comprising a network of human habitations. The present grid maps, however, still show extensive areas lacking evidence of the occurrence of the species. This pertains namely the western and NW parts of Bohemia, large parts of central Bohemia, the central part of the Bohemian-Moravian Uplands, certain regions of eastern Moravia, and a large part of central Slovakia, that is, regions in which no systematic chiropterological investigations have been carried out in recent years. New data have shown that *P. pipistrellus* s.str. does occur, even if less frequently, in all regions in which the sympatric *P. pygmaeus* predominates, incl. the lowland regions of southern Moravia and southern Bohemia. *P. pipistrellus* s. str. is obviously a species that shows wide ecological tolerance, inhabiting – contrary to *P. pygmaeus* – even the extensive regions of



Local distribution

3, 6, 51, 66, 167, 203, 293, 309, 331, 402, 415, 442, 475, 476, 523, 524, 557, 571, 572, 589, 663, 786, 813, 1011, 1013, 1061, 1029, 1052, 1067, 1152, 1230, 1465, 1527, 1538, 1539, 1581, 1622.



Taxonomy, phylogeny

702, 703, 1313, 1314, 1315, 1331, 1332, 1400, 1543, 1575.

Life history

6, 382, 417, 469, 501, 557, 629, 631, 646, 659, 964, 979, 1151, 1271, 1414, 1420, 1440, 1463, 1513, 1579, 1580.

medium and higher elevations (roughly up to 800-900 m a.s.l.). When the hypsometric data on *P.pipistrellus* s.lat. are compared to those on *P. pipistrellus* s.str., one obtains, for the two samples, a scheme similar to that obtained by evaluating the two species pooled. This is most evident in the more numerous summer records. The results show that 77.9 – 82.1 % of summer localities of *P. pipistrellus* s.lat. and *P. pipistrellus* s.str. are situated between 400 and 800 m a.s.l. Considering that these elevations are among the most frequent in the relief of our landscape, the affinity to medium elevations in the *P. pipistrellus* s. lat + s. str. complex is quite evident and considerably different from that of *P. pygmaeus.* This difference is also apparent in the average values of elevations frequented by *P. pipistrellus* s.lat. (379.7 m a.s.l.) and *P. pipistrellus* s.str. (369 m a.s.l.). Evaluating only the localities in which breeding colonies have been recorded leads to somewhat different results. Namely, the colonies of *P. pipistrellus* s.str. show somewhat more distinct preference for elevations between 200 and 600 m a.s.l. (none of the localities lying below 200 m a.s.l.) in contrast to the sample of *P. pipistrellus* s.lat. In Slovakia, all known localities are situated between 98 and 1170 m a.s.l., the species apparently preferring lower elevations (200 – 500 m a.s.l) in summer.

The fossil record of *P.pipistrellus* (supposedly just *P.pipistrellus* s.str.) is impressivelly extensive: in Czech Republic and Slovakia it appears in 60 fossil communities from 25 localities. In 7 caves from Moravian, Bohemian, and Slovak karsts it forms even predominant element of fossil assemblages and minimum numbers of individuals in these mass accumulations of pipistrelle remains amount even to thousands. Similarly rich are pipistrelle remains deposited in rocky fissures as evidenced in further 17 sites, mostly from the Carpathian mountains. Yet, all these assemblages are just of the Holocene age, no well dated record prior to late Vistulian is available from Central Europe. Consequently, *P.pipistrellus* can be considered an apochoric element of the Holocene in Central Europe. Although its mass spread in this region was undoubtedly stimulated by the post-Neolithic environmental rearrangements, the multiple records from our localities clearly demonstrated that its first appearance was already by the end of Vistulian and the first wave of its mass spread took part already in Boreal, i.e. long prior the Neolithic deforestations.

Despite its obvious vagility, until recently, pipistrelle exhibited clearly a patchy islet-like pattern of local distribution: in some regions or towns it presented the most common local species (e.g. Brno, Plzeň) in others (e.g. Prague and central Bohemia) it was absent at all (supposedly due to extinction event in the local mass hibernaculum in Bohemian karst - comp. quite a recent age of the respective mass bone deposit). Yet, the situation changed and during last two decades the species recolonized the central Bohemia again and just recently even a new mass hibernaculum (with about 4000 individuals) was discovered here.

Netopýr nejmenší

Večernica Leachova

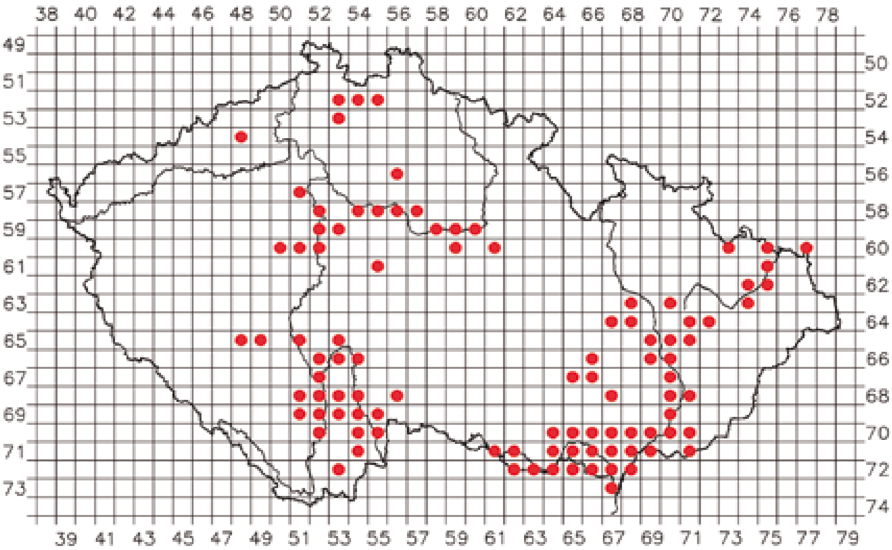
Soprano Pipistrelle

Pipistrellus pygmaeus

Distribution and taxonomy

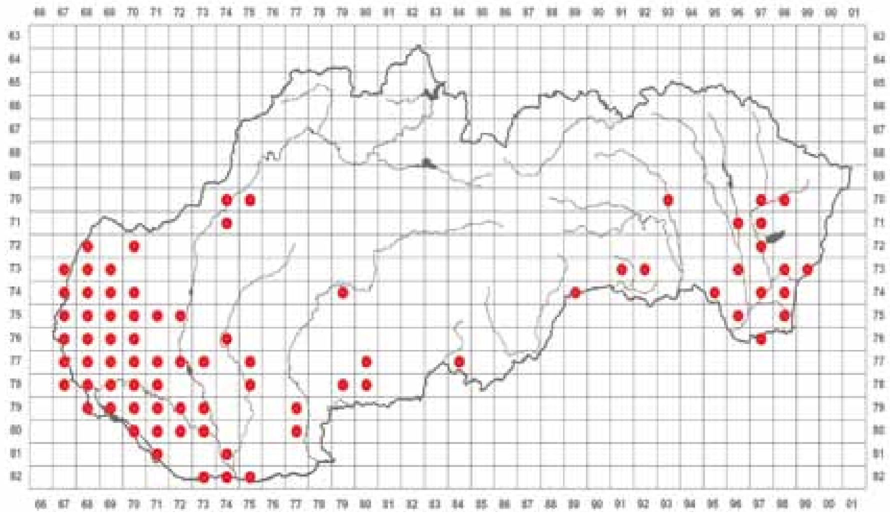
6, 66, 293, 415, 475, 476, 557, 589, 636, 659, 663, 703, 813, 1013, 1067, 1331, 1332, 1400, 1465, 1527, 1543.

The occurrence of this newly separated bat species in the Czech Republic is documented by records from 86 mapping quadrats, i.e. from about 13.7 % of the territory, and from 77 quadrats, i.e. about 17.9 % of the territory of Slovakia. Only a few of the documents pertain to hibernating individuals, no such data being available from Slovakia. The number of localities recorded so far and their distribution tend to show that the species is only locally distributed, with the gravity centre of its range lying, above all, in the southern Bohemian depressions, in the lowlands of southern Moravia (the lower part of the Podyjí and Pomoraví regions) as well as in the Záhorská nížina Lowland and the Podunajská rovina Plain. The species is distributed all over those parts and is very abundant (distinctly predominating over the accessory occurrence of *P. pipistrellus).* The mosaic summer records, while still of very low information value, are known from other places as well (central Pomoraví, Povltaví, and Polabí regions, the south of Slovakia, the eastern Slovakian plain, etc.). The hypsometric evaluation of the hitherto records in the Czech Republic indicates that the dispersal of the species is not necessarily tied only to the floodplains of major rivers and similar lowland habitats, as two fifth parts of the hitherto known localities are situated at elevations over 400 m a.s.l. (their overall range being 170 – 530 m a.s.l., averaging 335.7 m a.s.l.) A similar situation is found in Slovakia where the altitudinal range of the localities is 98 – 324 m a.s.l. The present maps showing the distribution of this species should be taken as a quite preliminary and certainly underestimated picture of the occurrence of *P. pygmaeus* in the Czech Republic and Slovakia. For obvious reasons, no reliable fossil records are available. Lack of genetic variation suggests a spread in the nearest past.



Life history

61, 62, 63, 67, 68, 69, 176, 979, 982, 1230, 1270, 1271, 1272, 1274, 1414, 1420, 1440, 1463, 1464, 1513, 1521, 1579, 1580, 1581, 1589, 1603, 1622.



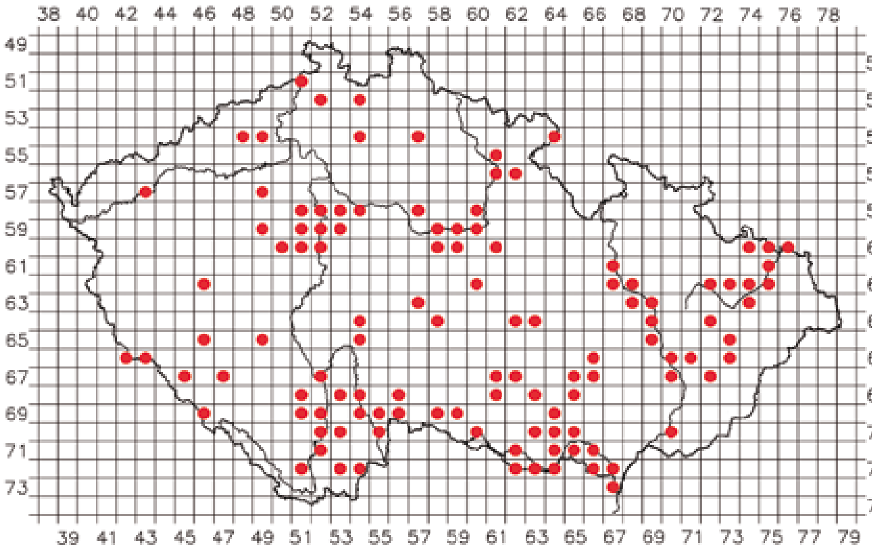
Netopýr parkový

Večernica parková

Nathusius' Pipistrelle

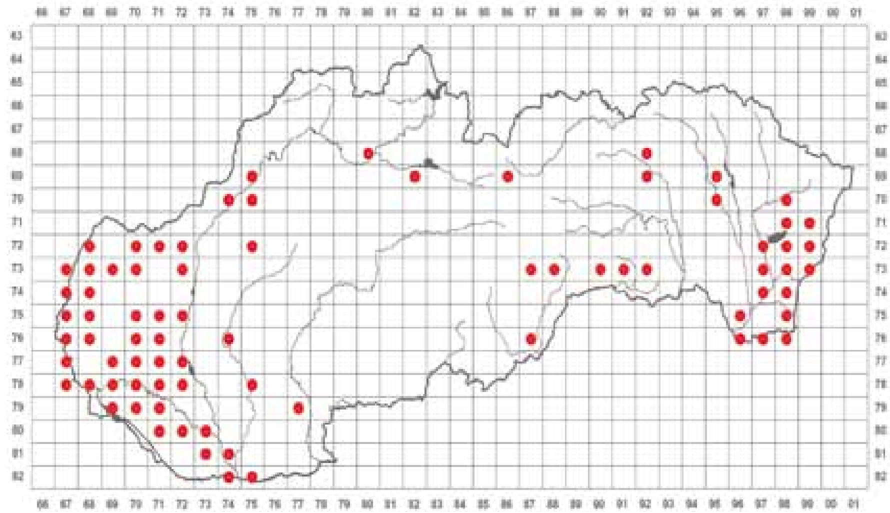
Pipistrellus nathusii

The review of records of *P. nathusii* comprises 232 localities lying in 98 quadrats of the mapping grid (15.6 % of the territory of the Czech Republic). Most of the records come from the summer season (94.8 % of localities and 88.8 % of the quadrats). In Slovakia, similarly, almost all records of this species come from the summer season, the localities lying in 61 mapping quadrats, i.e. about 18.8 % of the territory. The available data tend to change the view of *P. nathusii,* no longer classifying it among the little known and rare species occurring in the Czech Republic rather seasonally during the period of migrations. On the contrary, it becomes apparent that in ecologically suitable regions (varied and wooded landscapes containing fishponds, streams and wetlands) the species produces stable populations whose reproduction has been evidenced directly or is probable judging from indirect evidence. Such regions include, above all, the southern Bohemian depressions, the southern Moravian lowlands (the lower Pomoraví, Lednicko, and Valticko regions, the eastern part of the Znojemsko region), the wider environs of Brno, the Třebíčsko, central Pomoraví, and Poodří regions, the less thoroughly investigated wider Polabí and central Bohemian Povltaví regions; In Slovakia, the Záhorská nížina Lowland and the eastern Slovakian plain. The described gravity centre of permanent distribution of *P. nathusii* is completed by a rather dense mosaic of findings indicating the rather stable presence of the species in all suitable areas, above all, in smaller fishpond areas and along rivers at lower and medium elevations (e.g. the Český ráj region, foothills of the Šumava Mts., etc.). The complete absence of the species from a large part of central Slovakia is rather a reflection of lower research intensity in that part.



Local distribution

6, 66, 106, 164, 167, 233, 309, 331, 390, 402, 410, 415, 432, 442, 461, 475, 476, 525, 572, 661, 813, 1013, 1018, 1052, 1061, 1062, 1067, 1124, 1192.



While in the Czech Republic the known localities of *P. nathusii* are situated in a rather wide altitudinal between 140 and 1000 m a.s.l., their overall average is only 327.8 m a.s.l. (n=229), 98.4 % of them lying below 600 m a.s.l., which unequivocally confirms the traditional evaluation of *P. nathusii* as the inhabitant of lowlands and hilly country. The altitudinal range ascertained in Slovakia ranges from 95 to 860 m a.s.l. but most of the localities are situated between 100 and 400 m a.s.l.

Life history

201, 417, 662, 982, 1404, 1405, 1406, 1408, 1409, 1420, 1495, 1580, 1581, 1687.

Findings of ringed individuals and especially the marked increase in their numbers during periods of spring and autumn migrations tends to reconfirm that the territory of Bohemia, Moravia, and Slovakia lie within the action radius of migration routes of more northern populations (in Germany and the Baltic region, perhaps even in Poland), and evidence is available of their members hibernating in the territory of the Czech Republic.

Although no fossil record is available for this species either from our territory or from other regions, it is almost for sure not an apochoric element. More likely, it seems to be a plesiochoric element that in its life history traits (obligatory long-distance seasonal migrations, oportunistic roosting in trees, preference of loose woodland habitats and riparian vegetation) is perfectly adapted to instable conditions characterizing the late Quaternary history of central and northern Europe, including the glacial stages.

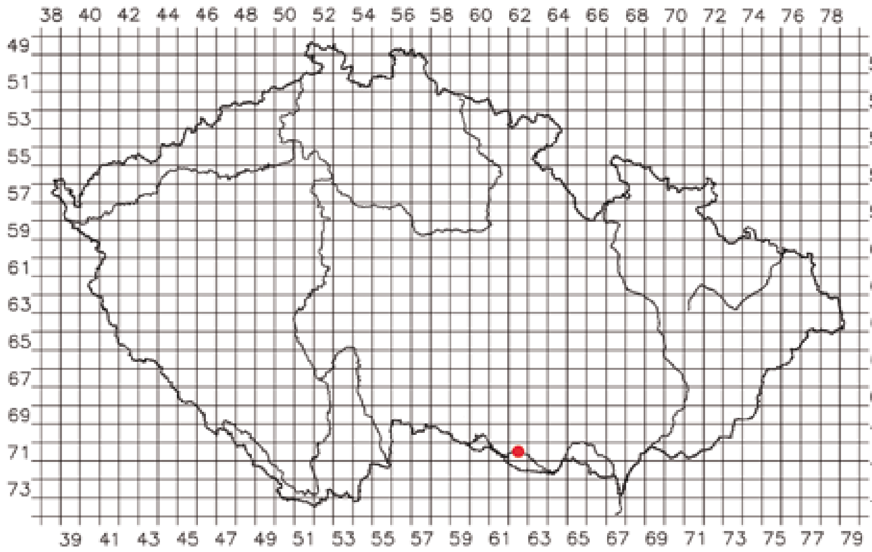
Netopýr jižní

Večernica južná

Kuhl's Pipistrelle

Pipistrellus kuhlii

The quite recent evidence of *P. kuhlii* occurring in the Czech Republic (southern Moravia, Znojemsko region) as well as in Slovakia in five mapping quadrats (1.2 %) lying in both the western and eastern part of the country at elevation between 102 and 160 m a.s.l. is another evidence of the rapid dispersal of this species into central Europe during the past decades. This is also in accordance with the character of its habitat (urban environments), as the dispersal is realised by progressive synanthropic populations finding favourable shelters, above all, in wall fissures of slab-block buildings. Further evidence of the presence of *P. kuhlii* may be expected to occur mainly in the warmer regions of S and SE Moravia as well as in the south of Slovakia. No fossil record is available.

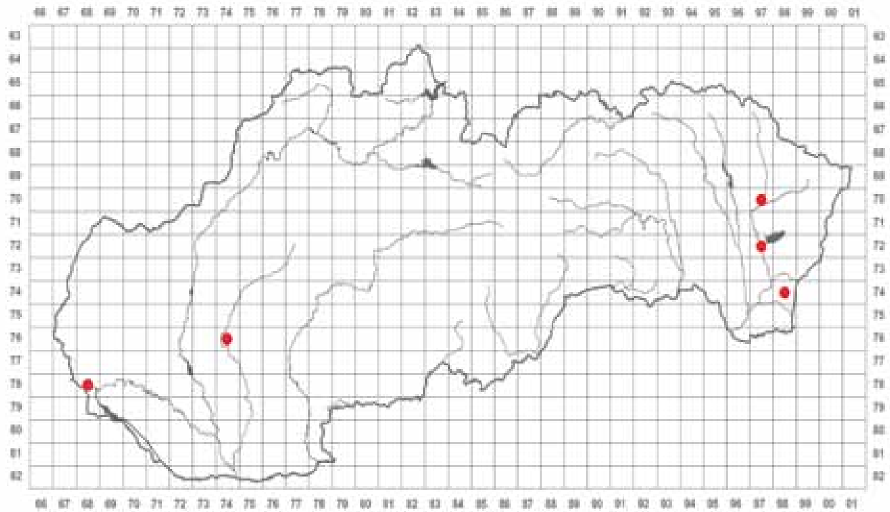


Local distribution

183, 226, 1014.

Life history

192.



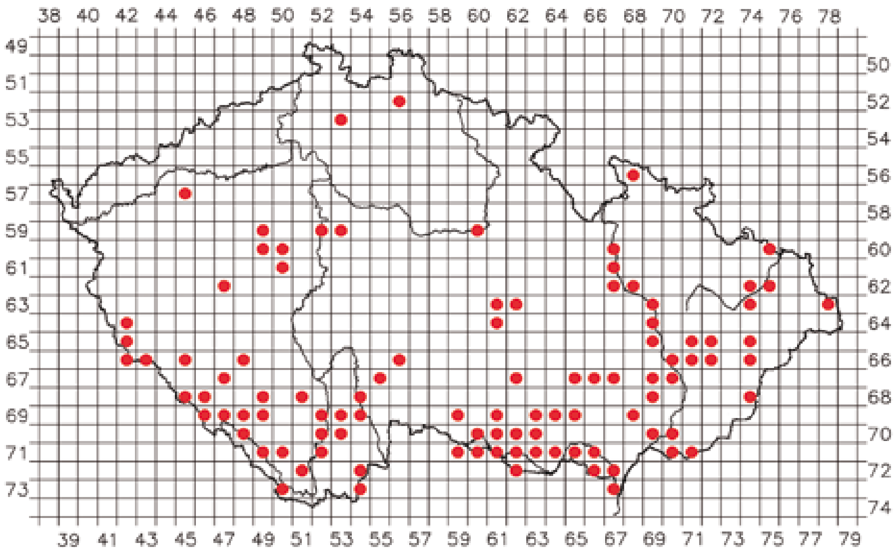
Netopýr stromový

Raniak malý

Leisler's Bat

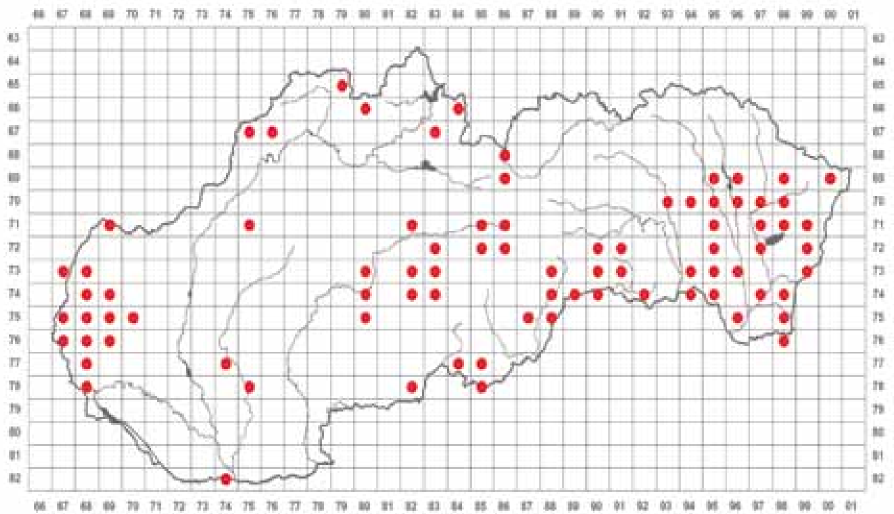
Nyctalus leisleri

In contrast to the Noctule, Leisler's Bat is among the species on which insufficient information is still available despite intensive investigations. So far, this species has been found in only 132 localities covering 94 quadrats of the mapping grid (15 % of the territory of the Czech Republic). These findings actually pertain only to individuals during their active life, supplemented by occasional reports on breeding colonies (in all, 129 localities in 91 quadrats. A similar character of its occurrence is expressed by findings in Slovakia. In all, the occurrence of Leisler's Bat has been recorded in 85 mapping quadrats (19.7 % of the territory of Slovakia), the least amount of information being available from the west of Slovakia, except for the wooded part of the Borská nížina Lowland. Information on the hibernation of this species is sporadic and mostly insufficiently documented (3 locality in 2 mapping quadrats in the Czech Republic), data on its summer and winter occurrence being known from a single quadrat. Thus, the picture of its occurrence in both countries is preliminary and evidently underestimated. More frequent findings were reported from the Pošumaví and Český les regions, both south Bohemian fishpond depressions and thoroughly investigated parts of the Bohemian-Moravian Uplands and namely from the floodplain forests in southern Moravian lowlands as well as wooded central Moravian hilly country, from the Pomoraví, Poodří regions and the Beskydy Mts. In Slovakia, more frequent findings have been reported from the Záhorie Region, the Cerová vrchovina Upland, the Poľana, Slovakian Karst, and various wooded parts of the eastern Slovakian mountain ranges (such as the Slanské, Zemplínské and Vihorlatské vrchy Hills, floodplain forests



Local distribution

3, 6, 46, 66, 75, 167, 203, 235, 309, 331, 402, 410, 415, 442, 448, 475, 476, 571, 636, 764, 786, 813, 10111013, 1052, 1057, 1061, 1067, 1092, 1230, 1629.



Life history

694.

in the Eastern Slovakian Lowland). Apparently, Leisler‘s Bat is not directly tied to a certain elevation, even if obviously preferring, especially in Moravia, broadleaved forests in river floodplains and the hilly country. Often it has been ascertained even at higher elevations – e.g. in the Pošumaví and Český les regions in the Czech Republic, or on the Poľana in Slovakia. During the migration period and exceptionally even during the breeding season, individuals are also found in the urban environment (Prague, České Budějovice, Olomouc, Klatovy as well as smaller towns). Analysis of the altitudinal distribution of the summer records of *N. leisleri* is not predicative due to the small number of data. It only shows that the species does occur in this country in summer in a relatively wide altitudinal range between 170 and 1100 m a.s.l. (averaging 439.1 m a.s.l., n=125), preferring lower and middle elevations below 800 m a.s.l. (92.4 %), the maximum number of data from elevations between 200 and 600 m a.s.l. (65.2 %) probably corresponding only to the large area covered by the hilly country in the Czech Republic The altitudinal range of the findings of *N. leisleri* in Slovakia is much the same as in the Czech Republic, ranging between 98 and 1220 m a.s.l.

As in other dendrophilous bats, the fossil record is quite rare. Two post-Neolithic records come from Nízké Tatry Mts. (Sásová, Jazvečie).

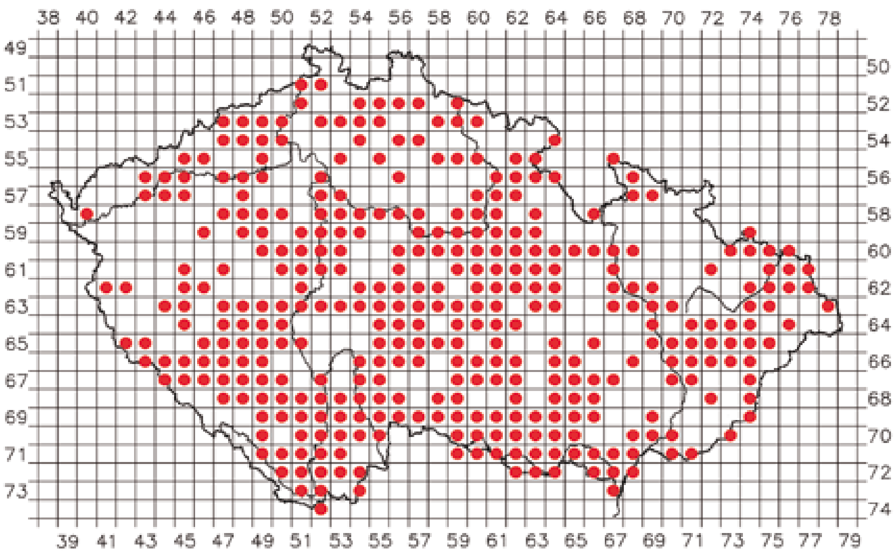
Netopýr rezavý

Raniak hrdzavý

Noctule

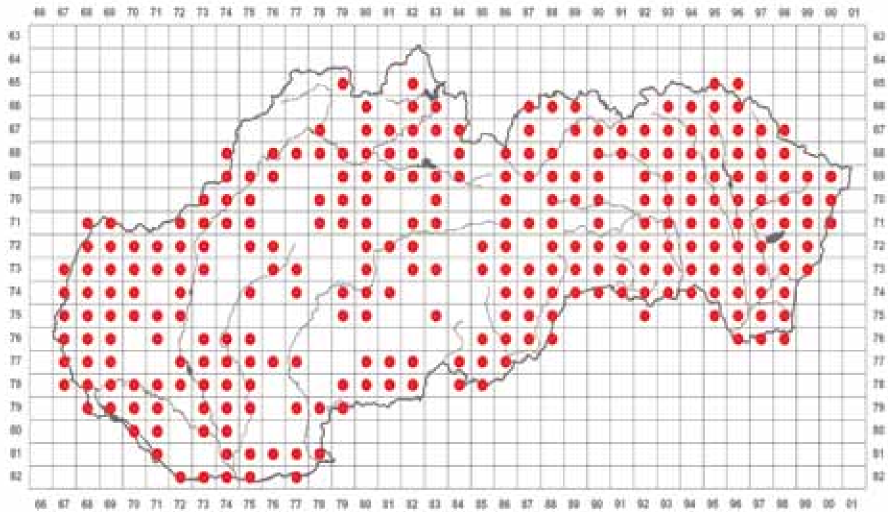
Nyctalus noctula

The Noctule is among the species the hitherto findings of which cover over a half of the territory of the Czech Republic and Slovakia. Until present, almost 1000 localities were collected from Bohemia and Moravia, predominantly from the summer season (795 localities), while the winter occurrence of the Noctule was ascertained in only 164 localities. These data cover a total of 338 quadrats of the mapping grid (53.8 % of the territory of the Czech Republic), and 285 quadrats in Slovakia (66.1 % of the territory. Thus it is evident that the Noctule is among our most frequent bats, the gravity centre of whose range lies in park-like and wooded regions with abundant water bodies, hilly country, floodplain forests (predominantly below 600 m a.s.l.), but does not avoid even smaller woodland complexes and extensive parks at medium and lower elevations. In recent years, this picture of a strictly woodland tree-dwelling species has been markedly changed by its tendency to utilise, for hibernation and during migrations (and possibly even for breeding), artificial shelters in urban high-rise buildings incl. slab-block ones. The picture of its summer occurrence, however, may be distorted to some extent by the fact that this is a demonstrably migratory species whose migration routes (and possibly also the hibernacula of alien populations) pertain to our territory. Even if presuming that our population is rather migratory or just more or less stable, it is not quite clear which findings evidence only a temporary occurrence (passage migration) of members of more northern populations. In Slovakia, breeding of this species has been confirmed by findings of maternity colonies in several localities (e.g. Kirť in the Ipeľska kotlina Basin, Šoporňa in the Podunajská



Local distribution

3, 6, 66, 167, 203, 309, 331, 402, 410, 415, 442, 475, 476, 572, 636, 786, 813, 1013, 1052, 1067, 1230, 1629.



rovina Plane, Nitra in the Nitranská pahorkatina Hills, and Prievidzy in the Hornonitranská kotlina Basin), specifying the hitherto data on the southern limit of the reproduction range of the Noctule. The overall altitudinal range of the localities in the Czech Republic is 140 – 1020 m a.s.l. (averaging 352.2 m a.s.l.) but ion the case of colonies (or aggregations) it falls below 600 m a.s.l. in over 95 % of cases recorded. In Slovakia the overall hypsometric range is 95 – 1400 m a.s.l. but the Noctule predominantly populates elevations below 500 m a.s.l.

It is a plesiochoric element: 3 records from Early and Middle Pleistocene, 44 of the Holocene age (mostly from rocky debris series) prove its continuous appearance from the Early Boreal.

Life history

176, 382, 406, 417, 469, 698, 701, 767, 1011, 1342, 1412, 1413, 1423, 1425, 1426, 1532, 1533, 1554, 1686.

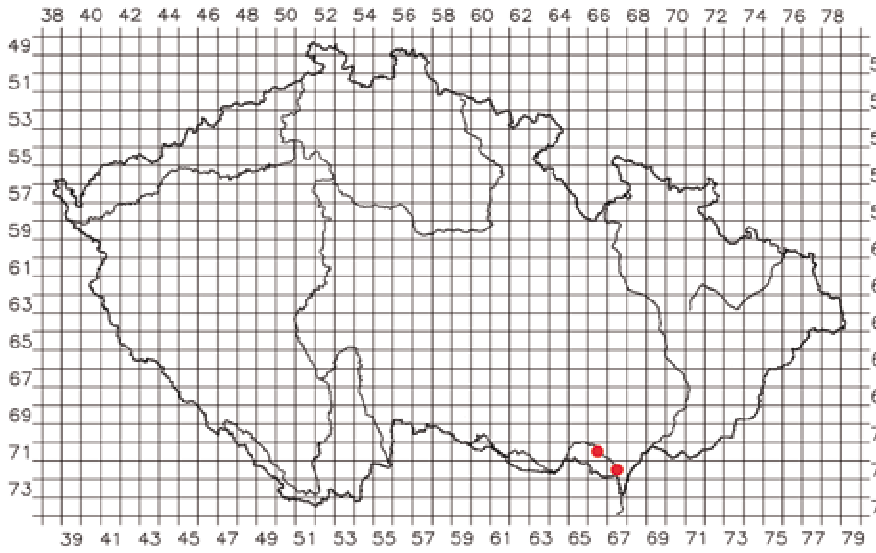
Netopýr obrovský

Raniak velký

Greater Noctule

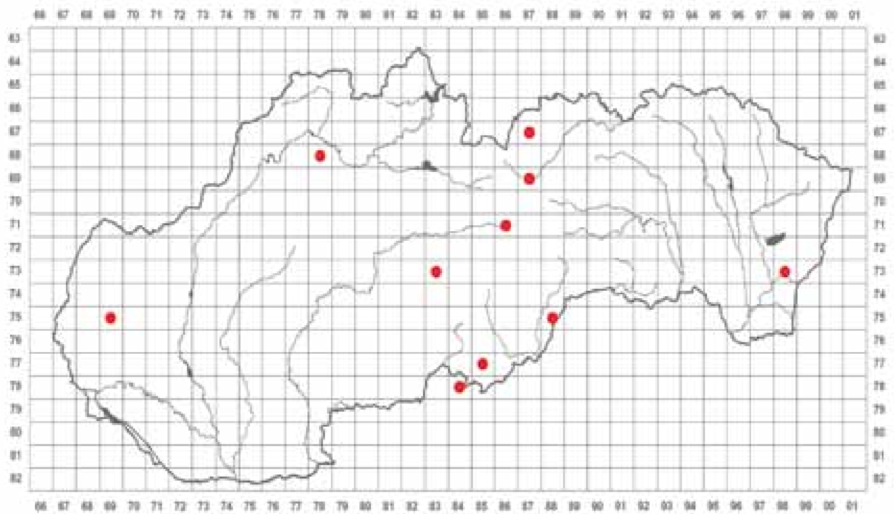
Nyctalus lasiopterus

Although the occurrence of the Greater Noctule has not been documented in the Czech Republic by concrete netted material so far, the species can be nevertheless included in this review of our fauna on the basis of several fairly reliable observations in the floodplain forests in the southernmost tip of Moravia (two mapping quadrats) and the earlier data on a mounted specimen in the collections of the Southern Bohemian Museum in České Budějovice, which appears to be of local origin. For that matter, the possible future demonstration of the occurrence in this country of *N. lasiopterus*, a species showing Mediterranean and East European distribution, is suggested by repeated findings of individual bats in the surrounding countries (Hungary, Bavaria) or even more distant ones in western Europe, or the quite recent reports on the presence of a permanent and breeding population in central Slovakia. Besides the repeated findings in central Slovakia (on the upper section of the Hornád River), the overall picture of its occurrence of *N. lasiopterus* in that country is also documented by mostly sporadic findings in 10 quadrats (2.3 % of the territory) scattered over the whole territory of Slovakia in such orographic units as the Malé Karpaty Mts., the Strážovské vrchy Hills, the Veporské vrchy Hills, Horehronské podolie Region, the Belianské Tatry Mts. Popradská kotlina Valley, Slovakian Karst, the Eastern Slovakian Lowland, and the Cerova vrchovina Uplands. The altitudes of all the above localities range between 103 and 760 m a.s.l. The breeding of this species has been confirmed by nettings of pregnant or lactating females in three of the quadrats (0.7 %). Thus, the case of the rather old mounted specimen from the České Budějovice Region in



Local distribution

6, 173, 221, 235, 860, 1067, 1080, 1175.



the Czech Republic may have been an occasional stray individual (the same as the two specimens known from the neighbouring Bavaria). The observations in the southernmost part of Moravia can hint at a further spreading of the probably stabilised population in Hungary and Slovakia. The final solution of the question whether *N. lasiopterus* does occur in the Czech Republic can only be answered by concrete findings, and the possible occurrence can most probably be expected in the submontane regions of southern Moravia in habitats similar to those in which the species has been discovered in central Slovakia. Except for two subfossil items in Slovakia (both in context of rocky fissures), no fossil records are available from our territory.

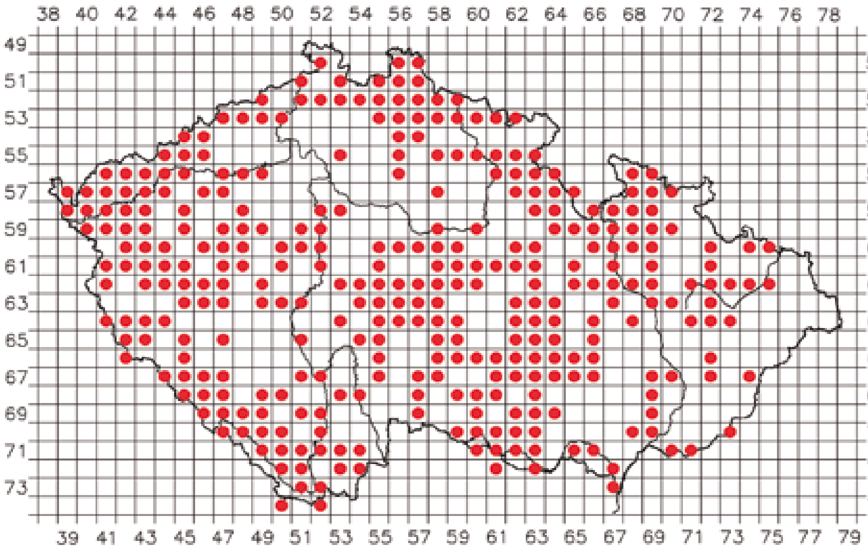
Netopýr černý

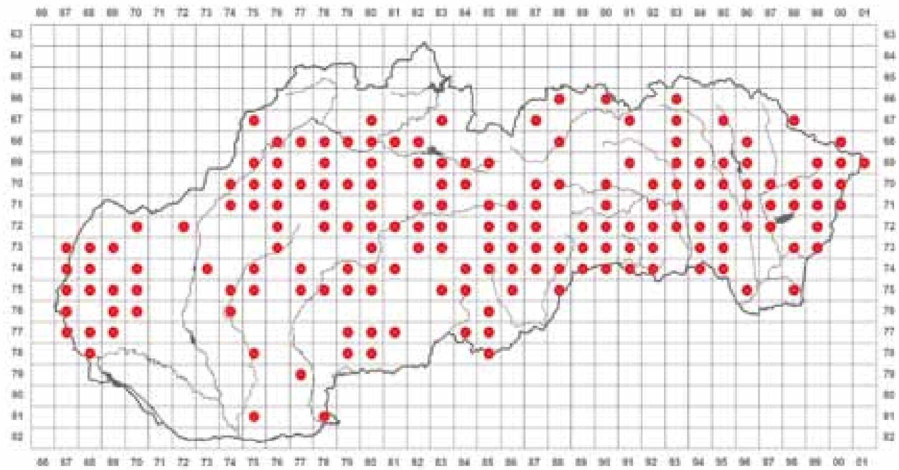
Uchaňa čierna

Barbastelle

Barbastella barbastellus

In contrast to most countries in the western part of Europe, *B. barbastellus* is among the rather common species of the bat fauna in the Czech Republic and Slovakia. After 1950, its occurrence was demonstrated in roughly 700 localities in 296 quadrats of the mapping grid (i.e. about 47.7 % of the territory of the Czech Republic. Most of them are records in winter (164 quadrats, 26.1 % of the territory), those of the solely summer occurrence are known from 51 quadrats (8.2 %). In Slovakia, all records come from 180 quadrats (41.8 %). The localities, however, are rather unevenly distributed, the coherent range of occurrence alternating with relatively extensive regions in which the occurrence of *B. barbastellus* has not been recorded so far. The question remains to what extent the absence of data from some of the regions corresponds to the actual absence or lower abundance of the species or whether it is due to different degrees of research activities in different regions. The difficulty of discovering this woodland species in summer tends to suggest the latter alternative. *B. barbastellus* occurs in stabilised populations all over the varied landscape of hilly country and mountain regions, locally also in woodland complexes at lower elevations. The absolute majority of localities recorded in the Czech Republic (about 80 %) are concentrated in the altitudinal range from 200 to 600 m a.s.l. but the proportion of records coming from 600 – 800 m a.s.l. over 13 %) should net be overlooked. In Slovakia the records of *B. barbastellus* come from altitudes ranging between 100 and 1390 m a.s.l., the summer ones from 130 – 600 m a.s.l. In agreement with the topography of the occupied mapping quadrats, the above values confirm the occurrence of the species mainly in the hilly country and uplands (or even submontane regions). Separate evaluations of the summer and winter records in the Czech Republic result in certain differences, however. While the summer records attain a maximum between 200 and 400 m





Local distribution

3, 66, 167, 293, 309, 331, 402, 410, 442, 450, 471, 476, 572, 636, 786, 806, 813, 957, 959, 1011, 1013, 1039, 1051, 1052, 1061, 1067, 1152, 1192, 1230 a.s.l (49.2 %) and decrease with increasing elevation, the winter occurrence was predominantly recorded in the 600 – 800 m zone (48.8 %), and at still higher elevations the winter findings markedly predominate over the summer ones in all cases.

The Early Pleistocene record of barbastelles in Europe is infrequent (18 sites, 2 in Czech Republic, 2 in Slovakia). It is clearly more frequent in the Middle Pleistocene and Holocene. 45 Holocene records are available from our territory (28 from continuous series): the first appearances are from the Boreal age, the species regularly appear also in the younger stages. No reliable record is available from the glacial communities.

Netopýr ušatý

Ucháč hnedý

Brown Long-eared Bat

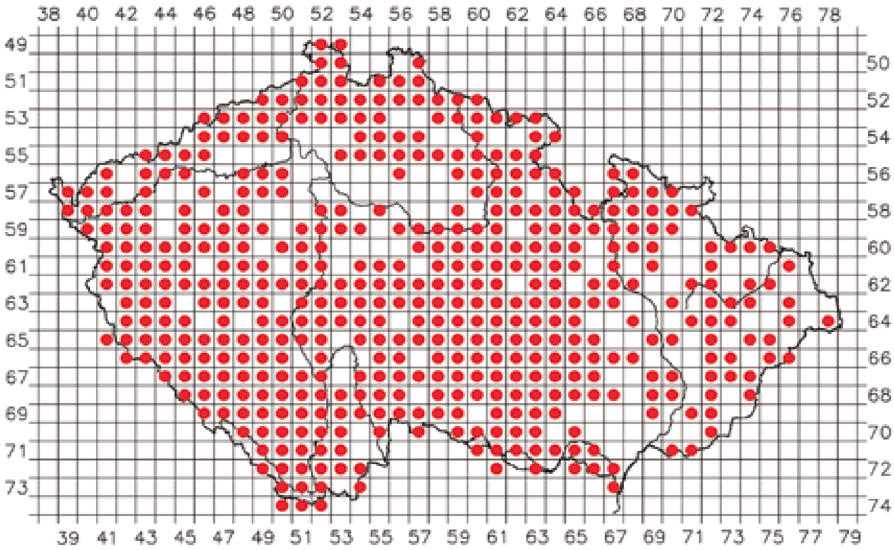
Plecotus auritus

Taxonomy, phylogeny

552, 1120, 1658, 1659, 1660.

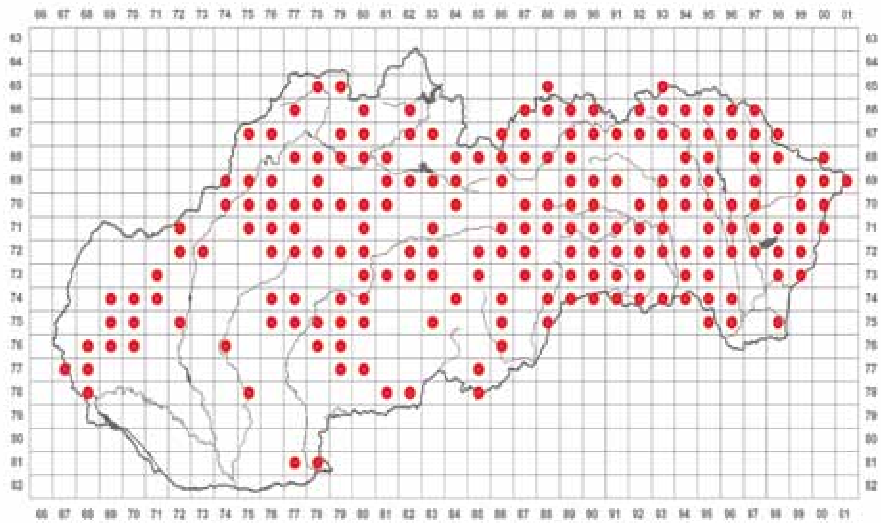
Occurring in over 1200 localities documented in the Czech Republic so far, *P. auritus* is among the bat species most frequently found in our territory, and in Slovakia the situation is much the same. The data obtained in the Czech Republic come from a total of 424 quadrats of the mapping grid (i.e. 67.5 % of the territory) and most of them report all-year-round occurrence (177 quadrats, i.e. 28.2 % of the territory), summer occurrence being documented in only 108 quadrats

(17.2 %), and winter occurrence in another 139 quadrats (22.1 %). In Slovakia, the species was recorded in 204 quadrats (about 47.3 % of the territory). *P. auritus* is distributed more or less evenly all over the territory of the Czech Republic, with the gravity centre lying in the varied and wooded landscapes at medium and higher elevations. A total absence or lower population densities of the species can only be expected in only two regions, viz., in the agriculture landscapes of southern Moravia and the part of the Bohemian tableland along the Labe River; in Slovakia, in the agriculture landscapes of the Podunajská rovina and the Eastern Slovakian Lowlands. Apparently, the occurrence of *P. auritus* in our countries primary depends on its ecological requirements rather than the hypsometric situation. For example, in the lowlands and hilly country of southern Moravia it is absent only from the intensely utilised and densely populated treeless agricultural landscape, whereas it is present all year round in sufficiently wooded regions (the floodplain parts of the Podyjí and Pomoraví regions, the Pavlovské vrchy Hills). The highest lying localities of the summer records of *P. auritus* are situated on the ridges of our mountains at 1005 to 1090 m a.s.l. They pertain to individual bats netted at the entrances to



Local distribution

3, 66, 167, 203, 293, 309, 402, 410, 415, 441, 442, 450, 471, 476, 572, 634, 636, 786, 813, 867, 1011, 1013, 1051, 1052, 1061, 1067, 1110, 1146, 1192, 1230, 1503, 1649.



underground spaces or, as in the case of the Orlické hory Mts., in a fore (93 quadrats) or winter (118 quadrats). The hypsometric maxima of the summer colonies are roughly 200 – 300 m lower (760 – 920 m a.s.l.). In Slovakia the species was ascertained within the hypsometric range from 100 m in the alluvial forests along the Latorica River up to 1489 m a.s.l. in the Tatra Mts. Of much greater information value on the hypsometric situation of *P. auritus*, however, is the quantitative evaluation of its occurrence in different altitudinal zones and, above all, the comparison with the situation in *P. austriacus.* As expected, most of the summer and winter records (about 80 % of both) of *P. auritus* in the Czech Republic fall into the medium elevation zone, 200 – 600 m a.s.l., and its occurrence at elevations over 800 m a.s.l. (around 15 % of the summer records) cannot be overlooked either, while only about 3 % of the records were obtained from elevations below 200 m a.s.l. Thus, *P. auritus* shows wider ecological tolerance than *P. austriacus.* In general, the varied and highly wooded type of our landscape provides optimum conditions for *P. auritus*, which fact is also apparent in its practically whole-area distribution over our territory. Quite logically, then, the overall picture of its distribution in the Czech Republic shows a number of characters identical with those of the preceding species.

The fossil record (almost continuous from the Late Miocene to the Recent) is relatively rich: 56 fossil assemblage of 35 localities in the Czech Republic and Slovakia, of which 34 (26 localites) are of the Holocene and/or Late Pleistocene age. The current revision demonstrated that all that material belongs to the *P.auritus* group (not to *macrobullaris* or other cryptic species and this concerns also the fossil taxon *P.abeli*). Repeated records indicate that the species survived in the region throughout the glacial stages and has been a common and widespread since the earliest Holocene.

Life history

51, 352, 382, 407, 417, 443, 469.

Netopýr dlouhouchý

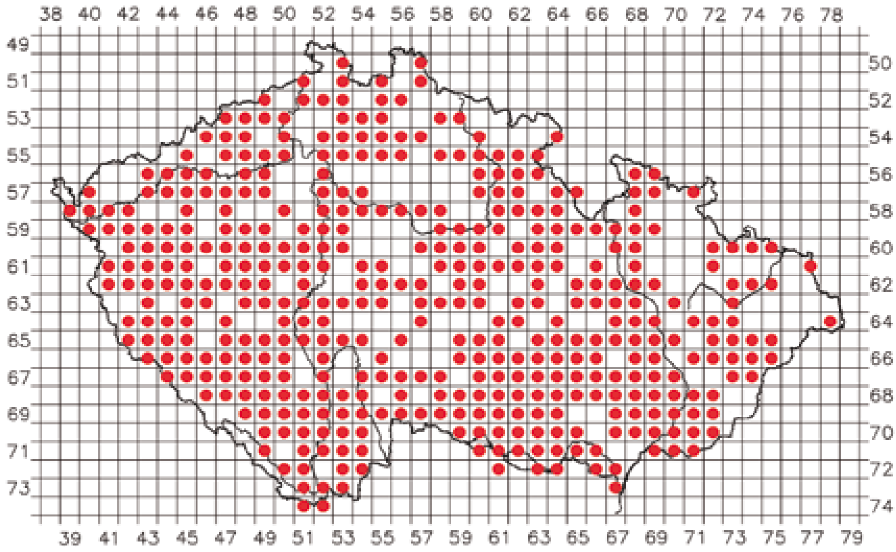
Ucháč sivý

Grey Long-eared Bat

Plecotus austriacus

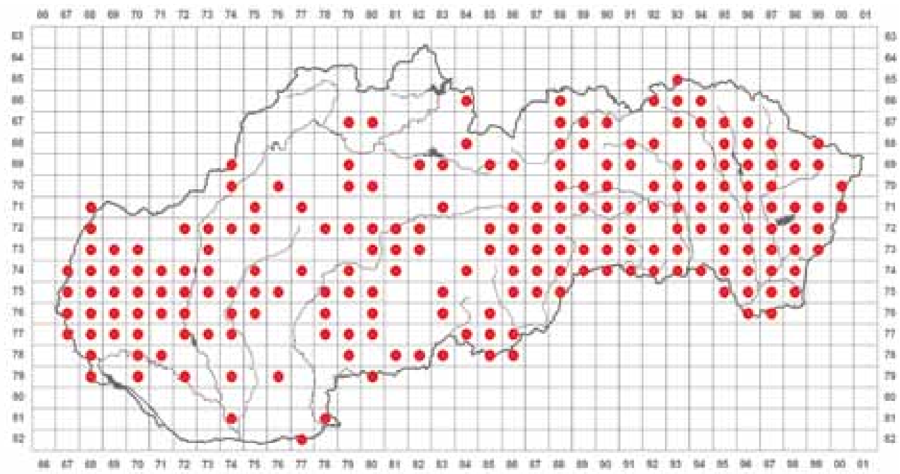
The list of records of *P. austriacus* in the Czech Republic contains over 1050 localities of documented occurrence in 392 quadrats of the mapping grid (i.e. 62.9 % of the territory, Fig.8). Of that number, 181 occupied quadrats (28.8 %) pertain to permanent (summer and winter) occurrence of the species, the remaining 211 quadrats (33.6 %) pertaining to its occurrence in summer

(93 quadrats) or in winter (118 quadrats). A similar situation is found in Slovakia the records coming from 208 quadrats (48.3 % of the territory, Like *P. auritus,* also *P. austriacus* is among the most frequent bat species, occurring practically all over the territory of the Czech Republic (being a demonstrably residing species, its findings are of basically equal information value), showing distinct preference for open and rather densely populated landscapes at lower and medium elevations. In Slovakia, *P. austriacus* is absent, above all, from the ridges of our highest mountain ranges. In spite of the large number of data collected, however, the picture of its distribution is still a mosaic of documented occurrence and places where it has not been found so far, which is the obvious consequence of different research activities in different regions (which tends to explain its seeming absence from the part of the Bohemian Tableland along the Labe River as well as other insufficiently investigated regions in central Bohemia and the north-western part of Slovakia). On the other hand, its low numbers or even absence from mountain regions can be expected, even if the species' permeating higher lying wooded regions during hibernation is not quite unusual. The picture of the distribution of this bat species is significantly completed by the hypsometric analysis of its localities. At first sight, the altitudinal



Taxonomy, distribution

3, 66, 167, 203, 293, 309, 402, 410, 436, 441, 450, 471, 476, 572, 575, 634, 636, 786, 813, 867, 1011, 1013, 1051, 1052, 1061, 1067, 1110, 1192, 1230, 1658, 1659, 1660.



distribution of the localities of the two closely related species is similar (among other things because a large part of the territory of the Czech Republic lies in the range of 200 – 600 m a.s.l.). However, a detailed analysis does reveal the following differences in their ecological requirements: (a) a significant part of the summer records of *P. austriacus* (about 10 %) come from localities lying below 200 m a.s.l. (in *P. auritus* it is only about 3 %); (b) most of the summer records of both species (86 % in *P. austriacus,* 83 % in *P. auritus)* come from the 200 – 600 m range; however, the gravity centre of the range of *P. austriacus* lies in the 200 – 400 m zone, that in *P. auritus* in the 400 – 600 m zone, which difference is yet more marked when comparing their winter records; (c) in *P. austriacus* only 2.8 % of summer and 7.8 % of winter records come from elevations between 600 – 800 m a.s.l., whwreas in *P. auritus* it is around 12 % of summer and winmter records; (d) *P. austriacus* shows a practically zero occurrence at elevations over 800 m a.sl., whereas in *P. auritus* it is still around 2 % of summer and as much as 5 % of winter records. In our varied environment with predominant hilly country and uplands, the above differences are persuasive evidence of the different ecological requirements of the two closely related species. In Slovakia, *P. austriacus* was recorded at elevations ranging between 100 and 1330 m a.s.l. Its maternity colonies were found at low elevations in lofts of buildings, the highest lying ones at 700 m a.sl.l., most frequently together with *Eptesicus serotinus.* Nevertheless, among our thermophilous bat species *P. austriacus* (togehther with *M. myotis)* is the most adaptable, not avoiding even higher elevations and wooded regions.

Life history

51, 352, 407, 417, 443.

In contrast to *P.auritus*, this species is for sure apochoric element of the post-Neolithic Holocene which spread to Central Europe occured probably as late as in the historical time via colonization of urban habitats. Two fossil records are available form the late Holocene of southern Slovakia.

contributed notes and articles
(not peer reviewed)

case studies in brief

Study on bat diet in the Czech Republic and Slovakia

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The first study concerning bats‘diet composition in the Czechoslovak territory was published in 1975 (Bárta 1975). The study is based on the sample of moths' wing remnants collected under the perch of *Plecotus auritus* in the church tower loft. The sample was dominated by *Hepialus humuli* and Noctuidae. Adroitly flying Sphingidae (*Deilephila elpenor, D. porcellus*) recorded in the sample were a surprise for the author.

The entire expansion of the bats' diet studies was in the eighties of 20th century, when outstanding research worker, Zdeňka Bauerová, emerged on this field. Only some main features or just nothing was known concerning the diet composition of the most of European bats at that time. Within her short life Zdeňka Bauerová analyzed enormous amount of the diet samples and published widely studied and until now frequently cited works regarding the diet composition of *Myotis myotis* (Bauerová 1978), *Plecotus austriacus* (Bauerová 1982), *Myotis emarginatus* (Bauerová 1986a), *Myotis nattereri* (Bauerová & Červený 1986; Gregor & Bauerová 1987) and *Vespertilio murinus* (Bauerová & Ruprecht 1989). She published also a short overview with notes regarding trophic niche partitioning and community structure based on preliminary results of her diet analyses of many Central European species (Bauerová 1986b). The topic was relatively overlooked until that time and thanks to her works and boom of similar studies, fascinating and complicated world of many different foraging strategies, trophic niche displacement and bat community structure arose in front of surprised bat workers.

The study concerning *M. myotis* was very comprehensive despite it was the very early bat diet work of Baueová. Analyzing 27 digestive tracts and 1 kg of feces along with the food supply collected using pitfall traps she confirmed the ground gleaning strategy in *Myotis myotis*, quantified proportions of particular prey items and diet seasonal dynamics, she pointed out selection of larger prey and quite low diet diversity of the studied species diet (Bauerová 1978).

Z. Bauerová published the first data on the trophic ecology of *Plecotus austriacus* (Bauerová 1982) which she studied along with the food supply. She pointed out selection of medium-sized and larger moths and presupposed important role of aerial hawking foraging strategy. For further discussion on diet of *Plecotus* see below.

The study concerning *M. emarginatus* (Bauerová 1986a) brought the first deeper insight on the diet of the species, proved foliage gleaning strategy and emphasized the role of spiders in the diet.

The papers of Z. Bauerová brought the first quantitative and detailed data on the diet of *Myotis nattereri* and direct evidence of foliage gleaning foraging strategy of the species (Bauerová & Červený 1986; Gregor & Bauerová 1987). The study also proved high diet flexibility of the species as the diet varied very significantly among different sites and seasons.

After the colony of *Vespertilio murinus* had been discovered in Bialowieza (Poland), Bauerová & Ruprecht (1989) soon reported very first data concerning the diet composition of this species. Nematoceran Diptera were found to be the most important component of the species diet. Further major components included Lepidoptera, Trichoptera and Homoptera. By the character of prey and on the basis of observations of its foraging activity they classified *V. murinus* as the bat of the aerial insectivore type.

The bat diet research continued in the Czech Republic in nineties of the 20th century. There was studied the diet composition of *Eptesicus serotinus* and *Eptesicus nilssonii* in Moravia (Gajdošík & Gaisler 2004). Although the material was not collected in sympatry and some distinctions between the observed diet compositions might have been caused by local conditions, the study brought interesting results regarding the preferred prey, seasonal diet changes and possible trophic niche overlap between studied species. Studied species were found to be aerially hawking predators feeding on swarming insects if possible and Nematoceran Diptera, mainly Chironomidae were the most frequent food items in both species. The prevalence of Coleoptera and Hymenoptera in *E. serotinus* and Heteroptera and Lepidoptera in *E. nilssonii* was highly significant. Trophic niche overlap was 69%.

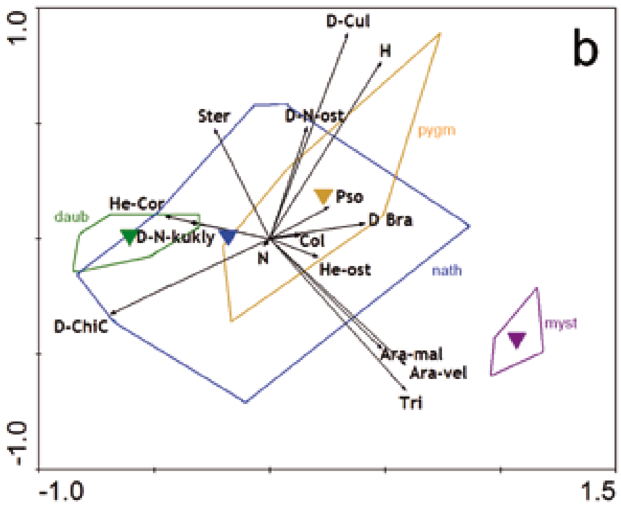

Fig 1: *Principal component analysis with aditional variables. Relations among bat species and selected diet components. Summarizing chart with centroids of particular species. The first axis explains 43% of variability. The first and the second together explain 58% of variability.*
daub = M. daubentonii, myst = M. mystacinus, nath = P. nathusii, pygm = P. pygmaeus; Ara-mal = Araneae small<5mm, Ara-vel = Araneae large>5mm, Col = Coleoptera, D Bra = Diptera-Brachycera, D-ChiC = Diptera-Chironomidae+Ceratopogonidae, D-Cul = Diptera-Culicidae, D-N-kukly = Diptera-Nematocera-puppae, D-N-ost = Diptera-Nematocera other, H = Hymenoptera, He-Cor = Heteroptera-Corixidae, He-ost = Heteroptera other, N = Neuroptera, Pso = Psocoptera, Ster = Sternorrhyncha, Tri = Trichoptera,

Extraordinarily good conditions for the study of bat community structure and trophic niche partitioning were discovered at the Ledové sluje caves, where extensive study was launched in the nineties of the 20th century (see chapter Projects).

The first study concerning the diet composition of *Nyctalus lasiopterus* north from the Mediterranean region was accomplished on material collected in Slovakia (Uhrin & al. 2006). The most important diet components were Lepidoptera and Namatoceran Diptera (especially Tipulidae). Carnivory suggested by Dondini & Vergari 2000 or Ibáñez & al. 2001 was not proved on the Slovak material.

Very interesting results were achieved within the frame of the study based on analysis of bat droppings regarding syntopic populations of four middle sized and smaller aerial hawking bats (*Myotis daubentonii, M. mystacinus, Pipistrellus nathusii* and *P. pygmaeus*): in the pond basin of Třeboňská pánev (S Bohemia) (Pithartová 2007). The entire bat species fed abundantly on Chironomidae / Ceratopogonidae, however they differed in contribution of particular size categories of that prey. *M. daubentonii* preferred a medium-sized (5.0–7.5 mm) and larger (>7.5 mm) prey and its diet consisted particularly of Chironomidae / Ceratopogonidae (71.7% of volume), the other prey (such as Corixidae and Sternorrhyncha) became important in the period of lactation. *Myotis mystacinus* hunted prey of medium size as a rule, nevertheless it fed more often than other species on a larger prey. The largest portion of its diet was formed by Chironomidae / Ceratopogonidae (29%), Araneida (29%) and Trichoptera (19.9%). Aspects of feeding selectivity were most pronounced in that species. In contrast, *Pipistrellus nathusii* exhibited the broadest feeding niche and the largest degree of generalistic predation: its diet varied extensively throughout the season both in taxonomic respect and in representation of particular size categories. Chironomidae / Ceratopogonidae (65%), and a medium and minute prey (<5 mm) predominated in the diet. *Pipistrellus pygmaeus* hunted above all medium and minute prey. Besides of Chironomidae / Ceratopogonidae (49.9%), the following taxa were important in some periods of the season: Diptera / Brachycera, Sternorrhyncha, Culicidae, and Hymenoptera. The results suggest a changeover of hunting ground from water habitats to woodland at the turn of lactation and postlactation period. *M. daubentonii* seems to start a selection of bigger individuals of several other preyed taxa within the period of abundance decrease of preferred bigger Chironomidae. Results of this study also points to possible selectivity of bigger prey within the pregnancy period as in the diet of all the studied species the percentages of larger prey significantly increased during that time as compared to other observed periods. The other way round, more frequent occurrence of smaller prey in droppings recorded in later season might have been caused by onset of volancy of inexperienced juveniles and their unselective hunting including more frequently smaller prey similarly to observations of Belwood & Fenton (1976).

Case study: Diet composition of the long eared bats (Plecotus)

Comparison of the diet compositions of P. auritus and P. austriacus in syntopic occurrence

The diet of *Plecotus auritus* has been widely studied (Robinson 1990, Shiel & al. 1991, Taake 1992 and many others) whereas there are only a few data regarding *P. austriacus* (Bauerová 1982, Beck 1995). Both species are reported to feed especially on Lepidoptera. *P. auritus* is believed to be a typical gleaner due to foraging behaviour studies (Anderson & Racey 1991) and relatively high proportion of non flying invertebrates in its diet.

Bauerová (1982) suppose *P. austriacus* to hunt its prey especially in open air, not lower than 2 meters. Barataud (1990) observed both species in syntopic occurrence and did not find the difference in the way of flight or microhabitat selection between them. The diet composition was studied using identification of prey remnants collected under perches used by both species and therefore they are not evaluated separately. This author also disagrees with Bauerová (1982) about the height of foraging flight of *P. austriacus*.

Within the frame of extensive study at Ledové sluje caves (see also chapter Projects) there was collected and analysed material which made possible to evaluate the diet composition differences in detail thanks to syntopic occurrence of both species (*Plecotus auritus* 578 ind., 4038 pellets; *P. austriacus* 41 ind., 396 pellets) (Andreas 2002). In order to preclude a distortion due to seasonal dynamics changes only summer samples (june-august, *Plecotus auritus* 158 ind., 1056 pellets; *P. austriacus* 23 ind., 226 pellets) were compared. A trophic niche overlap counted according to Pianka (1973) based on the material collected within the whole activity season was O_{jk}=0,938, for summer period (june-august) was O_{jk}=0,913. The diet composition of both species show similar design with prevailing Lepidoptera. More significant proportion of non flying Lepidoptera larvae (Statistica, Differences between two proportions, p=0,0396*) and slightly higher content (statistically not significant) of other non flying (Araneae, Dermaptera, Opilionida) or mostly diurnal prey (Brachycera) in the diet of *P. auritus* would indicate that the species is more obligate gleaner as compared to *P. austriacus*. Other dissimilarities between the diets are not possible to explain unequivocally as results of difference in foraging strategies. Tipulidae also represents important proportion of the diet of *P. auritus*, but in the different season (May, see Fig. 3) and important proportion of Coleoptera (p=0,0009**) or lower content of Neuroptera (n. s.) in the diet of *P. austriacus* can be interpreted as a result of different habitat use. Coleoptera (most frequently Scarabaeidae) in the diet of *P. austriacus* complemented occasionally with Hymenoptera resembles partly the diet of *Eptesicus serotinus* at the studied site. This species is known to be an aerial hawker of more open and agricultural habitats (Catto & al. 1996, Schober & Grimmberger 1998). As far as differences in habitat preferences and distribution patterns between *P. austriacus* and *P. auritus* are concerned, the first species is supposed to be a bat inhabiting warmer more open habitats whereas the second one is thought to be mostly forest species (Schober & Grimmberger 1998). On the base of diet analyses we are inclined to think that recorded differences between the diets of studied species are result of microhabitat preferences which could be a more important source of dissimilarity than the differences in foraging strategy. Due to

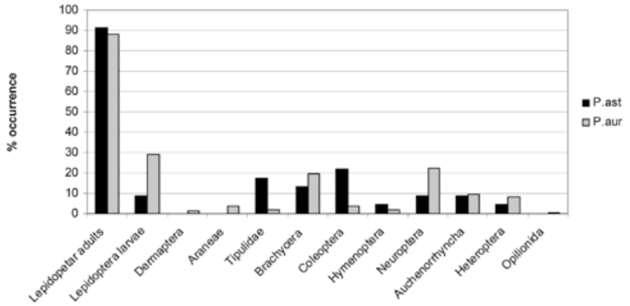

Fig. 2: *The diet composition of Plecotus austriacus (23 ind., 226 pellets) and Plecotus auritus (158 ind., 1056 pellets) from site of syntopic occurrence at Ledové sluje caves in summer season (June-August). Results expressed as % occurrence, i. e. proportion of bats in which droppings was particular food item identified. Not including all food items.*

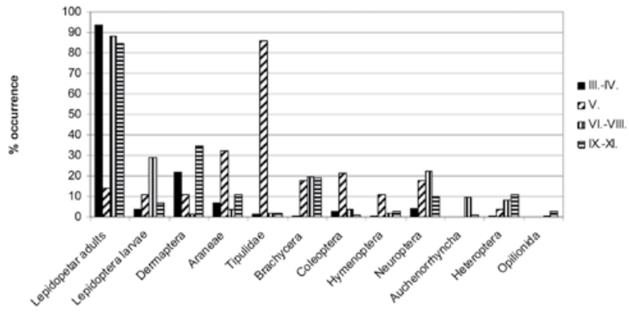

Fig. 3. *Seasonal changes in the diet composition of P. auritus. Numbers of individuals collected: n (III.-IV.)=189, n (V.)=28, n (VI.-VIII.)=158, n (IX.-XI.)=199.*

inconsistency in observations of Bauerová (1982) and Barataud (1990) the difference in the foraging strategy does not seem to be reliably proved and this topic begs for profound study including probably behavioural experiments. A detailed telemetry study of habitat preferences would be very helpful too.

Seasonal changes of the diet composition of Plecotus auritus

The species feeds predominantly on moths (Robinson 1990, Taake 1992), but in some regions dipterans may prevail in its diet even within the entire season (Rydell 1989) or at least in several other parts of its distribution range at least within spring season (Swift & Racey 1983, Shiel et al. 1991). The observed patterns of diet composition changes show, how vital are different seasons and regions comparisons to reveal the entire flexibility and trophic niche breadth of studied species.

Our detailed study of the diet of *Plecotus auritus* showed surprising adaptability of this bat. The studied species is able to change nearly completely its prevailing food component in May and feed predominantly on nematoceran Tipulidae instead of moths that prevails within the other parts of the year. This abrupt switch furthermore arises in the season, when absolute abundance of previously preferred prey (moths) is being on increase and indicates high opportunistic flexibility of *P. auritus*. The growth of proportion of Tipulidae in the diet is accompanied by notable increase of Araneae and Coleoptera and, on the other hand, by decrease of proportion of Dermaptera. Nevertheless, as compared to the changes of Lepidoptera and Tipulidae, these changes are of a much less importance and it is not possible to explain them unequivocally by the change of preferred microhabitat, food supply alteration or some foraging tactics adjustment.

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Study of diet in Middle East and African bats

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Extensive field studies on bats of the Middle East and in various regions of Africa, udertaken by Czech bat researches during past decades provided also a valuable material for study of bat diet. Thus, in more instances we obtained the very first data regarding the diet composition in species like *Myotis schaubi, Plecotus macrobullaris, Eptesicus anatolicus* or *Hypsugo arabicus* as well as the data contribution to refining knowledge of trophic biology of bats in the regions providing resources quite different than those in the proper temperate zone. *Myotis schaubi* was found to feed on Araneae and Brachycera most probably using mainly foliage gleaning foraging strategy (Benda et al. 1999). The very first data regarding the diet of *Plecotus macrobullaris* from Iran and Syria showed the species to hunt predominantly Lepidoptera (Benda et al. 1999, Benda et al. 2006). The diet composition of *Eptesicus anatolicus* was studied using samples collected in Iran and Syria (Benda et al. 1999, Benda et al. 2006). The results from Iran showed high proportion of Coleoptera (Scarabaeidae) similarly to the diets of other species of genus *Eptesicus*, but also relatively high proportion of Orthoptera. Two faeces samples from Syria on the other hand contained surprisingly enormous proportion of Hymenoptera and one digestive tract collected at the Qalat Marqab castle contained 70% volume of Brachycera and 30% Heteroptera. The entire data regarding the diet composition of *E. anatolicus* are therefore rather inconsistent and the matter needs further studies in order to shed light on the trophic ecology of this species. The diet of *Hypsugo arabicus* (Benda et al. 2002) in Iran contained especially Auchenorrhyncha, Coleoptera and Hymenoptera.

Case 1: Ground gleaning carnivorous bats

Carnivory in bats is typically combined with ecomorphological traits of ground gleaning: the bats of that group have relatively similar skulls (Freeman 2000) and flying apparatus morphology (Norber g & Rayner 1987). One of the species suggested as a potential carnivore is also *Otonycteris hemprichii* (Norberg & Fenton 1988, Horáček 1991). This relatively large bat is reported to fly in two different ways – very close to the ground above rocks or at the height of some 4–8 meters. It has been observed to catch flying insects as an obligatory echolocator and to glean passively listened prey from the ground (Horáček 1991). According to previous studies in different parts of the Middle East and Central Asia, the most important prey categories seem to include Tenebrionidae, Blattodea and Orthoptera (Horáček 1991), Scarabaeidae (Whitaker et al. 1994), Scorpionida, Solpugida and Orthoptera (Arlettaz et al. 1995), Coleoptera, Heteroptera and Hymenoptera (Fenton et al. 1999), Solpugida and Scorpionida (Benda et al. 1999).

Coleoptera, Solpugida and Orthoptera were the most abundant items in the analysed faeces samples of *O. hemprichii* from Syria. Regarding particular Coleoptera families consumed, Scarabaeidae (69% of volume), Carabidae (16%) and Tenebrionidae (15%) were the most frequently consumed beetles. At one site (Rasafah), the diet was sampled three times and important differences indicating certain flexibility in the feeding ecology of the species were found. The preyed arthropods undoubtedly picked up from the ground (Solpugida, Scorpionida, Coleoptera larvae and Chilopoda) represented a significantly large part of the diet composition. Contents of digestive tracts of four specimens collected at Ayyash were also studied. One was empty, one contained only Formicoidea, one contained only Scarabaeidae and the last one contained approximately equal proportions of Blattodea and Mantodea. The digestive tract from one individual collected at Qala'at ar Rahba contained 60% of volume of Carabidae and 40% of Solpugida. Three digestive tracts from Khazneh contained Coleoptera larvae and Mantodea. These results prove an important role of ground gleaning in the foraging behaviour of *O. hemprichii* and certain seasonal and regional variation in the diet. (Benda et al. 2006).

Taking into account body size and diet flexibility, we can not exclude absolutely a possibility that *O. hemprichii* is occasionally able to catch and consume some smallest vertebrates. On the other hand, if we concern all the data regarding the diet composition of the species, we can conclude, that *O. hemprichii* is probably only insectivorous bat. As a support we can mention that *O. hemprichii* would be one of the smallest carnivorous bats and within study of its foraging behaviour no perch feeding was observed (Fenton et al. 1999). The perch feeding is supposed to be a foraging tactics enabling to consume relatively bigger prey as compared to a bat body size (Fenton 1990).

Very interesting results were achieved by Czech researcher team, who surveyed bat assemblages in southeastern Senegal, West Africa. Among collected bats, two specimens of *Hipposideros gigas* (formerly included in *H. commersoni* – see Simmons 2005) provided evidence of carnivory (Vallo, Koubek and Červený, in prep.). Common prey of *H. gigas* (or *H. commersoni* s.l., respectively) consists generally of large beetles and cockroaches (Vaughan, 1977, Rakotoarivelo et al., 2009), and such specialisation finds support also in its robust skull morphology, which enables feeding on hard items (Freeman, 1984). Nevertheless, carnivory of this largest African microbat species has been suggested by e.g. by Eger and Mitchell (2003), who mentioned unconfirmed feeding on frogs, and hypothesized to be plausible by Rakotoarivelo et al. (2009) based on confirmed carnivory of smaller-sized congeneric *H. diadema* from Australia as stated in Pavey and Burwell (1997). Solid evidence stated by Vallo, Koubek and Červený (in prep.) includes a witnessed regurgitation of a frog by a specimen in mist net, and finding of mammal hairs in stomach of another specimen, which were confirmed as belonging to a rat (*Rattus rattus*) by means of molecular and morphological examination.

Case 2: Feathers in the bat diet

The matter regarding carnivorous and potentially carnivorous bats attracts researchers' attention to diet analyses of large bats. Several bat species are known to regularly prey on birds - *Macroderma gigas* (Pettigrew *et al.,* 1986; Schulz, 1986). *Nycteris grandis* (Fenton, Thomas & Sasseen, 1981; Fenton *et al.,* 1993). Pavey & Burnell (1997) proved occasional bird feeding in *Hipposideros diadema* although Norberg & Fenton (1988) predicted that *H. diadema* would not prey on vertebrates because it is an obligate echolocator with a high intensity call. Bird material consisted of small down feathers and they were present in nine of the 70 faeces (12.9%) examined at one of two studied sites. Feathers were abundant in seven pellets from the first site, being found throughout each pellet. A single feather was present in three pellets. In addition, a fragment tentatively identified as part of a bird tongue was located in one pellet. Thus *H. diadema* seemed the only species of obligate echolocator known to feed on vertebrates. Pavey & Burnell (1997) mentioned that *Hipposideros diadema* locates prey predominantly by perch hunting as do several other carnivorous species including *Macroderma gigas* (Tidemann *et al.,* 1985) and *Cardiderma cor* (Vaughan, 1976).

Results regarding possibility that *Nyctalus lasiopterus* feeds on birds [Dondini & Vergari (2000), Ibáñez & al. (2001)] seemed quite controversial and naturally caused a scientific polemic concerning this matter (Bontadina & Arlettaz 2003; Ibáñez & al. 2003). There were several options and all seemed a bit improbable. The first possibility was that *N. lasiopterus* is not able to distinguish between flying feathers and its usual preys and eats a lot of this indigestible material. The second possibility was that *N. lasiopterus* regularly feeds on birds and consumes prey that can represent some 30% of its body weight on the wing. The third possibility can be a predation in tree hollows. Extraneous substances may appear in bats diet also as a result of grooming activities and some feathers may emerge in the faeces if the bats would share tree hollow with birds. The puzzling matter was solved by Popa-Lisseanu et al. (2007) using a sophisticated study of seasonal dynamics of carbon and nitrogen stable isotopes in bat blood. Results presented in the paper showed high proportion of vertebrate food within the season of migration of small passerine birds.

The studies of the diet composition of *N. lasiopterus* carried out by Czech and Slovak bat workers did not bring any finding that this bat feeds on birds. The diet samples from Slovakia (Uhrin & al. 2006) collected in summer contained mainly moths, dipterans and lacewings. We also analysed the content of five digestive tracts of *N. lasiopterus* from Cyrenaica, Libya (M. Andreas, unpubl. data) collected in May. We recorded in three animals only middle sized moths (wingspan ca 30 mm), one bat fed on the carabid beetles and heteropterans and the last one fed on moths, neuropterans and cockroaches. The sample of 30 faecal pellets from 8 individuals from Cyprus collected in July (M. Andreas, unpubl. data) contained mainly Hymenoptera, Auchenorrhyncha and Scarabaeid beetles. Moths and heteropterans were also found in the sample. Aforementioned data indicates that birds are not a main food resource of the species and its carnivory is probably a local and/or seasonal phenomenon.

Within the studies of bat diet composition in the Czech Republic at Ledové sluje caves (see also chapter Projects) there were recorded some presences of single feathers in the diets of several species like *Myotis nattereri* or *M. daubentonii* (M. Andreas, unpubl. data). None of them is supposed to be a potential carnivore and feathers in their diets we believe to be a coincidental item taken randomly by bats when they confused it with a prey. Similarly, we recorded a single feather twice in sample of faeces of *Otonycteris hemprichii* within bat research in Syria (Benda et al. 2006). We expect it to be a coincidentally taken item too as the species does not apply perch hunting (Fenton et al. 1999) and most probably is not able to feed such a big prey on wing.

Taking into account aforementioned findings, it is obvious that the presence of feather in the diet of bats does not necessarily indicate their carnivory. Finding of feathers must be interpreted very circumspectly and the amount of feathers in one sample, foraging behaviour and body size of the potential bird eating bat must be taken into the consideration.

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Evolution and ecology of the bat bugs of the family Cimicidae (Heteroptera)

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The extreme sociality of bats provides them a lot of various advantages, at the same time, of course, it provides particularly favorable conditions for diverse parasitic organisms. Nearly 700 insect species of the orders Dermaptera, Heteroptera Siphonaptera and Diptera have been recorded as ectoparasites of bats. In all the orders, at least adults are permanently attached to the body of the host. The bat bugs of the family Cimicidae (Heteroptera) are different: both adults and larvae stay on the body of bat only when feeding, the rest of the time they remain nearby. When the bats are absent, in the winter for example, the cimicids are able to persist starving for a long time in the roost. Their transmission between roosts is usually passive and very occasional. They are very rarely found on the mist-netted bats. Still, the fact that only adults are found on the bats outside the roosts (e. g. Heise 1988, our material) suggests that cimicids sometimes stick to their body on the purpose of dispersal.

Our experience suggests that many bat specialists may not be aware of the presence of the bat bugs in roosts at all, just because they do not find them on the body of the bats. It may be one of the reasons why cimicids are seldom collected and poorly known. The most complex knowledge on the family Cimicidae is given by Usinger (1966) who described about two thirds of the known species.

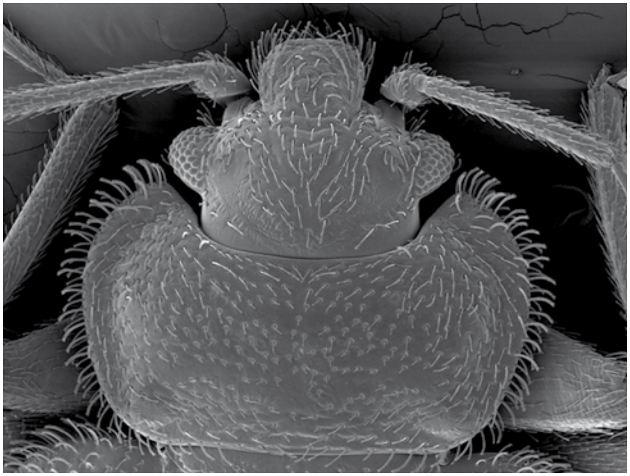

Fig. 1. Pronotum of a bat bug of the C. pipistrelli group.

Bats are the original hosts of the family (Horváth 1913). According to Usinger (1966), there have been four switches in the host specialization from bats to birds in the evolution of cimicids, one of the groups converted to birds was the genus *Oeciacus* Stål, 1873. The coexistence of bats and humans in caves in the past offered a new opportunity for the cimicids: three species extended their host specificity by attacking man, e.g. the common bed bug, *Cimex lectularius* Linnaeus, 1758.

Traditionally, the genera *Cimex* and *Oeciacus* had been considered sister but distinct genera because of their inwardly consistent and mutually different appearance and host relation: *Oeciacus* species as parasites of birds of the family Hirundinidae, *Cimex* species as parasites of bats and secondarily man and birds.

The study of cimicids at the Department of Zoology, Faculty of Science, Charles University is focused on the phylogeny, zoogeography and population genetics of the family in the context of the host specificity and its changes. Material of mostly European taxa is available at the moment. The results up to date are based on analyses of sequences of two mitochondrial genes (16S ribosomal gene, cytochrom oxidase subunit I) and thorough morphometric analysis. Use of nuclear markers is planned.

In the study, the swallow bugs of the former genus *Oeciacus* were found related to the palaearctic *Cimex pipistrelli* Jenyns, 1839 species group, one of the groups of the genus parasiting exclusively bats. Thus the species of the genus *Oeciacus* were reclassified within the genus *Cimex*. Our study also suggests that the evolution of the taxa of the former two genera included multiple changes in their host relations, as seen in Figure XXA, presumably as the cue in their speciation. The situation revealed suggests that the external morphology, which led previous authors to wrong taxonomic solutions, is only a consequence of the host relations of particular taxa. Also specimens of a single species may differ in morphology according to the actual host as showed by another our study on *Cimex lectularius*. Some of the differences found appear to be of a possible adaptive significance.

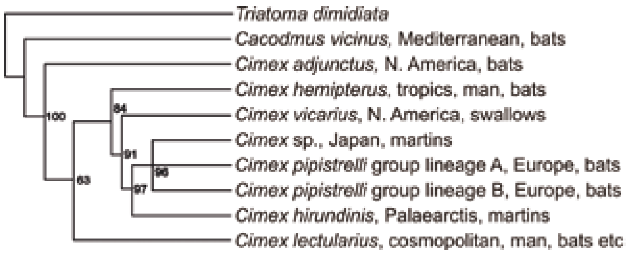

Figure 2. Result of the maximum parsimony analysis based on 16S ribosomal and cytochrom oxidase subunit I genes (total 1040bp). Simplified. Boostrap values for 1000 replicates. Triatoma dimidiata (Heteroptera: Reduviidae) used as an outgroup.

Based on the two mitochondrial genes and morphometrics a revision of the confused taxonomy of the European species of the *Cimex pipistrelli* group was attempted. Two divergent but sympatric mitochondrial lineages have been found in numerous sampled populations from many European countries. Both lineages are too variable in morphology to be assessed as any of the three species of the *C. pipistrelli* group described and reported from Europe. The distribution of the lineages in bat roosts or found on mist-netted bats in the Czech and Slovak Republics is shown in Figure XXB, as well as the roosts occupied by the bed bug, *Cimex lectularius*. One of the two lineages of haplotypes (B) is very little differentiated in contrast to the second (A). This suggests a recent invasion of the haplotype lineage over the area of Europe. Final taxonomic interpretation of the divergence requires future use of nuclear markers.

Our results based on sequences of the two mitochondrial genes of numerous sampled populations of *Cimex lectularius* from man and bat roosts from many European countries suggest that the population of the species is also largely structured. Only one haplotype out of 21 was found to be shared between the samples from man and bats; the two subpopulations are largely isolated. Also, the phylogenetic analyses showed a supported clade consisted only of samples from bats, which may suggest that a part of the population of the bed bug has never come into contact with man. We showed that we cannot blame bats for the transmission of bed bugs to our homes or even the recent dramatic resurgence of bed bugs in developed countries.

The observed heterozygosity of samples of the populations of both *C. lectularius* and *C. pipistrelli* group from particular bat roosts is very rare. This confirms that transmission of cimicids between the roosts is infrequent and the populations are founded by a limited number of individuals. On the other hand, the distribution of haplotypes in particular roosts often reflects the expected communication between colonies of a bat species in a particular area.

Our study points to a conflict between some of the previous taxonomic solutions and the actual relationships among particular populations or species of the genus *Cimex*. Such a conflict can be expected to be found in any other group of the family Cimicidae. Cimicids appear to be very plastic in their phenotype according to the actual host. Differences in external morphology could be confusing in discriminating species or their classification. Further work based on thorough sampling of world cimicids and modern molecular methods can reveal many other surprising stories illustrating mechanisms in the evolution of this interesting group of ectoparasites. Therefore any help with the sampling will be largely appreciated.

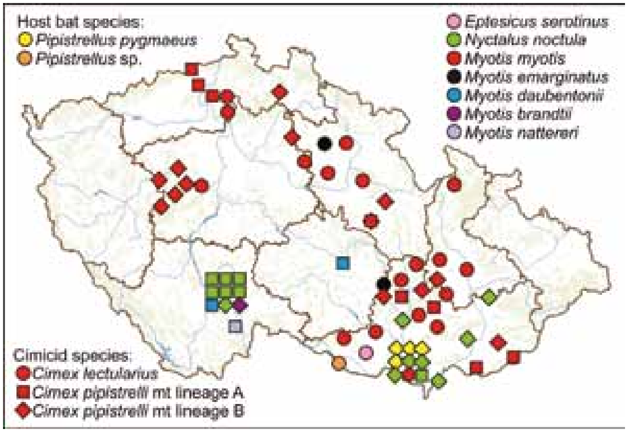

Figure 3. Distribution of Cimex lectularius and the bat bugs from the C. pipistrelli group in bat roosts in the Czech Republic. The 3x3 clusters both illustrate nine findings within few square kilometers.

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Olfactory communication in cryptic species of pipistrelles, *Pipistrellus pipistrellus* and *Pipistrellus pygmaeus*

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Olfactory discrimination between two cryptic species

The importance of advertising calls of bats is well known and differences among particular males are important for females and serve as inter-individual recognition among males before mating. However female bats do not only choose their sexual partners based on the vocalization of males, but also on olfactory cues (Bouchard, 2001, Voigt, 2002).The use of chemical signals by animals may represent the oldest form of communication and especially in bats, due to their nocturnal activity, olfactory cues are likely to be an important mode of gathering information. Until now, the few field studies dealing with olfactory communication in bats emphasize the general importance of this communication channel (Brooke & Decker, 1993; Safi & Kerth, 2003) and confirm the ubiquitous role of odours in bats' social life, e.g. in social communication within maternity colonies or foraging groups (e.g. Loughry & McCracken, 1991; McCracken & Gustin, 1991; Bloss, 1999; Nielsen et al., 2006) and roost recognition (De Fanis & Jones, 1995; Bloss et al., 2002).

Two cryptic bat species *Pipistrellus pipistrellus* and *Pipistrellus pygmaeus* occur in sympatry in most of Europe (Mayer & Helversen, 2001) where they often exploit the same foraging areas (e.g. Bartonička et al., 2007). The differences in acoustic characteristics of advertising calls become just one of the most robust arguments supporting their distinct species status. There is a presumption that females are able to immediately recognize conspecific males according to their advertising calls and fly to the male roost (cf. Barlow & Jones, 1997). However, across very small distances olfactory cues in mammals including bats could play a more important role than vocalization (Geyer, 1979). Regarding the common occurrence of both pipistrelle species with males advertising their territory by calls emitted in close proximity, therefore we assume that olfactory recognition of conspecific males can be crucial to avoid mischoice and potential interspecific mating.

The goals of our study were (i) to compare the level of attractiveness of facial glands and urinary scents for species discrimination in two closely related cryptic species *P. pipistrellus* and *P. pygmaeus* and (ii) to analyse the level of disassortative mate choice based on olfactory signals.

For odour preference tests, we used 14 females and 12 males of *P. pipistrellus* and 14 females and 15 males of *P. pygmaeus*. All the experiments were performed during the mating season of pipistrelle bats. We estimated preferences for olfactory stimuli in a dual choice system, where a tested animal had a choice between a pair of conspecific and heterospecific signal stimuli. The testing apparatus consisted of a glass Y-maze connected to a starting plastic roller as a place to habituate bats before entering into the tube. Washed cotton swabs were used to collect odour samples directly from the muzzle and face area of bats for 30 sec (Safi and Kerth, 2003) and were immediately inserted to the arms of a Y-maze. Urine was frozen (-20 °C) immediately after sampling by micropipettes. Prior to each experiment, the urine was defrosted and 10 µl were spotted in the middle of a sterile strip of filter paper. All sessions were performed during the night under infrared light in an air-conditioned and sound-proofed laboratory room. When the bat left the starting box, it entered the stem of Y-maze and video recording of its behaviour started. For 300 seconds the animal was free to explore the Y-maze.

Both sexes, without reference to the species, performed less intensive searching activity in tests with urinary scents compared to that with the scents of facial glands. Bats did not explore the arms with urinary scents as intensively as they did with the samples of scents of facial glands. No conspecific grooming was found in proximity to urinary scents. Contrarily, high levels of grooming were found in facial glands scents experiments. Special activity was recorded in males connected with slicing of glandular secretion on their body, mainly wings (Fig. 1). Males of both species were able to discriminate and prefer the odour of conspecific females, with small proportion of disassortative choices. Males spent a higher number of activity periods sniffing and also the total time for sniffing was significantly longer in the arm of Y-maze with conspecific than in that with heterospecific female scent (Fig. 2). Females of both species did not have species-specific preferences.

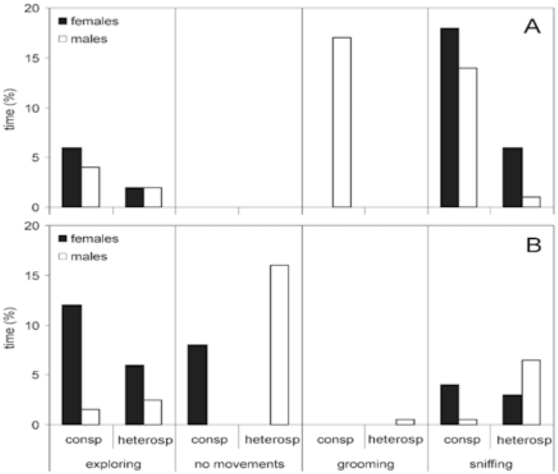

Fig. 1. *Relative activity (medians) spent by exploring, no movements (bats usually sit without any movement), grooming and sniffing under different stimulus (A – facial glands, B – urine) in the arms of the Y-maze with conspecific or heterospecific scents.*

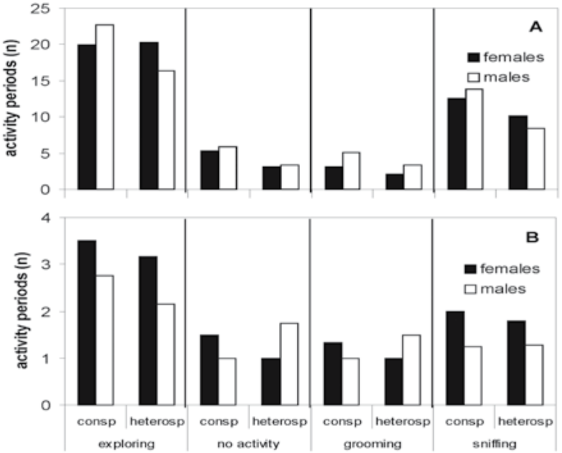

Fig. 2. *Reaction to conspecific and heterospecific facial glands secretion and urine (A – facial glands, B – urine) presented in number of activity periods (medians) found in particular experiments.*

Theoretically, the absence of females' odour preferences and a small proportion of males' disassortative choices can be considered a background for the existence of inter-species hybridization or point at more important role of acoustic than olfactory signals in pre-mating behaviour. Very low searching and sniffing activity when urinary scents were used seemed to show that in our model species the secretion of facial glands were more important as species-specific signals. Possibly the role of the urine in signalling is restricted to the intra-specific level and the same may be the role of other media, e.g. the faeces. The mischoice in olfactory allurement could be possible when one or more non-territorial males of different species were in the vicinity of the dominant male territory and they marked an area near the entrance of their own roosts only by scent. Current genetic analyses found that colonies of the same species are more similar to each other than to those of other (even related) species, thus supporting the hypothesis that the cryptic species do not hybridize (Racey et al., 2007; Bryja et al., 2009). In the case of the two pipistrelles, other types of isolation barriers are possible. In the case of the pre-mating isolation, however, social (territorial) calls may be more important than olfactory cues.

Roost selection in bats with respect to olfactory clues

In relation to changing requirements, bats prefer diverse roost characteristics and often change a set of specific roosts. This situation has been described as a fission-fusion model (Kerth & König 1999), where the bats either split into small groups dispersed in a few roosts or aggregate in one larger roost. For that reason the social interactions between individuals are of crucial importance and the ability to recognize members of the same social unit using a set of known roosts is required. To optimize the roosts searching strategies, bats thus need an extensive knowledge of a wide spectrum of suitable roosts and they should be able to identify and discriminate between them. They can use their landscape memory or an information transfer can occur during the social learning. Mainly vocalizations being heard from inside of the roost or from its surroundings have been described as main cues in the recognition process. However, olfactory signals, such as staining with urine or droppings, may present an important additive cue. In tree-dwelling bats a lots of their faeces and urine are being left near the entries to the roosts which are changed by some bat species very often. For that reason the importance of faeces and urine as olfactory signals used for discrimination between bat roosts was tested in the soprano pipistrelle (*Pipistrellus pygmaeus*).

We tested (i) if adult females of *P. pygmaeus* are able to recognize the odour of conspecific roosts in relation to the odour of heterospecific roosts of the closely related species, the common pipistrelle (*P. pipistrellus*) and (ii) if they are able to identify the odour of own roosts.

Experiments were also conducted in an Y-maze with a signal from the roost of the tested animal always present in one arm of the maze. In the second arm there was a signal from a roost unknown to the tested animal, either of the same species,

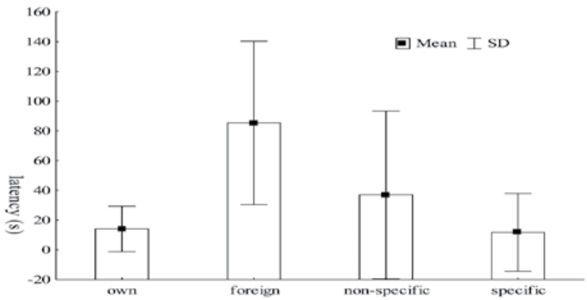

Fig. 3. Latency of the first searching period in arm with own/foreign and species specific (P. pygmaeus) and species non-specific (P. pipistrellus) signal tested on adult females.

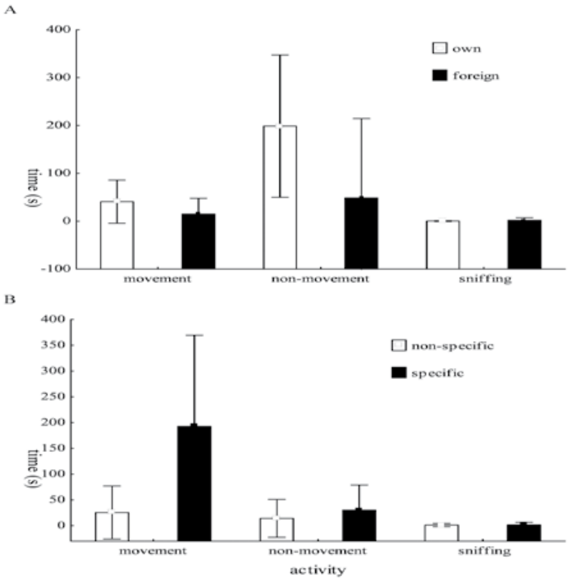

Fig. 4. Time of specific behaviour (searching, grooming, sniffing) in a Y-maze arm with a) own and foreign signal or b) species specific (P. pygmaeus) and species non-specific (P. pipistrellus) signal tested on adult females.

P. pygmaeus (1. „intraspecific type of experiment“) or of different species, *P. pipistrellus* (2. „interspecific type of experiment“).

In the arm of the maze with the signal from their own roost, adult females sniffed to it more and spend more time with non-movement activities here (Fig. 3, 4). The bats also explored much more intensively here, but the total values of movement activity did not differ from the values in the arm of the maze with the signal from an unknown roost. The behavior of juvenile females cannot be simply interpreted. Adult and juvenile females both explored the signals from their own roosts more than the ones from the roosts of the other species of bats. While adults spent a lot of time sniffing to the signals from their own roosts, the juveniles in the arm of the maze with this signal mostly spent their time with non-locomotory activities such as sitting or grooming.

In conclusion it is obvious that adult females can be able to recognize odours of their own roost. They also explore the odours of roosts of their own species more intensively than that of other, although related species. But the juveniles probably are not able to discriminate between roosts. However, with the respect to the fact that bats are very social animals, it is possible that they learn this ability from the older ones.

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Microclimate or bat bugs (Cimicidae): possible cause of roost switching by vespertilionid bats

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Recent studies show that females of bat species roosting in tree cavities and buildings are not restricted to one shelter. The same maternity colony may be spread among multiple trees on a given night or concentrated in one roost, usually a building, conforming with a fission-fusion model (Kerth & König 1999, Willis & Brigham 2004). The motivation underlying roost switching and reasons why groups change a roost or disperse among several roosts is not well understood (Lewis 1995, Vonhof & Barclay 1996). Roost switching might force social relationships among small „subgroups" that comprise one larger group. However, dispersion of colonies among tree cavities and bat boxes may result from a complex of different constraints. Typically, groups of females leave their respective roosts in early June and move to the main nursery roost few days before parturition. They move back to their previous roosts with flightworthy juveniles in mid-July (Swift 1980, Webb et al. 1996). Roost switching and dispersion may reflect differences in group size between bat species or populations forming large colonies in caves and buildings and those roosting in smaller colonies in trees, perhaps due to thermal differences or to competition for space when the number of individuals is increasing and one cavity is too small (Whitaker 1998, Lefebvre et al. 2003). Roost switching could be a good mechanism by which bats select roost sites with optimal microclimatic conditions (Kerth et al. 2001, Lourenço & Palmeirim 2004). Bats may know alternative roosts, including their general microclimates in advance, because the search for a new roost might be costly in terms of energy expenditure. In addition, there is another hypothesis assuming that by switching roosts the bats avoid the increasing invasion by ectoparasites and keep their individual fitness (Wolz 1986, Lewis 1996).

We attempted to answer the following questions: (i) Do the microclimatic parameters of bat boxes change during the reproductive season? (ii) Do reproductive requirements of bats influence roost switching or roost sharing behaviour? (iii) Are the densities of bat bugs correlated with parturitions of bats? (iv) Can temporary absence of bats in a roost decrease bug densities?

Nursery and temporary colonies of *Pipistrellus pygmaeus* with high densities of bat bugs *Cimex pipistrelli* were monitored in three wooden bat boxes within the Křivé jezero floodplain forest in south-eastern Moravia. The study was performed between April and October of the years 2003-2006. Three wooden bat boxes were studied; two of them were placed on trees inside the forest and at its edge, the third one was placed on a deer-stand at a forest edge. The reproductive season under study was divided into three periods: pregnancy, lactation and post-lactation. The beginning of lactation (7 June) was assessed according to first parturitions in a nearby (14 km) nursery colony of *P. pygmaeus* in a building at Vranovice. We also netted bats emerging from all boxes during the years 2001 and 2002, but never captured males. Therefore we suppose that adult males were absent during our study. The changes in bat activity with respect to the box entrances were monitored continually by passive infrared trail monitors (TM) (TrailMaster, Goodson & Associates, INC., USA) and active infrared (IR) gate. The IR gate allows discrimination between bats leaving and entering the bat box. With the event delay set to 0.1 minutes, the TM is capable of recording 10 events per minute. Data Loggers (Onset Computer Corporation, USA), continuously recorded the temperature (internal and external) and the internal relative humidity. Monitoring of bat bugs was carried out by manually sampling from inside the box roof and recording the activity of insects by a videosystem (B/W AVC 307R+12 IR diode). In each of the three boxes, the IR diode camera monitored a particular inside area (3 x 10 cm) and recorded the relative activity of bugs in 30 min periods. All monitoring was carried out regularly in 10-day periods just before most bats left a particular bat box to limit the effect of human disturbance. Each sample of bat bugs was divided into four groups: (1) adults, males and females together, (2) 1^{st} – 3^{rd} instars, (3) 4^{th} and 5^{th} instars, and (4) eggs. Bug movements within the experimental inside area scanned by the camera were counted regardless of the groups. During the two growing seasons, the three bat boxes occupied by soprano pipistrelles (*P. pygmaeus*) were monitored for 262, 304 and 230 days, respectively. For each day, hourly values were available of internal temperature, internal humidity and the level of bats' activity. The number of bats roosting in a box was counted via passive TM and/or active IR gate. The samples of bat bugs (*C. pipistrelli*) were taken on 19 occasions.

In the GAM models, relative humidity, external temperature and number of bats together described 87.1% of variability of the internal temperature. The impact of reproductive stage and exposure of bat box was insignificant. The number of bats in the box explained only 29 % of the residual variability of internal temperature (holding constant external temperature and internal relative humidity). Nevertheless, we found a negative correlation between the internal temperature and the number of bats roosting in the box the next day (Bartonička & Řehák 2007, Fig. 1). High value (52.6%) of described variability of internal relative humidity (holding constant external and internal temperature) showed positive correlation with the number of bats roosting in a box.

Intraseasonal differences in microclimatic parameters (internal and external temperature, relative humidity) were evaluated with respect to the reproductive periods using only days with the presence of bats. Only small differences in internal temperature and relative humidity among the periods (pregnancy, lactation, post-lactation) were found. The negative correlation between low internal temperature and presence of a large number of bats could also be the consequence of their flying off when the bat box was overheated. It seems that high internal temperature is the factor restricting occupation of roosts during pregnancy and lactation periods (Weigold 1973). Generally, we cannot assume that box overheating is a possible risk, because the test of internal temperature between occupied and non-occupied boxes was insignificant. But we always found boxes empty when internal temperature exceeded 40 °C (cf. Kerth et al. 2001, Lourenço & Palmeirim 2004). Finally, our results did not show more days when the boxes were overheated during lactation compared to other parts of the reproductive season. High internal temperatures therefore cannot explain the low number or absence of bats during this period.

The differences in the numbers of bugs and presence of bats among 19 checks were statistically significant. Two peaks in the occupancy of boxes by bats were recorded, in May and August. Pregnant females used these roosts before parturition and some of them returned with flightworthy young (Bartonička & Gaisler 2007, Fig. 2). During the pregnancy of bats until the parturitions in mid-June, a significant increase in the number of bat bug eggs was recorded. A significant decrease was found from early June until the end of July. No bug eggs were found on subsequent checks (Fig. 2). The number of adult female bugs, surviving from

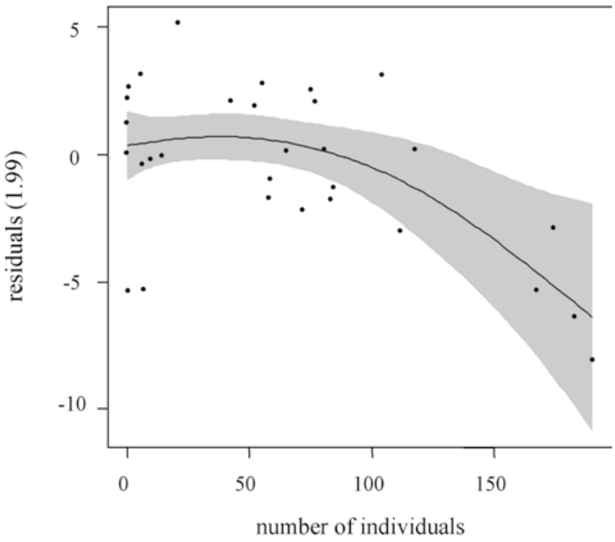

Fig. 1. Graphic output of a generalised additive model for the number of bats in bat boxes, holding all other predictors (external temperature, humidity, localization of bat boxes, seasonal aspect) constant at their mean value. 95% confidence limits for the function are also shown as grey zone. Degrees of freedom are labelled in brackets on a y axe.

previous winter, decreased until mid-June when they died out. Only nymphal stages were present in the boxes during the first half of August. A rapid increse in the number of adult bugs was registered after the bats, mainly young ones, returned to the boxes in mid-August. Only adults survived the winter period. Two peaks in the presence of bats were distinct throughout the season. The first peak during pregnancy, however, was insignificant. During the lactation period, the number of bats in boxes was very low. A significant increase was found from the beginning of July until the second half of August. During the period in which the bats were absent (lactation, June), a rapid dying of early stages of bugs (1^{st} – 3^{rd} instars) was recorded. After all bats had left, the abundance of this bug group decreased to a half in 9 days. A similar decrease in the number of 4^{th} – 5^{th} instar bugs was observed in 16 days. Likewise, the number of adults decreased to less than a half during the absence of bats. In general, the population of bat bugs survived the summer absence of bats in the egg and nymphal stages.

To conclude, the study did not show that bats leave bat boxes at the beginning of lactation due to different microclimatic needs during this period, but suggests that pipistrelle bats leave their roosts to prevent the massive reproduction of bat bugs by temporarily abandoning particular roosts. Nevertheless, they are unable to rid their roosts of the ectoparasites completely, which is the obvious consequence of co-evolution of *Pipistrellus* bats and *Cimex* bugs under the conditions of the temperate climate.

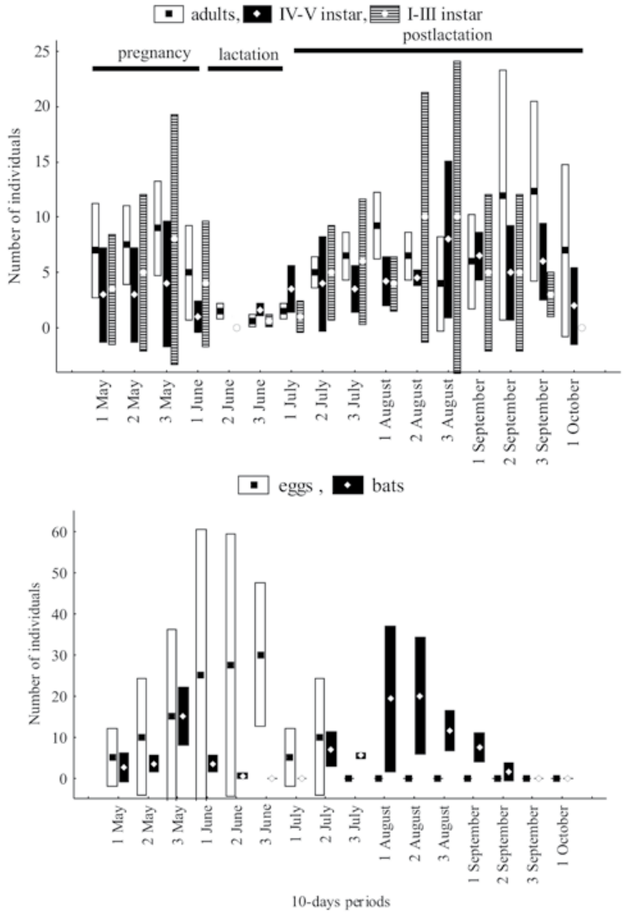

Fig. 2. *Changes in numbers of bat bug aduts, all instars and eggs, and numbers of bats; mean - central tendency, standard deviation - large box.*

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Roost switching and activity pattern of the soprano pipistrelle *Pipistrellus pygmaeus* revealed by radio-tracking

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Discovery of the systematic status of the newly validated species *Pipistrellus pygmaeus* is interesting, however little is known about its ecology, in particular its activity pattern and roost strategies. Females of *P. pipistrellus* sensu lato often switch roosts over the season (Thompson 1990, 1992). Pregnant females usually inhabit more temporary and cooler roosts, moving to one main parturition roost a few days before parturition (Swift 1980; Webb *et al.* 1996). In England and Scotland, large nursery colonies of *P. pygmaeus* rarely switch roosts (Haddow 1993), while individuals from less numerous nursery colonies in central Europe switch their roosts more often, as found in *P. pipistrellus* (Feyerabend & Simon 2000). Our preliminary results suggest that the nursery colonies of *P. pygmaeus* occurring in the floodplain area of south-eastern Moravia change roosts during the summer.

Contrary to *P. pipistrellus*, which occupies buildings in urban and rural habitats in almost 95% of cases (Simon *et al.* 2004), *P. pygmaeus* prefers forest and wetland habitats (Barlow & Jones 1999). However, nursery colonies of the latter were often found also in buildings (Park *et al.* 1996; Oakeley & Jones 1998; Sattler *et al.* 2003). In the Czech Republic, most records of *P. pygmaeus* come from low altitudes. The main range of this species is in the lowlands of Moravia and central Bohemia and in fishpond basins in southern Bohemia, where the bat prefers floodplain forests and other wetlands in the alluvial plain of large rivers as well as pond landscapes (Bartonička & Řehák 2004). Regarding the relatively high foraging activity of *P. pygmaeus* in well preserved floodplain forests, we expected that pipistrelles would use natural tree hollows or similar types of roosts such as bat boxes, hiding in them more often than in buildings. In our study we focused on whether *P. pygmaeus* switched its day roosts as often as *P. pipistrellus* throughout the lactation period (Bartonička et al. 2008). Further we described the movement patterns and habitat selection of females tagged in two nursery colonies of *P. pygmaeus* and considered whether the number of night/day roosts and frequency of roost switching were an important factor for monitoring and conservation of pipistrelle bat populations. The last topic of our study was to describe other activities connected with possible energetic costs during lactation.

Fieldwork was carried out in south-eastern Moravia. One nursery colony roosted under the roof of a pheasantry, a brick building in the vicinity of the village of Vranovice, in an oak wood forest along the Svratka River. The surrounding landscape is characterized by patches of woodland, linear vegetation, and fields. Another colony roosted in a guest-house in the village of Nové Mlýny, situated in the neighbourhood of the old-growth floodplain forest along the Dyje River. Between June and July 2004 and 2005 bats were netted when emerging from a colony roost, but only visibly lactating females were individually tagged. After capture, the bats were equipped with 0.38 g radio-transmitters (Holohil Systems Inc. Carp, ON, Canada). The minimum life of transmitter batteries was 8 days. The locations of the tagged bats were recorded throughout the night by two methods 1) triangulation when two mobile workers co-ordinated their movements by hand-held FM radios or cell phones, and 2) „homing-in“ on a bat.

We studied roost switching and habitat selection of 16 *P. pygmaeus* females tagged in two nursery colonies. There were differences in overnight roosting and flying among night thirds (early, middle and late). The highest foraging activity was recorded at the beginning of the night (1st third), whereas foraging activity decreased during the following thirds. A significant increase in roosting activity was recorded during the 2nd third. Roosting activity was as high in the 2nd as in the 3rd night period. The comparison of habitat use in the core foraging areas (50% contour line of the fixed kernel estimation) with colony range showed that bats preferred edges and water bodies to forests and open fields. The colony range covered mainly fields and pastures (56.8%) and woodlands (30.7%, Fig. 1). The composition of habitats did not differ between the colony range and the availability of foraging habitats. The highest foraging activity was observed over water bodies, at forest edges and near streetlamps. During each night, each female visited at least one night roost, and five females visited two roosts regularly,

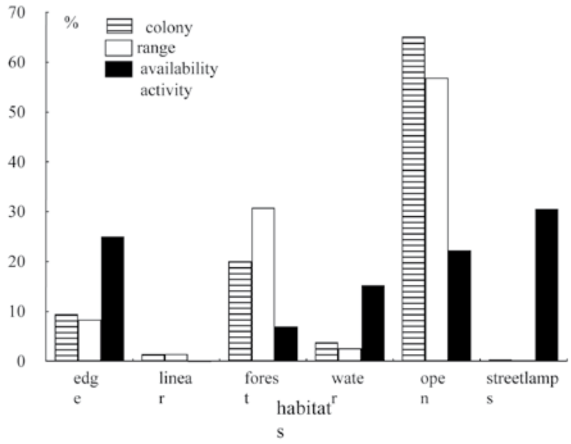

Fig. 1. *Habitat use by Pipistrellus pygmaeus. Comparisons of habitat availability versus habitat use are based on the minimum convex polygon of all females versus the level of activity (mean percentage) per individual. Habitat selection was investigated only for females from colony A, n = 11.*

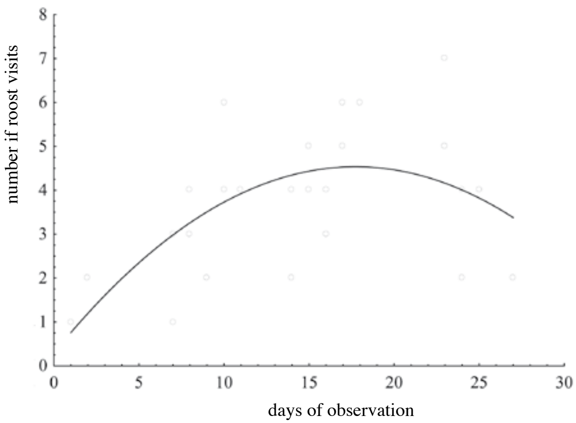

Fig. 2. *Number of roost visits per night during the whole lactation period. A quadratic polynomial ($R^2 = 0.45$, $F = 24.13$, $p = 0.01$) describes, significantly, the increase in number of roost visits at the beginning of lactation and the decrease at the end of lactation. X-axis legend: number of days after finding the first young.*

i.e. on 28% of the nights. On average, a female visited a roost 3.7 times per night. We found the increase in numbers of night roost visits at the beginning of lactation and the decrease at the end of lactation (Fig. 2). In all, 13 roosts were found in tree cavities and only two in buildings (the main daily roosts of the two colonies). The first nursery colony used six different day roosts, while the second only three roosts during the study period. After parturition, the distances between night roosts and day roosts increased. Some females transported their offspring to new roosts at night based on the observation of flightless young in new roosts. Our results support the hypothesis that females may change their roosts because alternate roosts are closer to attractive foraging sites (e.g. Feyerabend & Simon 2000). The distance between the first night foraging site and previous day roost was always longer than the distance between the subsequent night foraging site and the new day roost. For lactating females, transporting young and depositing them in a temporary roost within the hunting ground can be less costly than flying back and suckling the young in a distant nursery shelter.

Our data show that it is extremely difficult to determine the actual size of a *P. pygmaeus* colony in central Europe because females use more than one roost simultaneously. By contrast, numerous pipistrelle colonies in England do not switch roosts for most of the reproductive season (e.g. Davidson-Watts & Jones 2006). This fact is very important especially in view of long-term monitoring programmes in which the size of maternal colonies is considered a basic index of population dynamics. After lactation began, some females visited roosts occupied by vocalizing male *P. pygmaeus* and in one case simultaneously with male *P. nathusii*. Four lactating females visited sites where we recorded songflight calls of *P. pygmaeus*. We concluded that they might have been uttered by a male flying along the same flight route (Barlow & Jones 1997) although male advertisement calls were registered later, after weaning the young. Lactating females must be able to invest some of their stored energy in visits to male territories even during lactation, a period of highest energetic cost.

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Variability of pipistrelle echolocation calls. Can bats, foraging in a group, change parameters of their signals?

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Precise determination is practically impossible between European bat siblings within most of such species couples (*Plecotus auritus* vs *P. austriacus*, *Myotis mystacinus* vs *M. brandtii*, *Myotis myotis* vs *M. blythii*), when only their echolocation signals are involved. However, this is not the case of the cryptic species *Pipistrellus pipistrellus* and *P. pygmaeus*, that have been primarily distinguished according to their different ultrasound vocalizations (Ahlén 1990, Jones & van Parijs 1993). Echolocation signals with the peak frequency of 45 kHz were allocated for *P. pipistrellu*s, a taxon that has been considered valid for roughly 200 years. Signals with peak frequency of ca 55 kHz and differences recorded on the mtDNA level resulted in the definition of another species for which the name *P. pygmaeus* was applied (Barratt et al. 1997). The taxon *pygmaeus* was not new but it has been chosen from two names considered synonyms of *P. pipistrellus* and eventually accepted by the scientific community. At present, differences in peak frequency of echolocation calls still are in use when the two species have to be recognized in the field. Yet our research revealed that the peak frequency can vary due to a number of factors and even the difference of ca 10 kHz between the two species is sometimes insufficient to distinguish them with certainty (Bartonička & Řehák 2005).

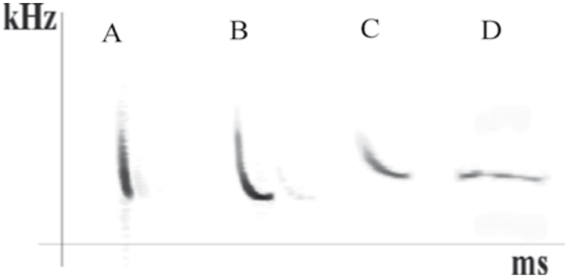

Fig. 1. *Proportions of particular types of signals divided by frequency-modulated component. On the x-axis are particular habitats: A – cluttered, B - side-cluttered, C - semi-cluttered, D - uncluttered space.*

In the first part of our study association of signal types with habitat structure (cluttered, side–cluttered, semi-cluttered and uncluttered space) was found in echolocation sequences of the search phase of flight. We focused on echolocation behaviour and signal structure of the newly defined species, *P. pygmaeus*. Its signals were studied in different habitats of a floodplain forest in south-eastern Moravia. Calls (nearly 500 observations) were recorded in different sites between April and mid June (before weaning) using a time expansion bat-detector. *P. pygmaeus* used mainly narrowband signals (bandwidths less than 15 kHz) in uncluttered space and wideband signals (more than 15 kHz) in cluttered space (Fig. 1). Almost 6% of the inter pulse intervals of signals were twice (or more) longer than usual inter pulse intervals (mainly in uncluttered space). In general, temporal variables of signals reached higher values in uncluttered spaces (except for inter pulse interval) than in cluttered ones. On the contrary, spectral variables of signals reached lower values in uncluttered habitats in comparison with cluttered ones. In addition, the signals were less variable in open spaces compared to cluttered and partly-cluttered habitats. We also studied the accuracy of identification of pipistrelles by call parameters and possible misidentifications in relation to habitat structure. Multivariate discriminant analyses were carried out on the time and frequency parameters of calls produced by pipistrelles. Analysis showed that 7.7% signals of *P. pipistrellus* had peak frequency over 50 kHz in uncluttered habitats. In uncluttered habitats *P. pygmaeus* emitted signals with low values of peak frequency, under 50 kHz (7%). Therefore, misidentification of *P. pygmaeus* due to the confusion with *P. pipistrellus* is more likely when the type of foraging habitat is unknown. Therefore, disregarding habitat conditions may cause a confusion of the two species.

Second part of our experiments was focused on the syntopic occurence of more species. Pipistrelles have a marked narrowband part of their echolocation calls and are able to avoid possible jamming, caused by the orientation pulses of their conspecifics, by shifting the frequency so that the echoes are not masked by calls or echoes from conspecifics. Echolocation behaviour was

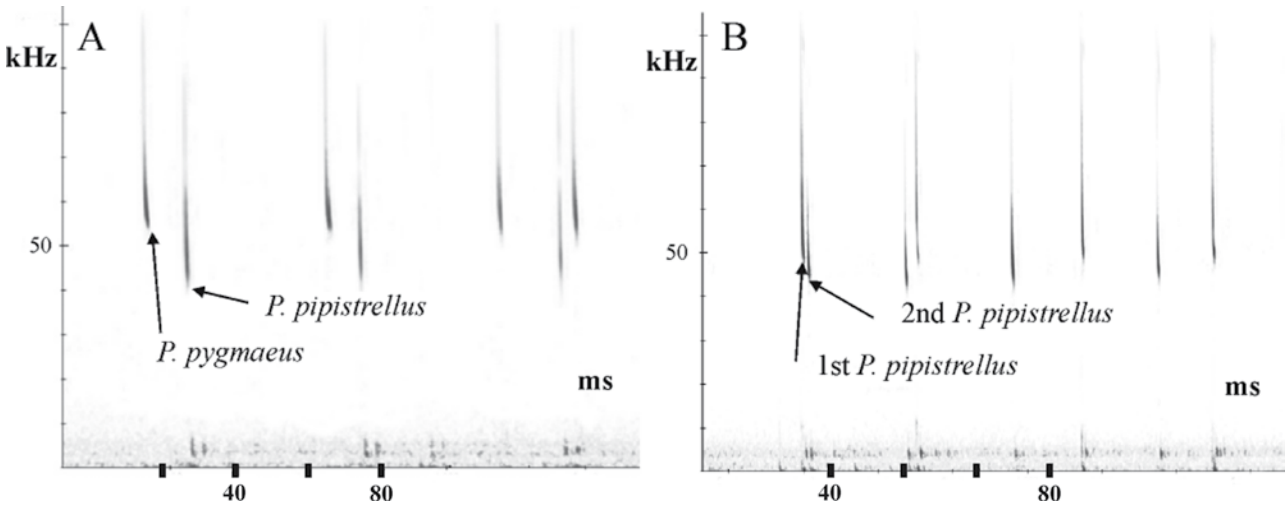

***Fig. 2.** Representative sequences (in spectrograms) of the two Pipistrellus species studied, A – flying in a mixed species group, B – flying in a monospecific group (only P. pipistrellus) at roughly the same direction and distance from the microphone.*

influenced by the presence of conspecifics and individuals of the other species. Individuals of *P. pygmaeus* emit signals with higher spectral variables during foraging in a group than during individual foraging. Echolocation behaviour and the structure of calls of *Pipistrellus pygmaeus* and *P. pipistrellus* were studied by using a time expansion bat detector. Echolocation signals were recorded in the field in south-eastern Moravia and northern Bohemia (Czech Republic) and in an ad hoc experimental laboratory. For each of the species, multivariate analyses of variance indicated significant differences between calls produced inside the experimental room and that in the open and the records were also used to reveal influences of inter-individual contacts in each of the cryptic species on the spectral patterns of call variables. Differences were found in the spectral variables of echolocation calls of an individual flying in the room alone and in a group of conspecifics. The possibility that bats use their flexibility to avoid mutual disturbances of echolocation calls was tested. We found that bats flying in a group modify the parameters of their echolocation signals according to the presence of other individuals of the same species (Fig. 2). These differences can indicate jamming avoidance and recognition of own echoes. However, they did not change the parameters if individuals of another species were present. Social calls are more frequent when bats fly in a species-mixed group than in a monospecific group.

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Abandoned mines near Dubník - the most important bat hibernacula in Eastern Slovakia

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The area of Eastern Slovakia is quite unique and bio-geographically a very interesting territory within Central Europe. Concretely, it is the area between Western and Eastern Carpathians, a lowland and hilly zone connecting the Pannonian basin with its sub-Mediterranean biota with the area of Eastern European steppe zone reaching to Southeastern Poland. All the different elements from the Carpathians, Pannonia and Eastern Europe contribute to the specificities of this zone. This unique aspect is evident also on the structure of the bat fauna in this area. The results from a long-term study of the most significant hibernacula in this area and one of the largest hibernacula in Slovakia - the abandoned mines near Dubník in Slanské vrchy Mountains - provide very reliable information on this subject.

Site History and Description

The abandoned opal mines are located in the northern part of Slanské vrchy near Dubník. Opal mining on this site ended in 1922 and since then all the underground space has been abandoned. It consists of the mining site Libanka approx. 37 ha large (length of tunnels approx. 20 km), to which 11 surface blind mines (total length of approx. 2 km) belong, and from the mining site Malá Šimonka approx. 8 ha large (length of tunnels up to 5 km), which is 2.5 km away from Libanka.

First Bat Research

With respect to chiropterology the Libanka mine was discovered in 1960 by J. Palášthy and F. Olejár, who were monitoring it in the first phase until 1962, in addition to one blind mine (Palášthy & Olejár 1963). During this period they discovered eight bat species with the following abundance: 2174 *Barbastella barbastellus* (the most abundant cluster had 600 specimens), 685 *Rhinolophus hipposideros*, 150 *Myotis myotis*, 96 *M. emarginatus*, 15 *M. blythii*, 11 *R. ferrumequinum*, 2 *Eptesicus serotinus* and 1 *Plecotus auritus*, altogether 3119 specimens but only in one not concretely specified area. In the next study phase during the years 1963-1969 Palášthy (1969) discovered other bat species on this site (*M. daubentonii*, *M. mystacinus* s. l., *E. nilssonii* and *P. austriacus*), altogether 12 species. The *E. nilssonii* was found in the Malá Šimonka mine. The author did not publish other data about the abundance on this site, only banding results.

Bat Monitoring in 1984–2010

Danko started to do systematic research on this site in 1984. He started to band all the bats found in 1988. Through a meticulous control of all the tunnels he gradually discovered new parts of the mine, practically 100% by the year 1994. He started to systematically monitor the Malá Šimonka mine in the year 1993. In 1996 a new part of it was discovered and since then the whole mine is being monitored. The results of the bat census until the winter of 1996 were published by Danko (1997). During a study in 1987 he discovered new species on this site, *M. bechsteinii* and *M. brandtii*, in 1992 *M. dasycneme* and in 1995 *M. nattereri,* which increased the number of species of hibernating bats in Dubník to 16. Since 1993, he did the monitoring together with Pjenčák and they published together the results up to 2001 (Pjenčák & Danko 2002a, b). Since 2006 only Pjenčák alone has been monitoring the site. In spite of great efforts, it was not possible to monitor all the underground space every winter, therefore in Graphs 1-7 are presented only those years where the entire space was thoroughly monitored (only with some small exceptions). The graphs represent the population trend (the progress, or actually regress) of the most abundant species in the entire territory of the Dubník site.

The most recent bat census was done using a unified method on the same routes always in the months of January and February. Considering the fact that it was done completely differently and in different parts of the underground space than previously, the results cannot be compared with those of Palášthy. Only in the species *Barbastella barbastellus*, it is evident that it was more abundant in the past than in the present. Its abundance was

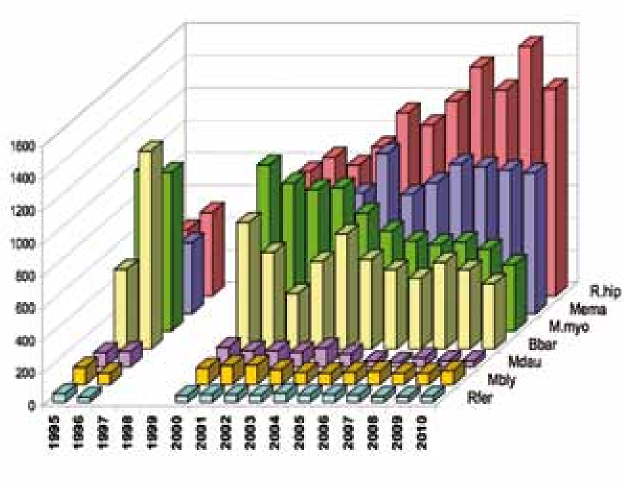

***Fig. 1:** The abundance changes in the total hibernating population of seven most common bat species as indicated by the regular winter census controls from 1984 to 2010.*

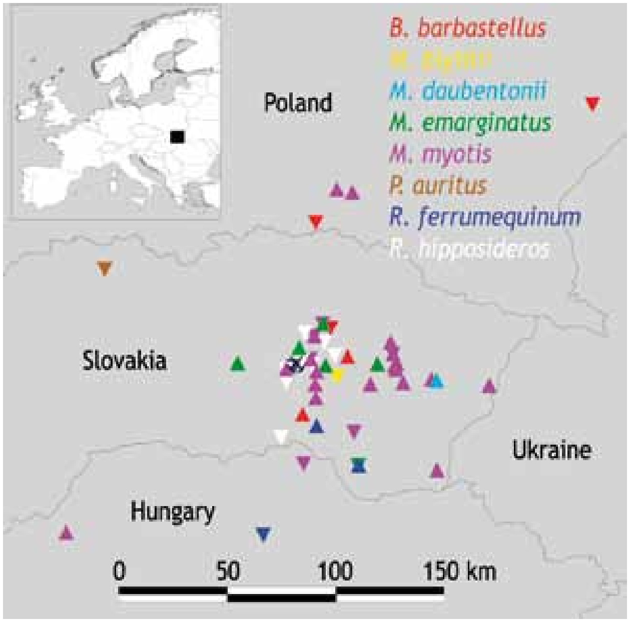

***Fig. 2:** Foreign recoveries of the banded bats from Dubník. Upper pointed triangles: banding sites of bats recovered in Dubník, lower pointed triangles: recoveries of bats banded in Dubník. The numerous movements shorter than 10 km are not indicated.*

***Fig. 3:** Entrance of the mine Jozef in Libanka. Foto: Š. Danko.*

***Fig 4:** Cluster of Myotis blythii with one individual of M. myotis. Foto: Š. Danko.*

***Fig 5:** Cluster of Barbastella barbastellus. Foto: Š. Danko.*

Fig 6: *Cluster of Myotis emarginatus. Foto: Š. Danko.*

Fig 7: *A group of R. hipposideros with two individuals of R. ferrumequinum. Foto: Š. Danko.*

estimated in 1962 only in the Libanka mine at more than 2000 specimens, while during our research since 1985 we have registered the highest number of 1221 specimens in all of Dubník in 1996. In our opinion the cause of the abundance drop was the intense banding of this species (1963–1970 Palášthy and 1984–1988 Danko) and after the opening of the lowest mine entrance, the lower, cold parts of the mine, where this species hibernated, were warmed up, therefore the bats abandoned the original locations. In spite of the fact that the hibernating specimens have been monitored since 1989 only visually, their numbers in various areas have been strongly fluctuating. Palášthy & Olejár (1963) indicated the *Rhinolophus hipposideros* as the second most abundant species in 1962 in the Libanka mine. In 1994 this species was not very abundant but gradually over the years its abundance has multiplied more than fivefold, which made it the most abundant bat species in the entire hibernaculum. On the contrary, an abundant bat species in the past was the *Myotis myotis* with a maximum of 1027 specimens in 2000 but since then its abundance has been decreasing and in 2009 it was only the fourth most abundant species. *Myotis emarginatus* is a significant species in the Dubník site. In 1962 it was the fourth most abundant species in the Libanka mine, but Palášthy (1972) discovered another hibernaculum in another mine under the Dubník hill where 120 specimens hibernated in 1970. We are presuming that it was the Malá Šimonka mine. In the most recent period, 154 specimens hibernated in the Libanka mine in 1994 and there was a maximum of 458 specimens in 2004. A more significant hibernaculum of this species is the Malá Šimonka mine where 243 specimens hibernated in 1993 and a maximum of 532 specimens in 2004. On this site the bats most often hibernate in clusters, the largest cluster was made up of 53 specimens. This is a progressive species where its abundance grows gradually over the years. A maximum number of 990 specimens was registered in the entire Dubník area in 2004 (Graph 4). A significant underground space for hibernation of this species is also the 220 m Dubník blind mine, where only 19 specimens hibernated in 1987 but their number gradually increased to a maximum of 86 specimens in 2006. A significant hibernating species in Dubník is *Myotis blythii,* the fifth most abundant. In 2002, a maximum of 100 specimens hibernated in the Libanka mine and in 2002 it was 119 specimens in the entire territory. But since then its numbers have strongly declined (68 specimens in 2009). During the research done by Palášthy the *Myotis daubentonii* was a very rare hibernating species that he found for the first time in 1964 and then in 1967, only one specimen each time. In 1995 at least 88 specimens hibernated in all of Dubník with a maximum of 120 in 2000. In recent years its abundance has significantly dropped, however. The last of the more abundant species is the *Rhinolophus ferrumequinum*, most often hibernating in the Libanka mine with a maximum number of 53 specimens in 2004 and 55 specimens in the entire territory in that same year. From the remaining species the *Plecotus auritus* hibernates in small numbers (a maximum of 31 specimens in 1995 and in the recent years there is a strongly decreasing tendency), the other species hibernate irregularly (with the exception of the *Myotis dasycneme* that since 1994 has had 4-11 specimens) and in small numbers.

Importance of the site

The Dubník mines are right after the Slovakian Karst the most significant bat hibernaculum in Slovakia. The Malá Šimonka mine is the most abundant hibernaculum of the *Myotis emarginatus* species, followed by the *M. myotis* and *M. daubentonii* species. The Libanka mine is the most abundant hibernaculum for the *Rhinolophus hipposideros, Myotis myotis* and *M. daubentonii* species, followed by the *M. emarginatus* and *M. blythii* species in Slovakia, and that is why the Libanka mine site was declared a protected area in 1964.

The long-term banding brought us results also about the age of individual species after being banded – *Myotis emarginatus* 22.5 years, *M. blythii* 22 years, *M. myotis* 19.5 years, *Rhinolophus ferrumequinum* 19 years, *Plecotus austriacus* 19 years, *Barbastella barbastellus* 17 years, *M. daubentonii* 17 years, *M. nattereri* 9 years and *M. dasycneme* 8.5 years.

An analysis of the banding recoveries (Fig. 2) confirms the expectation that the source area for the hibernaculum under study covers not only the mountainous slopes of Western Carpathians but also East Slovakian lowlands and those in SE Poland. In that respect the structure of the hibernating populations characterizes quite well the major biogeographic specificities of the region.

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The lesser horseshoe bat's tale

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The lesser horseshoe bat (*Rhinolophus hipposideros*) has been a common bat species within the territory of former Czechoslovakia, in particular in Moravia and certain regions of Slovakia. Therefore a field and laboratory study was launched, aimed at postnatal growth and development, ecology, activity and reproduction of that species. After preliminary sampling in 1954-1956, the bulk of material was gathered and processed (banding and recapturing, measuring of juveniles, histological examination of male and female genitals, etc.) in 1957-1960. The resulting Ph.D. thesis was written in Czech but of nine papers, having originated from it, six were published in English (Gaisler 1963a, b, c, 1965, 1966, Gaisler & Titlbach 1964) and one in German (Gaisler 1962). Subsequently, further nine studies were published, based on additional material of several bat species, but with *R. hipposideros* as the main or important research subject (Klíma & Gaisler 1967, Gaisler & Klíma 1968, Gaisler & Hanák 1969a, b, Gaisler 1970, 1991, 1997, Gaisler & Chytil 2002, Gaisler et al. 2003). This contribution is a brief summary of the data reflecting biology of *R. hipposideros* in the 2nd half of the past century, as recorded chiefly in Moravia, the eastern part of present Czech Republic.

Material and methods

Body mass, wing area, seven external and one cranial measurement were recorded in 60 living juveniles (incl. recaptures) and 45 juvenile and 11 subadult specimens at autopsy. The course of growth of juvenile pelage was followed in 23 fetuses, 11 juveniles and 5 adults. To study ecology, the occurrence of *R. hipposideros* was ascertained at 98 localities of which two summer and winter roosts (castles) were checked 21-23 times, two summer roosts 9-16 times and one hibernaculum (a set of galleries and caves) 34 times, and a total of 4,280 individuals were examined. The activity was recorded by direct observation of departures from and returns to a shelter of small maternity colony (7 adults, 4 young), by seven checks between 9 April and 8 October, and to a pre-hibernation shelter of an unknown number of individuals (but > 30) in a cave, by checks on 8/9 April and 27/28 October. Several climatic factors were registered during both ecology and activity studies. Sex ratio was recorded in 29 intrauterine fetuses, 275 unfledged young, 778 subadult and 1328 adult individuals. To study the reproduction at autopsy, 45 adult and 19 young males, as well as 56 adult and 29 young females were examined. In all specimens their colour and the appearance of their external genitals were first recorded, in females also the size of their false (pubic) nipples. The testes, epididymides and the unpaired urethral glands in males and the ovaries, oviducts, uteri and vaginae (incl. vaginal plugs if present) in females were examined histologically. Additional information concerning the process of reproduction was obtained during the field work, especially by banding and recapturing banded bats. In total, 6,172 individual *R. hipposideros* were banded on the territory of the Czech and Slovak republics within the years 1948-2000. The number of recaptures amounts to 1115 (18.07 %) and that of recaptured individuals to 851 (13.79 %).

Results and discussion

Postnatal growth is fast during the first 30 days after birth and the young start to fly at the end of this period, at first inside the shelter. With respect to the total length (body + tail), positive allometry was found in the growth of forearm and the 2nd to 5th fingers respectively, and negative allometry in the growth of the 1st finger and foot. Fledged young continue to grow until their age of about three months. No significant difference was found in the forearm lengths between young of the year and older animals in a sample (n = 1288) from hibernating quarters. Unfledged and still growing fledged young are proposed to be designated **juveniles**, grown-up yearlings until the end of their first hibernation and shortly thereafter **subadult**, all elder bats **adult**. Formation of pigment spots and hair follicles begins during intrauterine life and vibrissae are the first hairs to appear in fetuses. Newborn *R. hipposideros* show body covered with well developed pelage and the growth of the pelage is largely terminated before the first hibernation. No molting could be recorded at that time. Juveniles and subadults are characterized by their grey pelage in contrast with brown pelage of adults.

It seems that no supplement information concerning the postnatal growth and development of *R. hipposideros* has been published (cf. Roer & Schober 2001). Some problems need further investigation, e.g. that of molt timing and teeth development. Apparently, all horseshoe bats shed milk teeth before birth (Nowak 1994). Yet nothing has been known about the development of permanent teeth in *Rhinolophus* species. Schofield (2008) has recently written that „pups grasp the pelvic nipples (of their mothers) with their teeth“. The question is at what age of the pubs do their teeth erupt from the gum.

The habitats of *R. hipposideros* may be divided into summer roosts, hibernating quarters, temporary shelters and hunting grounds. Summer roosts include lofts of buildings, underfloor spaces, chambers, corridors and similar rooms in the same buildings, boiler rooms and channels of central heating in TBC sanatoria, cellars of buildings, caves and abandoned mine galleries. Summer maternity colonies are confined to buildings, in only one case a nursery colony was found in a small cave in eastern Slovakia. Typically maternity colonies roost in buildings which allow them to shelter in two different places: *a*, with fluctuating temperature reaching high values (up to 42 °C) during hot summer days; and *b*, with rather constant temperature (10-20 °C) (Fig. 1). During the day, breeding females prefer to roost in places *a* maintaining high body temperature, while non-breeding females and solitary males, if present, roost in places *b* and are torpid. When the weather is cold, even breeding females can gather in a *b* place and be torpid. Alternatively, highly pregnant or lactating females with small pups form clusters in order to prevent torpidity. The complicated problem of close relation betweenthe microclimate in shelters and the physiological state of horseshoe bats (various components of a population) was dealt with by Kolb (1950, 1954), Ransome (1990) and other authors with results similar to that in our study. Schofield (2008) studied the clustering behaviour of *R. hipposideros* females using infra-red video cameras. To determine the temperature maintained within a cluster, a temperature probe was placed at the apex of a roof where a colony was known to form a cluster with a control probe placed 0.5 m away. He found that the mean cluster point temperature, 30.9 °C, was on average 14.6 °C warmer than the control point.

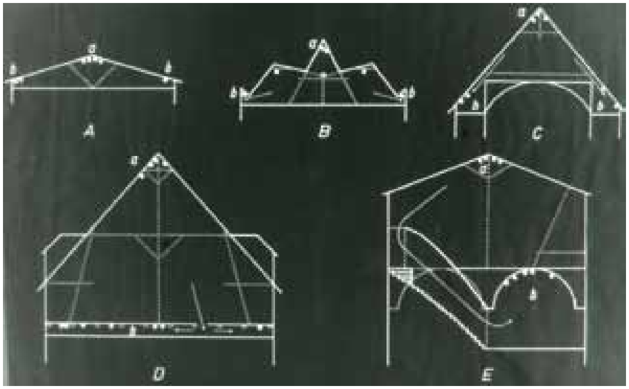

Fig. 1. Scheme of the summer roosts of R. hipposideros in buildings. A – hunting pavillions (without the underfloor space); B – hunting pavillions (with multipartite roofs); C – living houses with inaccessible attics; D – lofts with the underfloor space (the most frequent type); E – lofts and unoccupied rooms of old buildings; a – roosting sites of active individuals; b – roosting sites of torpid individuals; the arrows indicate shifts from places a to places b, dots indicate roosting bats.

Except in artificially heated cellars, mostly males and not breeding females roost in both natural and man made underground spaces. Entrance parts of underground spaces and unoccupied rooms in buildings are used as temporary quarters where individuals stay for a short time (days or weeks) between their movement from winter quarters to summer roosts, or back. All bats roosting there are torpid but they leave to feed at night. Temporary roosts are used mainly in April and October but in places *b* of summer roosts some individuals may stay until late autumn, the last record having been made on 22nd November. Caves, galleries, protected but unheated cellars and similar underground spaces are used as hibernacula. Hibernating *R. hipposideros* do not touch each other. The range of 4-12 °C was recorded close to torpid hibernating bats. Single active (flying!) individuals were observed in the hibernating quarters even throughout the winter. Parks, deciduous and mixed woods, bushy vegetation in kars grounds and immediate vicinity of buildings are supposed to be foraging habitats of *R. hipposideros*. This, however, has mostly been inferred from the situation of summer quarters. New data (Beck et al. 1989, Bontadina et al. 2002, Schofield 2008, etc.) show that the primary foraging habitat for lesser horseshoe bat is broadleaf woodland, including streams with riparian vegetation. Radio-tracking also revealed that tree-lines, hedgerows and similar linear structures are important as flight paths to this species with high frequency calls (105-115 kHz) that attenuate rapidly.

Foraging activity of *R. hipposideros* is strictly nocturnal. Prior to the departure, bats undertake light-sampling (sensu DeCoursey & DeCoursey 1964) in the form of brief flights out and back into the roost, which was observed both in the cave and in the loft. Within a year, both evening departures from, and morning returns to, the shelter depend on times of sunset and sunrise and the nocturnal activity outside the shelter lasts from sunset to sunrise approximately. During the night, however, individual bats return at times and depart again. At the time of the first departure, light intensity was 60-0 lux, at the time of the last return, 0-39 lux. Nocturnal activity is inhibited by heavy rain. Although the results have potentially been biassed by the small size of the summer colony observed, they are in good accordance

Fig. 2. Two embryos and a placenta in the uterus of a pregnant female, May. Heidenhain's iron haematoxylin, 40 ×.

with later observations in Ireland, based on larger material and using a bat detector and occasionally an image intensifier (McAney & Fairley 1988).

In adult males, the spermatogenesis commences in spring and culminates towards the end of July and in August. During the months December to April, the seminiferous epithelium of the tubules of testes is resting. On the contrary, the interstitial cells of Leydig are conspicuously developed in the period from October to April (or May). Towards the end of August and in September, the tubules of the cauda epididymidis begin to be filled with spermatozoa, being overcrowded with them in the period from October till April. In addition to current accessory sexual glands, male *R. hipposideros* possess a conspicuously developed gland, discovered by Robin (1881) and termed glandula urethralis. This gland is the greatest element of the male genital tract, being at the peak of its secretory activity in October and November. Urethral gland secretion is probably essential for the origin of female vaginal plug. According to the incidence of vaginal plugs, mating takes place from late September to November but can occur later.

In adult females, follicle development starts in September but rests over winter. Ovulation takes place in April after the end of hibernation. Pregnancy lasts for about $2^1/_2$ months, lactation for 4 to 5 weeks. Although the uterus of one pregnant female was found to contain two embryos (Fig. 2), our results indicate that the litter size equals one (n = 46 pregnant females, 52 females with young up to one week of age, clinging to their mother's body). While the first signs of estrus appear in females already at the age of 4 months, most of them attain sexual maturity only towards the end of the second year of their life. A small percentage of females, 15.8 % according to banding results (n = 19), reproduce already at the end of the first year of their life. However, some females older than one year do not produce young each year. According to banding results, 6.7 % of adult females (n = 164) do not reproduce. Of the non-reproducing females, about a half are still non-parous, the other half parous. Sex ratio among both the fetuses and the juveniles equals 1 : 1 ($\chi^2 = 0.03$, $P > 0.5$). In samples of subadult and adult individuals, males mostly predominate but this possibly does not reflect actual relations in a population. Our data about the reproduction of *R. hipposideros* correspond to that obtained elsewhere, e.g. in the UK and Ireland (Matthews-Harrison 1937, Schofield & McAney 2008). Csorba et al. (2003) reported about 35 % of females bearing twins in Europe but this was very likely based on unrealistic indirect estimation by Sluiter (1960) (cf. Ransome 1991). Irrespectively of that, our photographic record (Fig. 2) seems to be the only one of a uterus with two embryos in the whole genus *Rhinolophus*.

R. hipposideros was the sixth most often banded bat in the Czech and Slovak Republics until the year 2000, after *Myotis myotis*, *M. daubentonii*, *Barbastella barbastellus*, *Pipistrellus pipistrellus* (incl. *P. pygmaeus*) and *Plecotus auritus*. In a female banded as an adult, the maximum known age of 29 years and 5 months was recorded. In the sample of 243 movements of banded individuals, short movements prevail and the species is classified as sedentary. In several cases, females roosted in one and the same building all the year round. Roughly a half of the recorded movements are up to 10 km distance, and only one tenth are longer than 30 km. The longest movement (112 km) of an adult female, banded in a summer roost in northern Moravia and recovered in another summer roost in southern Moravia, was recorded five years after banding and cannot be considered a migration. Long-term monitoring in a large number of hibernacula resulted in the decrease in numbers of *R. hipposideros* recorded within the second half of the past century. Mass banding and recapturing could have been one of its reasons. Since 1981 hibernating bats are censused without marking or similar disturbance. The numbers of hibernating *R. hipposideros* started to increase towards 1990 and this positive trend has been observed even in the new millenium.

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The bats of Afghanistan

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At the beginning of the second half of the past century, Afghanistan was a relatively safe country. Foreign companies, cultural and scientific institutions and individuals were welcome to work there. Among them zoologists came to Afghanistan and first information was obtained concerning the bats of the country (Zimmermann 1956, Aellen 1959, Lindberg 1961, 1962, Meyer-Oehme 1965, 1968). On ground of a bilateral agreement, several Czech zoologists and parasitologists could visit the country for a couple of weeks in 1965-1967. In addition to other activities (e.g. lecturing), they collected animals, mainly insects and small mammals. The greater part of material and data concerning bats were gathered from March till early May, 1967, by D. Povolný (the head), Z. Šebek, F. Tenora and J. Gaisler in eastern Afghanistan, and in May of the same year by Povolný and Gaisler in the north of the country (Povolný 1967, Gaisler et al. 1967). The material was subject to the study of faunistics and taxonomy, with remarks on ecology (Gaisler et al. 1968, Gaisler 1970a), further two papers were addressed to zoogeography and distinguishing characters of all bat species hitherto recorded in Afghanistan (Gaisler 1970b, Gaisler 1971). Eventually, two papers were published which dealt with taxonomy of certain *Myotis* and *Eptesicus* species of Near and Middle East (Hanák & Gaisler 1969, 1971).

Material and methods

The material examined comprised 748 specimens of 17 species of bats from Afghanistan. The greater part of material (cca 80% of specimens) and all species but for *Plecotus austriacus* are deposited in the collections of the Institute of Vertebrate Biology, Czech Academy of Science in Brno. The specimen of *P. austriacus* and a small sample of duplicate specimens were deposited in the collections of the Institute of Systematic Zoology, Charles University in Prague, and at present are in the collections of the National Museum in Prague. Another sample of specimens, including the holotype of a new subspecies, was submitted to the collections of the then British Museum (N. H.), the present Natural History Museum in London. Save for several *Pipistrellus pipistrellus* collected in September by M. Daniel, all specimens represented grown-up individuals and were measured. Six external and 10 cranial measurements were taken by the author, for details see Gaisler (1970a). Comparative material, cca 400 specimens mostly in the collections of the Nat. Hist. Museum, London, was processed in the same way. In the tables, the dimensions of all specimens were given only where a series of one species and the same sex from one area did not exceed the number of ten. In case of more numerous material, only the minimum, maximum and the commonly used statistical data were published (Gaisler 1970a). Further observations concerning bat shelters, activity etc. (a part of material was obtained by shooting) were made in the field, the data concerning body mass, sex and reproduction were obtained in the laboratory at autopsy. Comparative material of several species of the genera *Myotis* and *Eptesicus* was processed by V. Hanák (Hanák & Gaisler 1969, 1971).

Results and discussion

In the Afghan material collected by Czech zoologists, the genus *Rhinopoma* is represented by *R. microphyllum microphyllum*, *R. hardwickei hardwickei* and *R. hardwickei seianum*. The males are significantly larger than the females. According to the comprehensive taxonomic revision of the genus *Rhinopoma* by Van Cakenberghe & De Vree (1994), the genus comprises four species and *seianum* is a subspecies of *R. muscatellum* which, accordingly, has been recorded in southern Afghanistan. The correct spelling of the lesser mouse-tailed bat's scientific name is *R. hardwickii* (Bates & Harrison 1997, Benda et al. 2009). The genus *Taphozous* is represented by *T. nudiventris kachhensis*. All specimens were collected in a small cave, only 12 km from the Pakistan boundary, the species, however, has also been known from southern Afghanistan. *Megaderma lyra lyra*, on the contrary, is confined to the eastern (oriental) edge of the country and our record seems to be the only one of live individuals (cf. Bates & Harrison 1997). Of the two bats captured on 20 March 1967, the female (47.5 g) had an embryo (15 mm). Only two *Rhinolophus* species are represented in the collection, *R. ferrumequinum* and *R. hipposideros*. While the subspecific status of the former is uncertain, that of the latter may be *R. hipposideros midas*. Within the Afghan territory, five species of this genus have been recorded (Bates & Harrison 1997). The first Afghan live individual of the genus *Hipposideros* represents *H. fulvus pallidus*. Prior to our record, the species was discovered in owl pellets (Meyer-Oehme 1968).

Of the genus *Myotis*, represented by five species in the territory of the country, only *M. longipes* was examined, being a monotypic species. A large mixed colony, cca 2,000 *M. longipes* and 200 *Miniopterus schreibersii*, inhabited a 50 m long sewage tunnel near the then Royal Palace in Jalalabad. Between 3 March and 3 May, 1967, 162 male and 176 female *M. longipes* were collected. We did not intend to get such a large sample but, in addition to bats caught by ourselves, 197 wounded individuals from the same locality were brought to us by the natives and it was impossible to release the bats into their colony. Hence, the world's largest sample was obtained and the taxonomy of *M. longipes* was analysed in comparison with similar species (Hanák & Gaisler 1969). The results indicate that *M. longipes* can be reliably distinguished from all previously described species of *Myotis*. We suggested it belonged to the subg. *Leuconoe* but recent molecular genetic analyses revealed that *Myotis* species with long feet do not represent a clade (Ruedi & Mayer 2001, Gaisler & Zukal 2004). Surprising is the sex ratio 1 : 1 of the Jalalabad colony. Most females were adult but their pregnancy was invisible until early May. In the last sample of 9 females (3 May), 8 were pregnant and one parous but not pregnant. The species has a range restricted to Afghanistan (3 localities), northern India and Nepal (Bates & Harrison 1997, Simmons 2005).

In the territory of the country, the genus *Eptesicus* is represented by four species. The sample of *E. nasutus* (submitted by natives, locality unknown) was used to study the taxonomy of several medium-sized *Eptesicus* species from the Near and Middle East (Hanák & Gaisler 1971). *E. ognevi* was found to be a subspecies of *E. bottae*. The sample of *E. serotinus* from Afghanistan comprises two distinctly different subspecies. After a taxonomic revision of this material and its comparison with samples from Asia and Europe, a new subspecies, *E. serotinus pashtonus* Gaisler, 1970, was described. The holotype, skin and skull of an adult female, has been deposited in the Natural History Museum, London (No. BM 69.786). This subspecies seems to be confined to eastern Afghanistan and northern Pakistan (Bates & Harrison 1997). Maternity colony of *E. s. pashtonus* was discovered in a fissure between two logs in the ruins of the former Habibulah Palace, Jalalabad (Fig. 1). Individuals from northern Afghanistan belong to *E. s. turcomanus*, a subspecies with much greater distribution. *Nyctalus montanus* was found to differ significantly from a similar *N. leisleri*, the main distinguishing criteria being in the fur colour and dentition. Both species have been recorded in eastern Afghanistan (Bates & Harrison 1997).

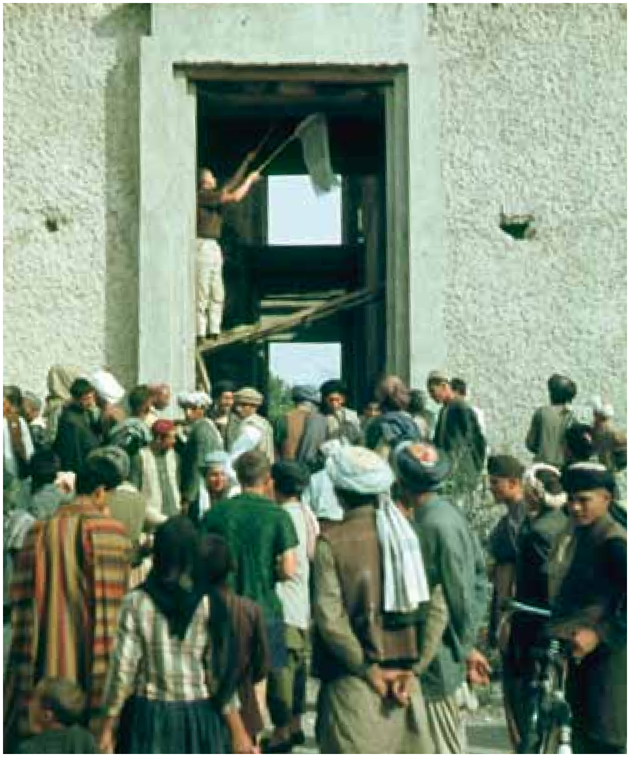

Fig. 1. *Collecting bats in the ruins of the Habibulah Palace in Jalalabad, type locality of Eptesicus serotinus pashtonus Gaisler, 1970.*

The remaining species and subspecies identified in the material collected by Czech zoologists in Afghanistan are: *Pipipistrellus pipistrellus aladdin* (syn. *bactrianus*), *P. p. mediterraneus*, *P. coromandra coromandra*, *P. kuhlii lepidus*, *Scotophilus heathii heathii*, *Plecotus austriacus wardi*, *Miniopterus schreibersii fuliginosus* and *M. s. pallidus*. Summer shelters of pipistrelle colonies were found in buildings, a colony of *Scotophilus* inhabited the bottom part of the crown of a date palm, the only individual of *Plecotus* was found in an artificial cavern (Fig. 2). Beginning of foraging activity of bats was observed (no bat detector available) from March till May. The onset of flight activity was roughly dependent of the time of sunset and, as far as it could be identified visually and by shooting, *Pipistrellus* spp. were the first to apper followed by *S. heathii* and *E. serotinus*. Individuals of *M. longipes* and *M. schreibersii* were the last to appear. Other species recorded in Afghanistan but not represented in the collection are *Asellia tridens*, *Tadarida teniotis*, *T. aegyptiaca*, *Pipistrellus tenuis*, *Hypsugo savii*, *Otonycteris hemprichii* and *Barbastella* *leucomelas* (Bates & Harrison 1997). An attempt at the zoogeographical classification of the 32 bat species known to occur in Afghanistan at the time of the publication (Gaisler 1970b) has been made, using the conception of de Lattin (1967). About two thirds of species appear to be Palaearctic, about one quarter are Oriental and the rest represent various faunal elements of the two regions or are species of other origin.

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Fig. 2. The „statue" of the Lesser Buddha, Bamyan, as it looked like in 1967; both Greater and Lesser Buddha were completely dostroyed during the Afghan civil war. A male Plecotus austriacus was collected in one of the caverns near the Lesser Buddha.

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The bats of Algeria

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Collecting bats and other vertebrates was done as a private activity of the author in addition to his lecturing and other pedagogic duties at the University of Setif (Centre Universitaire de Setif) from April 1981 to August 1983. Information on mammals of Algeria were mostly published by French biologists (Lataste, Loche, etc.) but all essential data on bats prior to 1975 were summarized by Anciaux de Faveaux (1976). The Belgian M. Anciaux de Faveaux, then professor of biology at the University of Constantine, assisted J. Gaisler in various ways, but he himself did not work in the field any more. New data concerning bats were published by Kowalski (1979, 1984). At that time, this great Polish zoologist and palaeontologist worked as a professor at the University of Oran. The distance between Oran and Setif is roughly 1000 km what made a joint field research of K. Kowalski and J. Gaisler rather difficult. Nevertheless, the two performed several research trips in common, assisted in all cases by Kowalski's wife B. Rzebik-Kowalska and in two cases by Gaisler's wife V. Gaislerová. During his short visits to Setif, an American zoologist of Palestinian origin, M. B. Qumsiyeh, took part in two netting nights.

The data on the bats of Algeria are subject of six papers. Three of them refer to the distribution, ecology and activity of bats in northern Algeria (Gaisler 1983, 1983-84, Hanák & Gaisler 1983). Two papers combine the data of Kowalski (and his students) and Gaisler and concern the life cycle and reproduction of cave-dwelling bats (Kowalski et al. 1986) and the results of netting (Gaisler & Kowalski 1986). A short paper aims at the mating system of *Myotis blythii* (Horáček & Gaisler 1985-86), in fact concerning two bat species (see below).

Material and methods

During the field work with Kowalski, all samples were divided between the two collectors, concerning both the species and specimens obtained. During individual work, Gaisler collected all netted bats but released most individuals obtained by catching with a hand net from large summer colonies in caves. Hence, the present sample comprises only those specimens brought to Brno and preserved in Czech collections; this material comprises 408 specimens of 21 species and 4 families. Major part of the material was originally deposited in the collections of the Faculty of Science, Masaryk University in Brno but has recently been presented to the Institute of Vertebrate Biology in Brno. Minor part of the material is deposited in the collection of the Regional Country Museum in Olomouc. The huge territory of Algeria, a second largest country in Africa, has traditionally been divided into three zones: (1) the northern or Mediterranean, (2) the middle characterized by the presence of a grass Stipa tenacissima, and (3) the southern or desert zone (Ledant et al. 1981). Our material was collected mostly in the northern zone, from the coast southwards to about 34°N. Mist netted samples were obtained also in the middle and in one case in the southern zone (Gaisler & Kowalski 1986). Body mass, lengths of head and body, tail, forearm, foot (not including claws), ear, tragus (if present) and width of ferrum equinum (in Rhinolophus) were measured and reproductive organs were dissected in all specimens. Cranial measurements were not taken since, upon the agreement with Kowalski, taxonomy would be part of his monograph about the mammals of Algeria. Therefore, subspecific status of bat species is not mentioned in the following results. The book on the mammals of Algeria was eventually published by Kowalski & Rzebik-Kowalska (1991).

Results and discussion

In the author's material from Algeria, following taxa are represented, species names referring to their status in the eightees of the past century: *Rhinolophus mehelyi*, *R. blasii*, *R. euryale*, *R. hipposideros*, *R. ferrumequinum*, *Asellia tridens*, *Myotis blythi*, *M. capaciinii*, *M. emarginatus*, *M. nattereri*, *Pipistrellus pipistrellus*, *P. kuhli*, *P. deserti*, *P. rueppelli*, *P. savii*, *Nyctalus leisleri*, *Eptesicus serotinus*, *Otonycteris hemprichi*, *Plecotus austriacus*, *Miniopterus schreibersi* and *Tadarida teniotis*. *M. nattereri* and *N. leisleri* were recorded for the first time in Algeria and for the second time on the African continent (Gaisler 1983, Hanák & Gaisler 1984). In addition to the above list of species, *Tadarida aegyptiaca* was mentioned as belonging to the collection (Gaisler 1983-84). An adult female of that species was obtained in exchange from M. B. Qumsiyeh but apparently has been lost later on. The bat was netted on 3 June

1981 in Tamanrasset over a sewer from a hotel (Qumsiyeh, in verbis). Without any details, the record of "several specimens of *T. aegyptiaca* in Tamanrasset" has been mentioned in Qumsiyeh (1985) and Kowalski & Rzebik-Kowalska (1991).

In addition to different spelling of some species names, *ii* instead of *i* in *blythii*, *kuhlii*, *rueppelii*, *hemprichii* and *schreibersii*, in two species the nomenclature changed radically during the last decades. Algerian populations of large mouse-eared bats were shown to represent *Myotis punicus* which was originally described as a subspecies of *M. blythii* (Ruedi & Mayer 2001, Simmons 2005). The paper by Horáček & Gaisler (1985-86) on the harem organization and related phenomena in large mouse-eared bats concerned in fact two different species, *M. blythii* and *M. punicus*. The taxon *savii* was transferred from *Pipistrellus* to *Hypsugo* (Horáček & Hanák 1985, Horáček et al. 2000). There are 18 species actually classified as belonging to the genus *Hypsugo* Kolenati, 1856 (Simmons 2005). *H. savii* is a common bat in uplands and mountains of the northern and middle zones of Algeria. Up to 1983, 26 species of 6 families of bats have been recorded in Algeria, 17 of which occurred in the northern, 13 in the middle and 12 in the southern zone of that country (Gaisler 1983-84). The situation did not change during next years and the same 26 bat species and 6 families are listed in the book by Kowalski & Rzebik-Kowalska (1991) which is the most comprehensive work ever published on Algerian mammals. In the bat section, the distribution, records, morphology (external and cranial measurements), taxonomy (subspecies) and ecology of each species are described. The book contains both published and unpublished data on Algerian bats gathered by Gaisler what has been acknowledged by its authors.

Fig. 1. *Camping with the husband and wife Kowalski, Amentane near Menaa, Aures Mts., 8 to 9 August 1983.*

Fig. 2. *An adult female of Tadarida teniotis netted in the wadi next to the camp at Amentane.*

Population dynamics and reproduction of 6 cavernicolous *Rhinolophus* species and of *M. blythi* (=*punicus*), *M. emarginatus*, *M. nattereri*, *M. capaccinii* and *M. schreibersii* was studied on the material from caves in northern Algeria. Histological examination of reproductive organs was made in *R. mehelyi* and *M. punicus*. The duration of hibernation was shorter in Algeria than in Europe, but the reproductive cycle was similar in that insemination took place in autumn and fertilization in spring. Parturition occurred earlier than in European populations of the same species. Observations were made on the choice of roosts, formation of intra- and interspecific associations, as well as individual and geographic variation in dates of parturition (Kowalski et al. 1986).

Three hundred seventeen bats of 20 species were mist-netted at 26 localities, most of them in northern Algeria. The sample has been evaluated with regard to faunal size, relative abundance, species diversity in areas, and the foraging diversity of the species. The species diversity corresponds in a certain degree to the diversity of environment, and on the whole it is higher in samples from western Algeria than from the east of the country. The highest foraging diversity has been found in *P. kuhlii*, the only species caught both in the Mediterranean zone and in the desert. Two peaks of nocturnal activity, with the maximum after sunset, have been ascertained in three most abundant species. Flying bats were seen and/or netted also during the winter months. Nevertheless, the percentage of captures was lowest in January and February, increasing from March to July and showing much variation from August to December (Gaisler & Kowalski 1986). An example of a netting site with the sample of bats netted during one night is given in Figs. 3 to 5.

Fig. 3. Tikjda, Djurdjura Mts., foraging habitat of Hypsugo savii at the elevation of 1,500 to 2,000 m.

Fig. 4. Three mist nets set over a stream at the Point de Vue de Djurdjura, 2 July 1983. Free ranging cows did not damage the nets.

Fig. 5. The bats netted on 2 July 1983, 20:47 to 21:50 hrs (Algerian summer time). From left to right and from top to bottom: Plecotus austriacus, Hypsugo savii, Myotis punicus and Eptesicus serotinus.

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The bats of Egypt

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Upon a cultural agreement between Egypt and Czechoslovakia, J. Pelikán and J. Gaisler collected Egyptian mammals of the orders Insectivora, Chiroptera, Lagomorpha and Rodentia between 15 April and 20 May, 1969. Owing to the participation of an Egyptian, G. A. Madkour, in the field work, we were authorized to sample bats even in sacral buildings like Ancient Egyptian temples or tombs and Moslem mosques (see the itinerary in Pelikán et al. 1971). Several papers were published prior to our investigations, concerning the whole chiropterofauna or individual bat species of Egypt (Anderson & de Winton 1902, Flower 1932, Wassif 1949, 1962, Sanborn & Hoogstraal 1955, Madkour 1961, Hoogstraal 1962, Wassif & Madkour 1963, 1970). Also the monograph by Kock (1969) on the bats of Sudan was found very useful with respect to the taxonomy and distribution of bats in Egypt. Taxonomical evaluation of the material collected in Egypt – being the core of our study – was therefore easier than in the case of Afghan bats. Similarly to the Afghan story, remarks on ecology were also given (Gaisler et al. 1972).

Material and methods

The material examined comprises 236 specimens of 11 species and 7 families of bats collected by Gaisler and Pelikán in 1969, and an additional sample of 7 specimens, 3 species and 3 families collected by J. Groschaft in 1971. They are all grown-up individuals, save for 4 juvenile *Nycteris thebaica* which have not been involved in taxonomical analyses. All specimens are deposited in the collections of the Institute of Vertebrate Biology in Brno. The material was obtained in the Nile Valley from Cairo southwards to Luxor and Karnak, in the northern Mediterranean coast from Mersa Matruh to Alexandria, and westward from the Nile Valley in Giza, Sakkara and the Kharga Oasis (Western Desert). Six external and 10 cranial measurements were taken as in the bats of Aghanistan (see the preceding chapter). The baculum was examined of four male pipistrelles collected and of one specimen from the collection of the Natural History Museum in Vienna. Most bats were captured inside their shelters. Ambient temperatures were measured close to roosting individuals. All *Pipistrellus deserti*, a species new to Egypt, were captured out-of-doors when flying in the garden of the Luxor Hotel, using a hand net. Body mass and the state of reproductive organs were recorded in all captured bats (Gaisler et al. 1972).

Results and discussion

Taxonomical evaluation resulted in the allocation of the sample to following species and subspecies: *Rousettus aegyptiacus aegyptiacus*, *Rhinopoma hardwickei senaariense*, *R. h. cystops*, *Taphozous perforatus perforatus*, *T. nudiventris nudiventris*, *Nycteris thebaica thebaica*, *Rhinolophus clivosus clivosus*, *R. c. brachygnathus*, *Asellia tridens tridens*, *Pipistrellus kuhlii marginatus*, *P. deserti*, *Plecotus austriacus christiei* and *Otonycteris hemprichii hemprichii*. Much larger material of 2,684 specimens from Egypt and an additional 296 from adjacent territories was later examined by Qumsiyeh (1985). The author recognized the same taxa in species and subspecies represented in our material, except in *Rhinopoma hardwickei* (*arabium* instead of *senaarense*) and *Pipistrellus* (*aegyptius* instead of *deserti*). All small mouse-tailed bats from Egypt are actually referred to *R. cystops cystops*, *R. c. arabium* being confined to south-western Asia, while *R. senaarense* is nomen nudum (Benda et al. 2009). Concerning *Pipistrellus*, the name *deserti* is to be preferred to *aegyptius* since the type material of *aegyptius* is not available and its description is obscure while the holotype of *deserti* is preserved in the collections of the Nat. Hist. Museum, London (Horáček et al. 2000, Simmons 2005).

Maternity colonies were found in 6 species but in most cases, males were admixed with them. The colony of *R. aegyptiacus* in the Sultan Hassan Mosque, Cairo, comprised some 1,000 individuals and was found in several vaulted rooms on the second floor of the mosque at a temperature of 26 °C. Pregnant females (n = 8) had one embryo each (length 6-50 mm) and body weight 101.5-162.0 g (ave 136.5 g); not pregnant females (n = 3), one of them with a vaginal plug, had weight 89.5-151.0 g (ave 118.2 g). Eight males had body weight 125.0-170.5 g (ave 149.8 g), 5 of them were sexually active (testes 15 by 10 mm) and 3 were inactive (testes 5 by 4 mm). Colonies of *R. hardwickei* (= *R. cystops*) (n = 6) were found in mosques, ancient temples and underground tunnels at the temperatures of 22.8-27.5 °C. In all cases the bats hung freely, attached to the walls or the ceilings. The estimated colony sizes varied from 30 to 100 individuals. Pregnant females (n = 27) had one embryo each (max length 4 mm) and body weight 7.5-12.0 g (ave 8.8 g). The weight of not pregnant females (n = 12) was 6.5-9.5 g (ave 8.1 g) and that of males (n = 21) 6.5-11.5 g (ave 9.0 g). The colony of *T. perforatus* in an unnamed tomb in the Valley of Queens, Luxor, consisted of some 200 bats crowded on the walls and in shallow crevices. In the shelter, ambient temperature was 32 °C, at outdoor temperature of 35 °C (16:00 hrs). All collected females (n = 16) showed advanced pregnancy, each containing one embryo 13.5-21.5 mm in length, body weights 20.5-24.5 g (ave 22.8 g). Of the collected males 19 were adult and 2 subadult, body weights 19.0-21.5 g (ave 19.9 g). The colony of *T. nudiventris* in the Sultan Mahmud Mosque, Cairo, comprised some 50 individuals, mostly hidden in crevices. The ambient temperature near the main concentration place was 24.5 °C, near solitary bats 23.2 °C. In the Big Temple at Karnak (Fig. 1), these bats inhabited a large number of various crevices between stone blocks, often being hidden within the reach of light. From a crevice, we extracted 4 females, each containing one embryo (9.6-18.5 mm), temperature being 35 °C in that crevice and 37 °C outdoor (midday). Two colonies of *N. thebaica* were discovered, one numbering cca 20 individuals in a lateral corridor of the Big Temple at Karnak, another numbering cca 80 individuals in the Temple of Hathor at Dandara; ambient temperature near that colony was 26.5 °C. Within the 24 specimens collected from 26 April to 1 May, 9 were pregnant females, each with one embryo (10-23 mm), 3 lactating females and 4 juveniles (3.5-5.0 g). They were the only young-of-the year among the bats we collected in Egypt. Five colonies were found of *A. tridens*, two of them with cca 500 individuals each: in a big dark room of the Temple of Hathor at Dandara (27 °C), and in an underground crypt of the so-called City of Deads in the Kharga Oasis (28 °C). Another colony of some 50 individuals was situated in an underground tunnel of the Temple of Ibis of the same oasis (30 °C). All were mixed colonies with pregnant females (n = 13) that showed one embryo each (5-14 mm). Only males (n = 22) were obtained from a crypt in Deir-el-Medina, Luxor. The observations are in good fit with the data on ecology of *A. tridens* in Iraq (Robaae 1966), in particular concerning the temperatures in shelters and partial isolation of males and subadult individuals from maternity colonies.

In all, 8 families, 13 genera and 21 species of bats were known to occur in Egypt at the end of 1970. Zoogeographical notes were submitted following the classical concept (Darlington 1957, de Lattin 1967, Kock 1969). Most of the species (76.2 %) are Palaearctic, those of Afro-eremic origin predominating, the rest (23.8 %) are Ethiopian (= Afrotropic) species. The chiropteran fauna of Egypt is related especially to that of the Near East and of the Maghreb. The bat fauna of Egypt – like its avian fauna – is considerably poor as to species, apparently due to the dry climate and the absolute absence of woodland. Actual situation will be dealt with in the chapter about the bats of Eastern Mediterranean.

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Results of bat census in the city of Brno

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On the territory of former Czechoslovakia, records of bat species, or groups of species, in towns and cities were dealt with in several papers (e.g. Hanák et al. 1962, Palášthy & Gaisler 1965, Hůrka 1966, Gaisler & Hanák 1969). However, Brno was the first Czechoslovak city where a systematic census of bats was made (Gaisler 1979, Gaisler & Bauerová 1986a). This census resulted from classical methods such as searching bats in their shelters, netting and visual observing of flying bats and occasional records by the public. Particular attention was given to a mass hibernaculum of *Pipistrellus pipistrellus* which, in the years 1978-1985, was visited 114 times (Gaisler & Bauerová 1986b). Most data concerning *P. pipistrellus*, however, came from invasions, this term denoting sudden occurrence of groups of pipistrelles, consisting of varying numbers of individuals, in rooms inhabited by humans. Late summer invasions of pipistrelles in Brno in the years 1959-1988 were described and discussed mainly in Gaisler et al. (1990). Independently of the above sampling, acoustic recordings of bats by bat detectors were made in 1993 in seven different urban habitats (Gaisler et al. 1998). The next data set concerns bats hibernating in two underground galleries within the territory of Brno (Gaisler 2000). The last published records are that of *Hypsugo savii*, a species previously unknown in Brno (Gaisler & Vlašín 2003, Bartonička & Kaňuch 2006). In this paper, published information will be supplemented by new, so far unpublished data.

Material and methods

From July 1957 to March 1985, data were collected on the bat community within the boundaries of the city of Brno, covering an area of 230 km^2 and inhabited by 350,000 people. At that time built-up areas covered ca 40% of the town, forests (including parks) and fields (including similar open spaces) covered about 30% each. There are two middle-sized rivers (streams) in Brno and a water reservoir. The first information in this paper is derived from 1934 records of captured bats, mostly marked and released. The second sample was obtained through visual census of flying bats in 1976 and 1977. While preliminary observations and training of the observers were made in 1976, the census itself was realized in 1977. Results of 28 observers represented by the total number of 310 filled forms giving data on 669 individual records of bats were evaluated. In 1980-1985, the autumn to spring occurrence of *P. pipistrellus* was regularly checked at least twice a month in the spire of St. Thomas' church. The bats were counted after crevices were illuminated, and captured by means of simple and harmless traps (vessels 19×13×13 cm). Maximum numbers recorded per one winter check (monitoring in January or February) fluctuated between 93 and 164 with the average of 124 individuals per winter. After 1985, the hibernaculum was visited irregularly to find out if *P. pygmaeus* was present. Pipistrelle invasions into 56 rooms were recorded and evaluated in the years 1959-1988, but only 972 individuals could be exactly determined (see results). The total number of all *P. pipistrellus* captured in Brno in 1959-1988 was 149 males, 164 females, 1406 juveniles, and 1765 specimens of unknown sex. Pipistrelle invasions were recorded in the years 1989-2009 as well but, for the most part, the bats were neither captured nor counted.

Four bat detectors were used, D-980 Pettersson, SKYE, and two QMC Mini, to make acoustic recordings of bats in different habitats within the town of Brno, from March till October 1993. Habitat types included: A, the citycentre – historical centre of the town; B, old residential quarters – streets with blocks of buildings, mostly four-five-storeyed; C, old suburbs – streets of family houses with small gardens; D, villa quarters – scattered villas with large gardens; E, old outskirts – old warehouses, factory premises, open areas, trees; F, new housing estates – blocks of high rise (typically 8-storeyed) flats, lawns and newly planted trees; G – the river and its immediate surroundings. Most observations started 10 min after sunset and lasted 30 min. Four observers covered 55 such transects labelled "standard" which encompassed 1650 min of monitoring. In addition, 41 transects, 1230 min, were either performed at standard dates and localities but earlier or later, or they represented different dates and/or different localities. The level of bat activity was assessed as the number of individual minutes in which bat ultrasound signals were detected. This number was converted into percentage of total number of monitoring minutes (per transect type, habitat, time interval, etc.).

Since the end of the 20th century, repeated records of hibernating or swarming individuals of *Vespertilio murinus* and *Nyctalus noctula* in new housing estates were obtained in unsystematic checks, usualy after phone call of civil service for local people (supported by members of the Czech Bat Conservation Trust). Several bat species previously recorded by one specimen each (*Myotis brandtii*, *M. emarginatus* or *M. mystacinus*), were found due to occasional records by the public. Since the bats were often found in crevices among prefabricated panelboards, three new housing estates with prefabricated houses were monitored by bat detector transects in 2009. Two detectors D 200 Pettersson were used and one transect per month was made in the duration of 60 min starting with the time of sunset. Within the years 2000-2009 bats were also captured at least in 12 netting nights in five different sites (in parks, over historical fountains, near the small ponds etc.).

In 1976-2000, 27 checks were made in two underground galleries, 333 m and 85 m long, excavated into the foot of a Jurassic limestone hill Stránská skála. Bats were recorded inside the galleries at 22 checks and outside the galleries at 4 nettings, in total 114 individuals. These published data will be supplemented by records of additional 134 individuals from the census in 2001-2010.

Results and discussion

In total, 18 species of bats were recorded within the town of Brno (Tab. 1). Seven species were found throughout the year, viz, *P. pipistrellus*, *Eptesicus serotinus*, *N. noctula*, *Myotis myotis*, *M daubentonii*, *Plecotus austriacus* and *Rhinolophus hipposideros*. *P. pipistrellus* was found to be the most abundant by collecting in buildings, visual observation of flying bats and by the number of bat call minutes revealed by acoustic detectoring in 1993. In addition to numerous records of foraging individuals as well as frequent invasions into buildings in the past, two maternity colonies with ca 150 and 200 individuals were found on the territory of Brno after 2005. It is now evident that *P. pipistrellus* reproduces in the city. Flying pipistrelles were recorded in all habitat types but the citycentre (A), new housing estates (F) and riverine habitats (G), when coupled, were significantly less frequented than the remaining habitats, viz, old residential quarters (B), old suburbs (C), villa quarters (D) and old outskirts (E). In the hibernaculum in St. Thomas‘ church, bats were first seen on 20 October and seen last on 31 March with maximum numbers recorded in either January or February. In or near the occupied crevices a considerable temperature range was found, especially in November (-2 to 17 °C), in January and February the average temperature was 4.9 and 5.2 °C respectively. On 21 February 1994, 36 pipistrelles were captured and examined with respect to possible occurrence of *P. pygmaeus*. All bats were determined as belonging to *P. pipistrellus* and the same was found during five checks in subsequent years. So far, *P. pygmaeus* has not been recorded in Brno during bat detector transects either. August and sometimes early September are the typical months of pipistrelle invasions in Brno. The earliest date of such an invasion was 20 July, the latest one 8 October and the maximum number was 381 pipistrelles in one room. Invasions into one and the same room may be repeated within 1-4 weeks of the same season or in subsequent years. The longest interval between the first and the last invasion into the same room was 11 years. Of the determined individual invasion members, 950 (97.7 %) were young-of-the-year with a sex ratio of 56.2 % females to 43.8 % males. There were 18 (1.9 %) adult females and 4 (0.4 %) adult males. According to our data, the majority of invasion members are young bats. However, repeated invasion into the same locality suggests that old experienced bats must sometimes take part in the invasions as well.

E. serotinus and *N. noctula* are further common species in which both foraging and roosting individuals were recorded. *E. serotinus* is a typical „house bat“ and, in 1963-1988, nine nursery colonies were recorded roosting in ventilation shafts and similar shelters of buildings, mostly in housing developments, with the mean number of 23.7-32.5 individuals (including young) per colony. There are also 10 winter records of individual serotines in buildings. Hibernating *N. noctula* were found in 14 prefabricated buildings, with maximum estimated number of 500 individuals in one shelter. Prefabricated buildings are used by the species also as temporary shelters during the vegetation season and the only noctule nursery colony (80 observed individuals) was recorded there as well. In the built-up area of the city four nursery colonies of *P. austriacus* and one of each *R hipposideros*, *M. emarginatus*, *M. myotis* and *M. bechsteinii* were found (Tab. 1). The maternity colony of *M. bechsteinii* roosted in a bird nest box in a periferal broad-leaved forest close to the Brno water reservoir. It consisted of 25-30 individuals of which 6 adult females and 9 juveniles (3 males, 6 females) were caught.

Besides the regular monitoring the material collected in Brno is represented by frequent finds of dead/injured individuals. At least during the last 10 years growing numbers of *Vespertilio murinus* were found. Most winter records of this species came from the crevices in prefabricated buildings, where bats roost individualy but sometimes in small winter colonies up to 10 individuals. *N. noctula*, *P. pipistrellus*, *E. serotinus* and *V. murinus* were recorded by ultrasound detection in three new housing estates in 2009. By the number of minutes in which echolocation signals were detected, the noctules were most abundant during the whole season (April to November). *V. murinus* was only detected at the end of monitoring; the first flying individual was recorded on 20 August.

***Table 1.** Past and present records of bat species observed in the city of Brno concerning all published and unpublished data up to the winter 2009/2010. Ultrasound records of sibling species Myotis mystacinu s/ M. brandtii and Plecotus auritus / P. austriacus, that could not be distinguished apart, are in parentheses.*

Species	netting	ultrasound recording	cadaver	visual observation	hiber-nating	nursery colony
Rhinolophus hipposideros	+	+	+	+	+	+
Myotis brandtii		(+)	+			
M. mystacinus		(+)	+			
M. emarginatus	+	+	+			+
M. nattereri		+				
M. myotis	+	+		+	+	+
M. bechsteinii	+					+
M. daubentonii	+	+		+	+	
Eptesicus serotinus	+	+	+	+	+	+
Nyctalus noctula	+	+	+	+	+	+
N. leisleri		+				
Vespertilio murinus	+	+	+	+	+	
Pipistrelus pipistrellus	+	+	+	+	+	+
P. nathusii		+		+		
Hypsugo savii	+	+	+		+	
Plecotus auritus	+	(+)	+	+	+	
P. austriacus	+	(+)	+	+	+	+
Barbastella barbastellus	+	+				
Total number of species	13	15 - 17	11	10	10	8

In addition to published records of *Hypsugo savii* in Brno and its environs (Gaisler 2001, Gaisler & Vlašín 2003, Bartonička & Kaňuch 2006), three adult males were found up to the winter 2009/2010 (leg. P. Koutný, Z. Řehák). The present sample of *H. savii* consists of four adult males, one adult and one subadult female, being the only records of the species in the Czech Republic. The only adult female Savi's pipistrelle was mist-netted above a park fountain close to the centre of Brno. The female showed signs of postlactation like the presence of bare patches around its bulgy nipples. This is the first reliable record indicating reproduction of this species in the territory of the Czech Republic. Low spectral parameters of echolocation calls recorded during bat-detectoring observations and, in particular, low peak frequency of pipistrelle like echolocation calls recorded in Brno (lower than in signals of *Pipistrellus nathusii*) suggest more often occurrence of *H. savii* in urban areas than expected. New records from Bratislava and Nitra support the hypothesis that the species has been gradually spreading northwards in Central Europe (Bartonička & Kaňuch 2006, Lehotská 2006).

A small but stable hibernating bat assemblage was monitored in the underground galleries of Stránská skála in 1976-2010. Earlier monthly checks revealed the maximum numbers of bats in late February to early March, therefore, during the last 12 years, the census was made at that time of year. Six species were recorded, *M. myotis*, *M. daubentonii*, *E. serotinus*, *R. hipposideros*, *P. auritus* and *P. austriacus* with a maximum total number of 18 individuals per one census (2009). *M myotis* was recorded in every visit, *R. hipposideros* in every visit since 1998, records of other species were rare. Due to their situation at the border of a city, the galleries are frequently visited by people what is a possible reason for the small number of hibernating bats. Another probable reason is the existence of the nearby Moravian Karst with plenty of caves, some of them serving as mass hibernacula to bats.

Bat communities living in various large cities, so far studied in Europe, were compared by Hanák et al. (2009). The data from Prague, Brno, Vienna, Warszaw, Berlin, Hamburg and Budapest reveal mutually similar composition and diversity of bat species. When dubious and old records, such as that of *Rhinolophus ferrumequinum* in Prague and Vienna, are eliminated, the minimum of 12 species have actually been known from Hamburg and the maximum of 21 species have been known from Budapest. With the number of 18 bat species, Brno and Vienna rank second in the sample. In the paper by Hanák et al. (2009), *P. pygmaeus* was erroneously included among the bats of Brno but the species was in fact never documented by either finding in a shelter or recording its echolocation signals. Bat communities of Brno and Vienna are identical with two exceptions: *M. emarginatus* has only been recorded in Brno while *P. kuhlii* has only been recorded in Vienna. Bat community of Prague consists of 17 species, the differences with respect to that of Brno concern missing (or dubious) species *M. bechsteinii*, *M. emarginatus* and *H. savii* on the one hand, and occurring species *Eptesicus nilssonii* and *P. pygmaeus* on the other. The same number of bat species as in Prague was recorded in Berlin. Compared to Brno, species missing in Berlin are *R. hipposideros*, *M. emarginatus* and *H. savii*, species occurring in Berlin but missing in Brno are *M. dasycneme* and *E. nilssonii*. Stoycheva et al. (2009) studied bat diversity in two large Bulgarian towns, Plovdiv and Stara Zagora. A similar variety of methods as in Brno and Prague were used – ultrasound detectors, mist netting and searching for roosts and dead individuals. In Plovdiv, 14 species and 4 groups of species were recorded, in Stara Zagora, they were 9 species and 3 groups of species. Cluster analysis of qualitative similarity in species composition among bat communities of six towns revealed the highest similarity between Plovdiv and Stara Zagora and between their complex and Brno. This, however, was an artifact because the authors used only the data from bat detector transects made in Brno (Gaisler et al. 1998), not the material gathered by other methods. Also they did not include the bat fauna of Budapest into their comparison. As can be expected, bat communities of Plovdiv and Stara Zagora are similar to that of Budapest except that *Rhinolophus* species and *Miniopterus schreibersii* were only recorded in Budapest and *T. teniotis* only in the Bulgarian towns. There is no particular similarity between bat communities of the Bulgarian towns and the one of Brno, if all species found in Brno are considered.

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Advertisement behaviour and mating system of the migratory bat *Pipistrellus nathusii*

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This contribution reports the research project focused to mating system of a migratory bat, *Pipistrellus nathusii*, and behavioral specificities characterizing it.

The field investigation was performed from 1999 to 2007 in southern Bohemia, a variegated landscape densely patched with forests, fields, meadows and fish ponds connected by a stream. In the study area (Fig. 1), two maternity colonies of *P. nathusii* were found. The study was particularly focused on roosting strategy and male advertisement behaviour in the mating season. In total 46 resident males were individually recognized, 30 of them appeared for more seasons. Males occupy the roosts (territories) along migration pathways, and perform there loud and intensive acoustic advertisement display. In the study area the number of individually recognized resident males varied from 13 (2003) to 32 (2001). The advertising calls were recorded throughout the season from April to the end of September 20 with the highest peak in August and smaller peak also in May. At the beginning of the seasons the advertisement calls were performed almost exclusively as songflight and included a large portion of echolocation calls. In August the advertising vocalization was performed predominantly as a sedentary display (SD, 76% of vocalization activity) and, in that time, it presented a prevalent component of male activity (58% of whole night activity).

The advertisement call of *P.nathusii* is composed of several contrasting motiffs (A, B, C, D, E) including a greatly variegated social calls similar to calls of females and juveniles (D) (Fig 2). The calls are presented either during sedentary display (SD) or songflight (SF), which can be produced very close to a male‘s roost, around it or in a far vicinity. Possible semantic correlates of advertisment call of *P.nathusii*:

A: loud signal widely *attracting attention* of conspecific bats, B – C: probably modified distress signals, with individually specific characteristics – an *acoustic signature of the particular male,* D: components of mother-young and female social comunication, supposedly a *reference to a (locally?) specific syllabic pool,* E: call which *evoke an act of landing.*

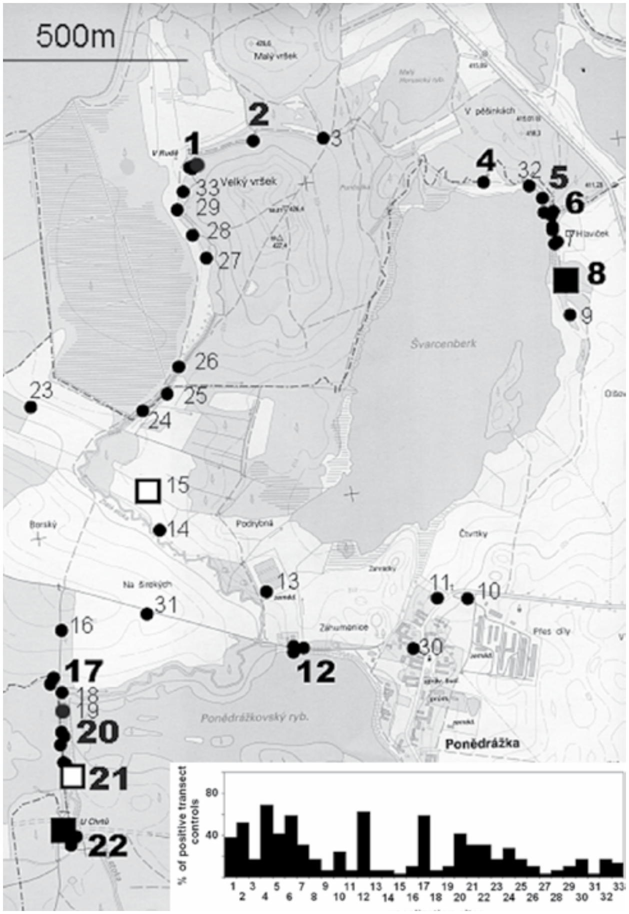

Fig. 1. *A map of the study area with position of male roosts (circles) and roosts of maternity colonies (full squares = regular roosts, empty squares = alternative roost of the colony from the roost 22). Graph below shows overall percentages of the controls with active vocalization in particular sites, 1-33, throughout period 2000-2007.*

Mean values of the end frequency of *B* (*B enf,* between-individual variability 7,60 - 28,30 kHz) and the lowest frequency of of the third call of motive C (*lof c3,* between-individual variability 25 - 56 kHz) was found highly specific for individual males, enables their individual recognition in the field. Other important individual characteristics can be found in motif D (shape and frequency of D syllables) and in regular sedentary display it is also number of syllables in A and C motiffs. The state of these variables is individually specific and invariant throughout life of individuals (up to 8 years in two males) and serves probably as an acoustic signature of particular males.

Within-season variation in advertising calls change is apparent in their syntax composition (increasing complexity in the peak of mating season), type of display (increase in SD) and behavioural context (presence of other individuals).

The vocalization was concentrated repeatedly at specific vocalization sites centered with a roost of a resident male as a rule. In most instances, the resident males were found at their vocalization sites in several subsequent seasons (2.05 years on average).

Repeated occupancy of the same vocalization site for at least three successive years was proved in 12 males, two of them (*6a, 12a*) for 7 years and other two (*4, 12b*) even for 8 years.

Males‘ roosts were concentrated in a close vicinity of maternity roosts. The roosts, which were not situated nearby the maternities fit to equal distance model much better, though the distribution is skewed to close neighbourhood too. In total, 28 resident males (61 % of 46 recorded during the study period) roosted at least one season in closest vicinity to a roost of another resident male. The distance to the nearest roosts showed markedly skewed exponential-like distribution with a distinct peak at 0-20 m. Such groups were composed of two (5 vocalization sites) or three resident males (3 vocalization sites).

The number of males in a group and presence of particular individuals changed during the study period as some males disappeared and new males arrived. The average duration of a dyadic association of two males was 2.60 ± 1.89 years. The longest duration was observed in males *12a* and *12b* (7 years). In vocalization sites of dyadic residents also alien males appeared more or less regularly (both sexually active and inactive) including those which performed temporarily the advertisement displays. In such instances we observed often apparent agonistic behaviour of the resident male including chasing of intruders.

The resident males roosting in close vicinity and sharing the same vocalization site tended to synchronize their vocalization activity pattern. The male dyads associated for more years (males 12a,b; 17a,b; 6a,b) revealed it quite regularly throughout each season of the study. Such a dyadic synergy in advertising acoustic display was repeatedly observed also in other localities beyond scope of the study area and it seems to be quite a typical for the species under study. In three vocalization sites we observed even the triadic displays. We can hypothesize that such a behaviour is driven by immediate effects of the amplified outcome acoustic image of the site in increase of its attraction for females, or groups of females during autumn migrations. Such busy sites

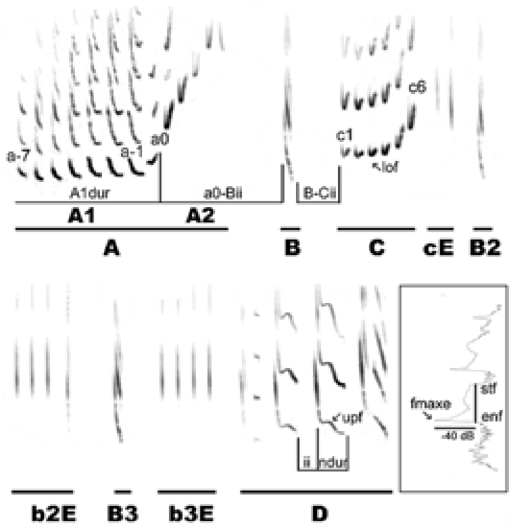

Fig. 2. A complete syntactic structure of males'advertisement call of Pipistrellus nathusii, with denoting particular syllables and their sonographic parameters.

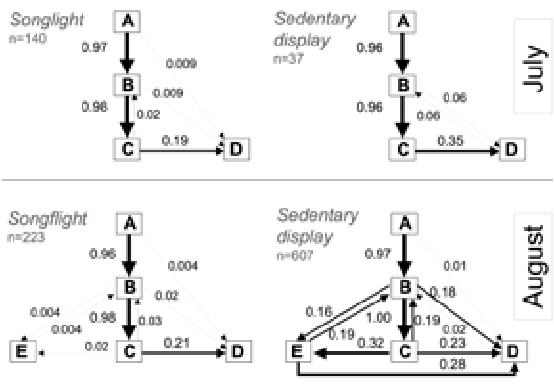

Fig. 3. *Transition probabilities of the motifs of advertisement calls during songflight and sedentary display in July and August. The numbers refer to frequencies of incidence of particular node in the total sample (n gives the number of samples analysed).*

apparently attract also the alien males, which can perform there a strategy of satellites or sneaks.

Mating system of P. nathusii

The observed characteristics do not fit to the resource-defence model predicted for all temperate bats, the present species including. The differences are in (i) aggregation of male roosts, (ii) long-lasting dyadic or triadic male groups, (iii) synchronous advertisement, and (iv) obviously a minute value of the „resource“ (=roost) to the attracted females (typically: low quality fissures nearby a colony roost).

It some of these characteristics there is a good correspondence to the lek mating system at least in (i) general appearance of the situation in busy vocalisation site, e.g. song-flights of multiple alien males, (ii) highly specialized acoustic advertisement of males and way of its perfomace (incl. synchronous vocalisation), (iii) spatial activity of resident males limited to their vocalisation sites (as revealed by radiotracking). At the same time the observed pattern markedly differs from a typical lek system at least by: (i) a large number of mutually separated vocalisation sites, (ii) small size of advertising groups centered with resident males roosting at the sites as using it as their foraging grounds as well as (iii) long-lasting dyadic associations among particular resident males.

Nevertheless, all the above mentioned characteristics suggest that the mating system is designed, first of all, in respect to female choice. This conclusions seems to be well supported also by other specificities of the species in study, among other e.g.: (i) intensive, highly ritualized advertisement with complex structure of the calls containing even (ii) acoustic signatures of each particular male and (iii) components taken from repertoire of mother-young communication, (iv) aggregations in vicinity of nurseries, (v) a large variety of strategies observed in males (*resident dyadic, resident solitary, migratory, sneaks* etc.).

In short, the mating system observed in *P.nathusii* is characterized by extreme variation and index role of the female choice. We can hypothesize that the diversity in males'tactics reflects the background diversity of criteria of the actual females' choices and just that makes the mating system quite plastic. The aggregation of males, cooperative advertisement and even the essential role of female choice in the mating system of *P. nathusii* can be looked upon as adaptation to specificities of life history of the long-distance migratory bat, eventually. A question is to which degree all these characters do appear in mating system of the other temperate bats and whether just such a combination could not be the most pertinent characteristic of the mating system of temperate bats in general.

For further details see:

Jahelková H., Horáček I. & Bartonička T., 2008: The advertisement song of *Pipistrellus nathusii* (Chiroptera, Vespertilionidae) a complex message containing acoustic signatures of individuals. *Acta chiropterologica*, **10**: 103–126.

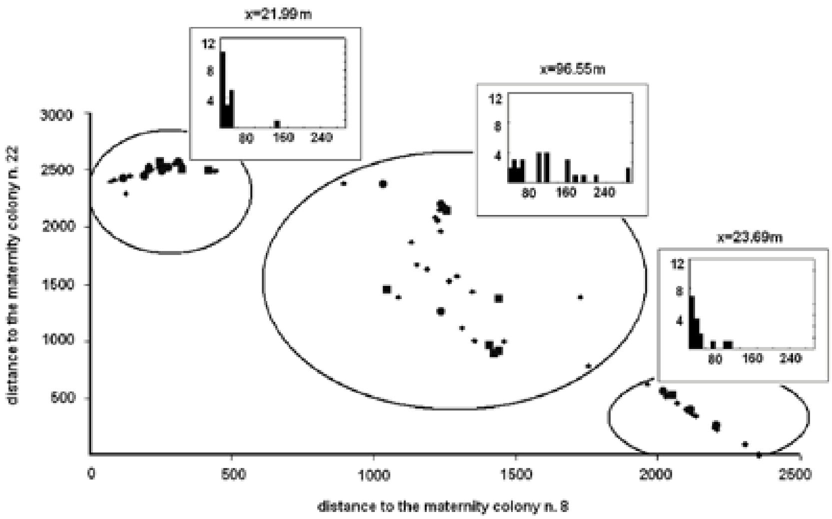

Fig. 4. Distribution of all records of advertising males in respect to their distances to both maternity colonies (roosts no. 8 and 22). The records clearly split to three clusters, encircled here, which differ also in distances to the nearest male neighbours shown at histograms (abscissa – distance to the nearest male neighbour in m, ordinate – number of cases). The average distance to the roost of the nearest male (x) for each encircled group is above each histogram.

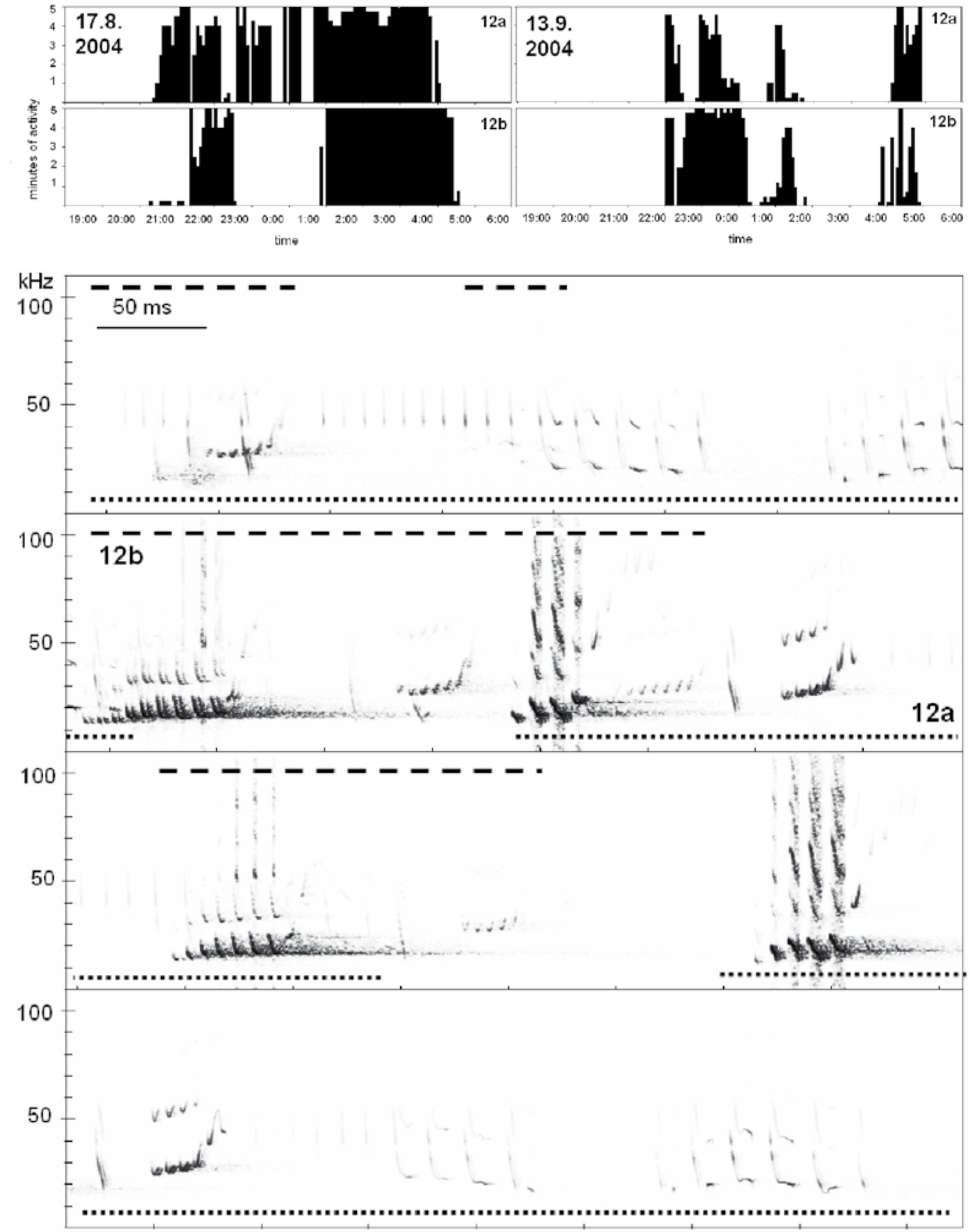

Fig. 5. Left: two examples of continuous records of their vocalization activity during whole-night observations on 17 August and 13 September 2004. Note apparent synchronization both in timing of major burst of vocalization and amount of vocalization activity. Below: A sonographic record of synchronous vocalization of male 12a (brown) which performed sedentary display and 12b (green) which performed songflight.

Forest and tree-dwelling bats of the Western Carpathians

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Bats assemblages

Mountains of Western Carpathians cover important part of Slovak country area where forests dominate. They represent unique ecosystems but in large extent under significant human influence. The knowledge about the species composition of bats in local forests dramatically increased during the last decade. Thanks to extensive mist-nettings supplemented with using of bat-detectors, data were collected in various types of forest stands (i.e. oak, hornbeam, beech, spruce) which represented natural habitat diversity. Almost all (25) species listed in country were found there (Danko et al. 2007, Kaňuch et al. 2008). The most frequent species were *M. mystacinus* (occurred in 57% of mist-nettings), *M. myotis* (44%), *B. barbastellus* (32%), *P. auritus* (32%), *N. noctula* (31%) and *M. brandtii* (31%). However, overall dominance of *M. mystacinus* should be revised now, since its cryptic relative *M. alcathoe* was found more common in some sites (Danko et al. in prep.) Due to limits of used methods, relative abundances were analysed in more detail only in some particular sites (e.g. Ceľuch & Kaňuch 2004a, Kaňuch 2005, Kaňuch & Ceľuch 2007). Species occurrence responded to wide altitudinal gradient in Western Carpathians (various forests occur from ca. 100 up to more than 1500 m a.s.l.) and decreasing number of species with increasing altitude was found. For lower altitudes were usually considered to be typical *E. serotinus*, *P. pipistrellus*, *N. noctula*, *M. daubentonii*, *M. emarginatus* and *P. austriacus*. On other hand, in higher elevations occurred characteristically *E. nilssonii*, *V. murinus*, *M. brandtii* and *P. auritus* (Kaňuch & Krištín 2006, Danko et al. 2007, Kaňuch et al. 2008).

Habitat selection and foraging activity

To assess the habitat use of bats with respect to complexity of forest habitats some large-scale multivariate approach is required. Based on environmental variables with significant influence on the species' presence, two main groups of species inhabit Carpathians forests (Fig. 1). In the first, the tree-dwelling and gleaning species of forest interior (*M. bechsteinii*, *M. nattereri* and *P. auritus*) were connected mainly with old forests of natural tree-species composition. Whereas in the second group, species which foraged in more open space or along the forest edge dominated (*E. serotinus*, *N. noctula*, *N. leisleri*, *P. pipistrellus*) and their presence does not respond to the certain forest composition or structure (Kaňuch et al. 2008). Foraging assemblages and their activity patterns were locally investigated also by recording of echolocation calls (Ceľuch & Kaňuch 2004a, b, Ceľuch & Kropil 2008). The highest species diversity was found in the forest interior; however, the highest flight activity was recorded at the forest edge, forest stream and in open area (Ceľuch & Kropil 2008). When the available area and time spent there was considered, forest interior was found as the most important foraging habitat (Ceľuch & Zahn 2008). Similarly, niche of trees canopy layer had importance as foraging habitat of bats. The most of feeding buzzes (96%), belonging mainly to the *Myotis*-group species were recorded there (Ceľuch & Kaňuch 2004b).

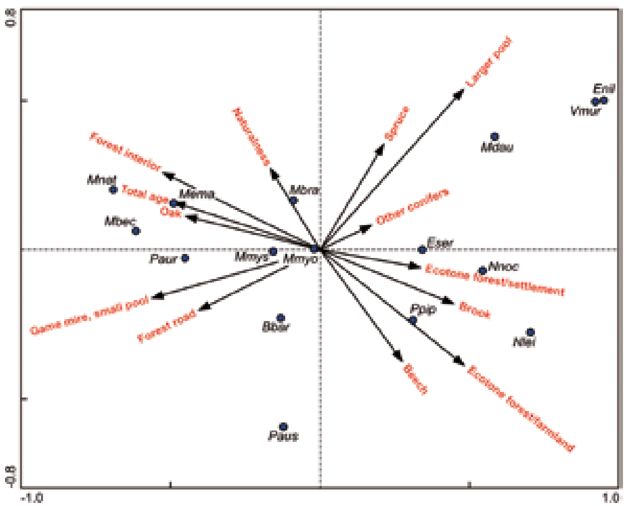

Fig. 1. *Relating presence of bats to environmental factors in forests of Western Carpathians visualised in Canonical Correspondence Analysis (by Kaňuch et al. 2008).*

Fig. 2. A female of Bechstein's bat is preparing to emerge from maternity roost in an oak tree (photo by P. Kaňuch).

Roosting ecology, parasites, diet etc.

Few studies about the roost-site selection of tree-dwelling bats in study area revealed or confirmed already several patterns. Up to present, some limited data about tree roosts characteristics and their occupancy by *N. noctula*, *N. leisleri*, *M. bechsteinii* (Fig. 2), *M. daubentonii*, *M. nattereri*, *B. barbastellus* and *P. auritus* were collected (e.g. Sklenář 1981, Kaňuch 2005, Kaňuch et al. 2005, Kaňuch 2007, Kaňuch & Ceľuch 2007). In general, bats selected tree-hollows that had certain specific features (i.e. older tree-hollows, rotted in their roofs, often made by woodpeckers). However, also different roost-site features were found between the studied bat species (location of entrance, entrance diameter, etc.) whereas hollows were reused frequently during several years as well as alternately by two species (Kaňuch 2005, Kaňuch & Ceľuch 2007). Additionally to the roost-site occupancy, also data about breeding phenology (Kaňuch 2005, Kaňuch et al. 2005), activity patterns (Kaňuch 2007), diet spectra (Ceľuch & Kaňuch 2004a, Kaňuch et al. 2005) or ectoparasites (Kaňuch et al. 2005) of various tree-dwelling species were collected but presented information has very preliminary character and is more a challenge for future research of this interesting group of bats in Western Carpathians.

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Bat fauna of Bratislava: review of last 15 years

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Bratislava, the capital of the Slovak Republic, with its 426,000 inhabitants covers an area of 367.9 km^2. It spreads on the banks of Danube River in the altitude of 126 – 514 m above sea level. Besides urban elements, it is possible to find here also plenty of natural complexes at which the majority of them belong to the protected landscape area Malé Karpaty Mts.

Fig. 1. *A lot of bat roosts in buildings is destroyed by insulation works (photo Roman Lehotský).*

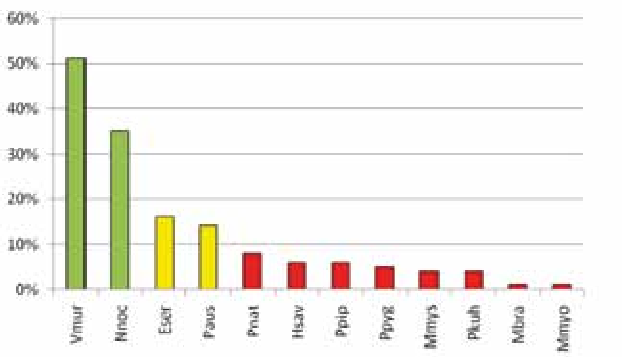

Fig. 2. *Frequency of occurrence of bat species in buildings.*

Old literature data about occurrence of bats in Bratislava territory come mainly from the first half of 20th century. From this period various authors described occurrence of 8 species of bats (*Nyctalus noctula, Vespertilio murinus, Pipistrellus pipistrellus*, *Eptesicus serotinus, E. nilssoni*, *Barbastella barbastellus, Plecotus auritus, Miniopterus schreibersii)* directly from the Bratislava territory and further 4 species (*Myotis myotis, Myotis mystacinus, Myotis daubentonii, Nyctalus leisleri*) from the Bratislava surrounding. Afterward, there was strong decay in the bat study and the intensive research started only in the end of 20th century (e.g. Lehotská 2006).

During last 15 years, 19 bat species (*Rhinolophus hipposideros*, *Myotis myotis*, *M. bechsteinii*, *M. nattereri*, *M. mystacinus*, *M. brandtii*, *M. daubentoni*, *Nyctalus noctula*, *N. leisleri*, *Eptesicus serotinus*, *Pipistrellus pipistrellus*, *P. pygmaeus*, *P. nathusii*, *P. kuhlii*, *Hypsugo savii*, *Vespertilio murinus*, Barbastella *barbastellus*, *Plecotus auritus*, *P. austriacus*) were recorded from Bratislava territory (68 % of the bat fauna of the Slovak Republic). The records come from the following habitat types:

1. Buildings – inside spaces (rooms, corridors), crevices in blocks of flats, crevices between building and roof covering, between building and its facing, etc (Fig. 1). All together, 12 bat species were recorded in buildings, especially during the non-hibernating period but also during the hibernating period (Tab. 1). The most frequently observed species were *Vespertilio murinus* and *Nyctalus noctula* (Fig. 2). Mostly there were solitaire individuals, but also maternity colonies of 3 species (*Eptesicus serotinus*, *Pipistrellus pipistrellus*, *Pipistrellus pygmaeus*) and several winter colonies of *Nyctalus noctula* were found. Several founds of *Hypsugo savii* and *Pipistrellus kuhlii* (species gradually spreading from the south) are also important. First record of *Hypsugo savii* in Slovakia was from Bratislava in 2005 (Lehotská, Lehotský 2006). Concerning *Pipistrellus kuhlii,* first record in Slovakia was also from urban area – from Nitra in 2006 (Ceľuch, Ševčík 2006). In Bratislava, there were found 1 death individual of this species in 2006 (Lehotská 2006) and several alive individuals in 2009.

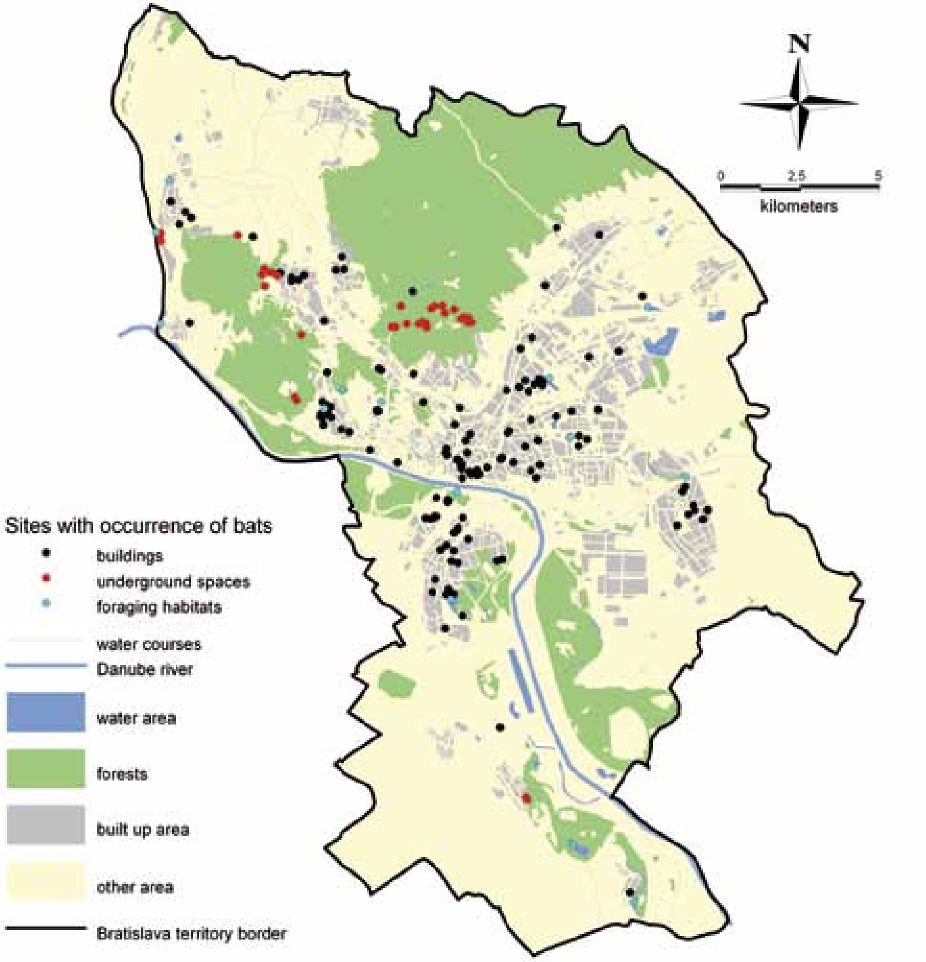

Table 1: Occurrence of bats in various habitat types.

	No. of sites	No. of species	Rhip	Mmyo	Mbech	Mnat	Mmys	Mbra	Mmys/bra	Mdau	Myotis sp.	Nnoc	Nlei	Eser	Ppip	Ppyg	Pnat	Pkuh	Hsav	Vmur	Bbar	Paur	Paus
buildings	161	12		+			+	+				+		+	+	+	+	+	+	+			+
caves	3	5		+							+										+	+	+
mines	2	6		+						+	+			+	+							+	+
cellars	3	4		+						+												+	+
bunkers	27	10	+	+	+	+			+	+				+							+	+	+
foraging habitats	15	8		+						+	+	+	+	+	+	+	+						

Fig. 3. Inside the old military bunker (photo Blanka Lehotská).

Fig. 5. Foraging habitat (photo Blanka Lehotská).

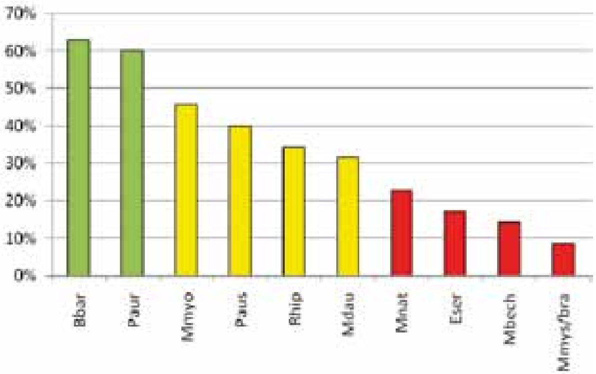

Fig. 4. Frequency of occurrence of bat species in underground roosts.

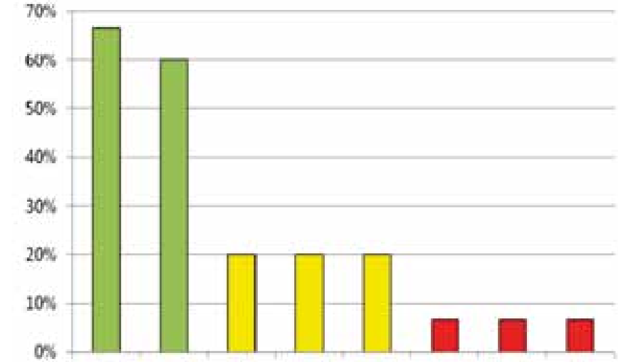

Fig. 6. Frequency of occurrence of bat species in foraging habitats.

2. Underground spaces situated in surrounding forest and used as hibernacula – caves (3 sites, 5 species), old mines (2 sites, 6 species), cellars (3 sites, 4 species), and old military bunkers (27 sites), where 10 bat species were observed (Tab. 1). *Rhinolophus hipposideros*, *Myotis bechsteinii* and *Myotis nattereri* were observed in Bratislava territory only in this habitat type. Bunkers represent the special type of underground roosts (Fig. 3). They belonged to the city fortification in the beginning of the 20th century. They have concrete entrance followed by several times turning tunnel. Approximately 5-10 m far from the entrance, there is an incoming pit in plenty of bunkers. In several cases it is filled up, but in some bunkers it is the only way how to get inside. The overall length of bunkers varies from 10 to 50 m. The most frequent species here were *Barbastella barbastellus* and *Plecotus auritus* (Fig. 4).

3. Foraging habitats – water areas (Fig. 5), forest edges, natural corridors nearby the forest, etc. where the activity of 8 bat species was detected by bat-detector (Tab. 1). The most frequent species were *Nyctalus noctula* and *Pipistrellus pygmaeus* (Fig. 6).

The results confirmed that also urban area can offer to bats a plenty of sites with suitable conditions for their life during the whole year. Almost 200 sites with bat occurrence were recorded in Bratislava territory during last 15 years. Also in the future, urban habitats require enhanced interest of chiropterologists.

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Bats in tree cavities: a long term study 1968 – 2007

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Semi-natural mixed forests of Třeboňsko pond basin (South Bohemia, Czech Republic) provide numerous roosting opportunities to cavity-dwelling bats. Using a combination of direct capturing of bats and audiovisual inspections of tree cavities in a model study area covering some 10 km^2, we studied roost use, population structure and seasonal dynamics of Daubenton's bats (*Myotis daubentonii*) and noctules (*Nyctalus noctula*). These two species were the only bats regularly roosting in tree holes in this region (Gaisler et al. 1979, Hanák et al. 2007).

Tree cavities and their use by bats

Over forty years, we inspected more than 150 tree cavities of which 80 were used by bats. Vast majority (>95%) of occupied cavities were originally excavated by woodpeckers (mostly the Greater Spotted woodpecker, *Dendrocopos major*). The most frequently used roost trees were willow *Salix fragilis* (ca. 30% of all occupied cavities), oak *Quercus robur* (ca. 25 %), lime *Tilia cordata* (ca. 25%), alder *Alnus glutinosa* (ca. 11%) and Scots pine *Pinus sylvestris* (ca. 8 %). Most cavities were inspected in multiple years and thus their re-use could be evaluated. Although more than half of the cavities were occupied for < 4 summers, 35% were re-used for 5–10 years. The longest period a cavity was used was 11 and 16 years for Daubenton's and noctule bats, respectively. Twenty percent of all cavities were occupied solely by Daubenton's bats and 41% only by noctules. The other 39% were used by both species, either at separate times or simultaneously. Our data suggest that the larger volume of a cavity, the longer duration of re-use and the greater the probability of being occupied by both species (Lučan et al. 2009). Contrastingly to a general idea of frequent roost switching in cavity-roosting bats, we observed that many tree cavities were occupied by bats for a significant part of the reproductive season (Lučan 2001).

Population structure of Daubenton's bats and noctules in tree cavities

Altogether, we captured more than 3000 bats (1600 Daubenton's bats in 150 samples and 1400 noctules in 201 samples). Adult females clearly outnumbered males in both species throughout the reproductive period. The skewed sex ratio towards females was

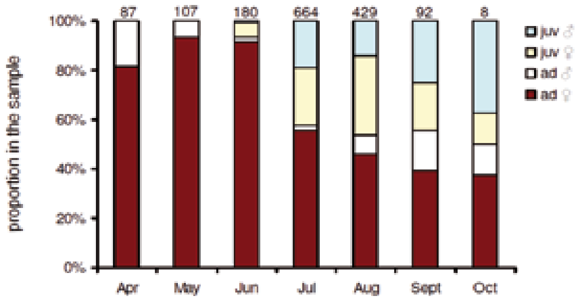

Fig. 1: *Monthly proportion of diferent sex- and age- classess of Daubenton's bats captured in tree cavities in the study area, 1968–2007. Number above each column refers to a total number of individuals.*

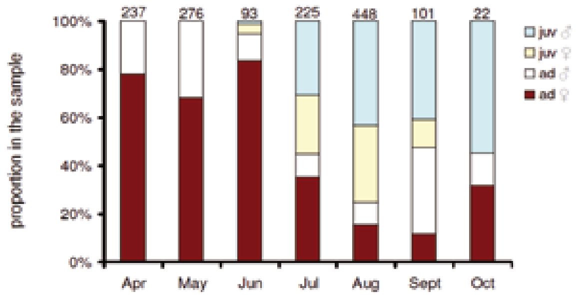

Fig. 2: *Monthly proportion of diferent sex- and age- classess of noctules captured in tree cavities in the study area, 1968–2007. Number above each column refers to a total number of individuals.*

more pronounced in Daubenton's bats (Figure 1) than in noctules (Figure 2). Group composition varied throughout the season in both species (Figure 3 and 4). The major difference between the two species was regular formation of multi-male groups in noctules, while this type of aggregation was rather rare in Daubenton's bats.

Phenology and seasonal dynamics

Both species started to occupy tree cavities from the end of March/beginning of April based on local weather conditions.

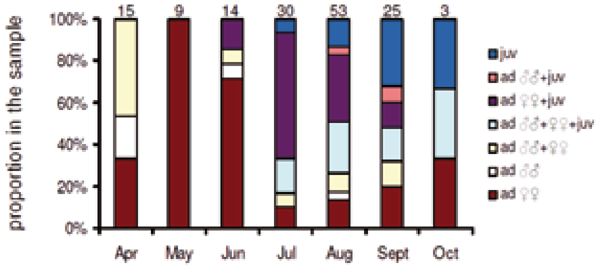

Fig. 3: Different types of aggregations of Daubenton's bats found in tree cavities in the study area, 1968–2007. Number above each column refers to a total sample size.

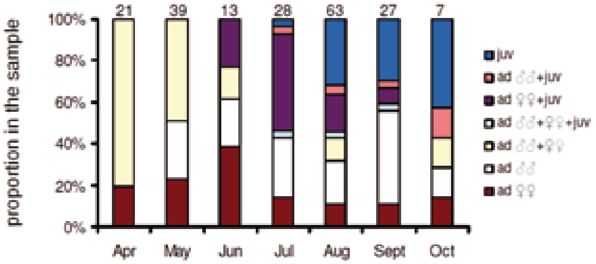

Fig. 4: Different types of aggregations of noctules found in tree cavities in the study area, 1968–2007. Number above each column refers to a total sample size.

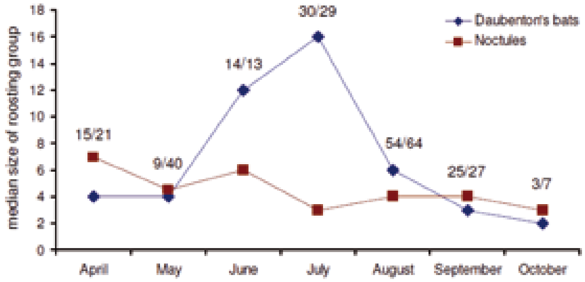

Fig. 5: Seasonal dynamics in group (colony) size of Daubenton's bats and noctules occupying tree cavities in the study area, 1968 – 2007. Numbers above each couple of marks refer to total sample size for Daubenton's bats / noctules.

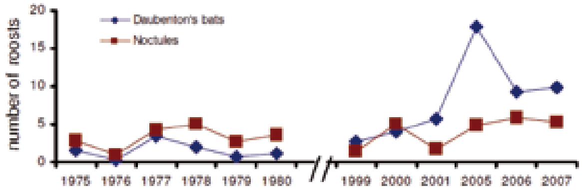

Fig. 6: Long-term trends in numbers of occupied roosts in the study area. Only years with representative datasets are shown. Total number of occupied roosts was adjusted to research effort in particular year.

Timing of reproduction was well synchronized between the two species. Females gave birth in the first half of June and first volant juveniles appeared as early as last week in June. The two species displayed different seasonal patterns in the size of colonies in tree cavities (Figure 5). In Daubenton's bat, the largest type of aggregations occurred in July and contained both adult males and females and juveniles. In noctules, largest groups comprised adult females and their young during August, considerably large groups composed of adult males and females were found also in April.

Long-term changes in abundance of the two species in the study area

Monitoring of long-term changes is generally difficult in bats and even more challenging in the case of forest bats (Weller 2007). Our long-term data provide an excellent opportunity to achieve this goal. To assess long-term changes in numbers of bats living in the study area, we compared yearly numbers of occupied roosts from two time periods (1975 – 1980 and 1999 – 2007) for which representative datasets existed. Between 1975 and 2007, number of noctules remained stable or only slightly increased, however, numbers of Daubenton's bats increased more than five times over the study period (Figure 6). While increase of Daubenton's bats well corresponds with trends observed in hibernacula elsewhere, our long-term estimate of population trends in noctules is, to our knowledge, a unique in Europe and there are no comparable data available in the literature.

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Activity and ecological parameters of bat hibernation in caves of the Moravian karst

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The ecology and behaviour of temperate zone microchiropteran bats are fundamentally affected by seasonal changes in day length and associated climatic variables, which become more pronounced at increasing latitudes. These changes require flexible behavioural adjustments of their circadian as well as circannual activity patterns.

A characteristic feature of the annual cycle of insectivorous temperate zone bats is hibernation, as an optimal adaptation to a prolonged fall in temperature and reduction in prey availability. Selection of suitable hibernation site is crucial for overwinter survival and caves and mines are the most common type of hibernacula.

Our research conducted during last 15 years in several model caves in the central part of Moravian karst was aimed to various aspects of bat hibernation including the variation of flight activity of bats at the entrance of cave (seasonal and overnight) and different factors which influence it, the selection of places with specific parameters within a hibernaculum and the level of bat movement activity during hibernation period, the thermo-preferendum of various bat species etc.

Two major model species are studied i.e. mouse-eared bat *Myotis myotis* and lesser horseshoe bat *Rhinolophus hipposideros* by means of various research methods including visual census without any handling and marking of animals, as one of the main requirements of our research is to avoid any disturbance of the hibernating bats, automatic recording of activity with a double infrared-light logging system, census by night-vision scope, measurement of thermal parameters with non-contact thermometer.

The results published in a series of separate papers (see below) can be summarized as follows:

Based on the major pattern of the bat flight activity, five distinct periods can be distinguishes. All the periods showed a non-random temporal distribution and a concentration of flight activity around specific time and its level was influenced by climatic factors. However, the effect of individual variables and their contribution to variability in activity levels changed during the year.

(1) Hibernation period (half November – beginning of March), with very low activity. During hibernation, average temperature (T_{avg}) and the range of daily temperature ($T_{dif\ Max\text{-}Min}$) were the best predictors of the general level of activity. The percentage of nights on which activity occurred increased with increasing temperature. Activity occurred even at temperatures <0°C (T_{min} = -13.2°C). The recordings were all positive at T_{max} ≥6.2°C. The activity within corresponding temperature groups was significantly lower during hibernation than during late hibernation. (2) Late hibernation (March – mid April), with intensive departure during the first quarter of the night. Flight activity was positively affected by T_{avg}, and negatively by minimal temperature of the preceding day. (3) Departure period (mid April – beginning of June), with emergence activity in the first quarter, and a small number of bats entering the cave in the fourth part of the night. The peak of activity was in the second part of the night. A significant positive relationship was found between total daily activity and T_{avg} and P_{avg} (mean barometric pressure). Rainfall in the preceding day caused drop in activity levels. (4) Summer period (beginning of June – mid/ end July), with low activity. Activity increased as $T_{dif\ Max\text{-}Min}$ increased and was suppressed by rainfall in the preceding day. In contrast, rainfall in the study day caused increase in activity. Differences were also apparent in the course of the night. (5) Autumn period (late July – half November), with very high activity and increasing number of bats entering the cave. The peak of activity was around midnight. The activity was positively related to T_{avg}, P_{avg} and amount of rainfall in the study day.

Hibernation is usually interrupted by periodical arousals. Such arousals may concern drinking, feeding (in mild periods), or even mating but switching hibernation site (i.e. leaving of used site) was not registered. Movement activity of bats inside of hibernaculum, expressed as percentage of new findings during a particular visit, was registered during the whole winter season.

Its level fluctuated in different ways and the hibernation period of *R. hipposideros* could be divided into three different parts (early, deep and late hibernation), while the level of *M. myotis* movement activity was relatively high during all season.

The shelter selection of *R. hipposideros* did not change during the season and it was not dependent on the part of cave where the bats were hibernating. Hibernating specimens of *R. hipposideros* most frequently used exposed places, in which they were always hanging free. *M. myotis* was registered in all types of shelter. High vulnerability of *R. hipposideros* to human activities was not registered as the specimens (continuously increasing number during the last 8 years) were able to hibernate next to frequently used footpath in the cave visited by speleotherapy patients. However, *R. hipposideros* is a highly specialized species which prefers parts of the cave with very stable microclimate conditions (stable temperature and humidity with minimal air flow) and, on the contrary, *M. myotis* appears to be indifferent to all parameters studied, and it uses the shelters indiscriminately.

The results of comparison of *Myotis myotis* hibernation in two natural caves indicate that the bats are using various strategies of hibernation (level of movement activity, preference of different types of shelters) in caves with different microclimatic profile (dynamic vs. stable). Additionally, the level of clustering behaviour is different (number, stability and size of clusters of hibernating bats). Used strategies are always tend to the same target i.e. use of roost place with maximum stable microclimate during the late part of hibernation period. High fidelity of bats to the particular underground shelter also suggests that accepted strategy of hibernation limits the bats in consecutive use of hibernacula.

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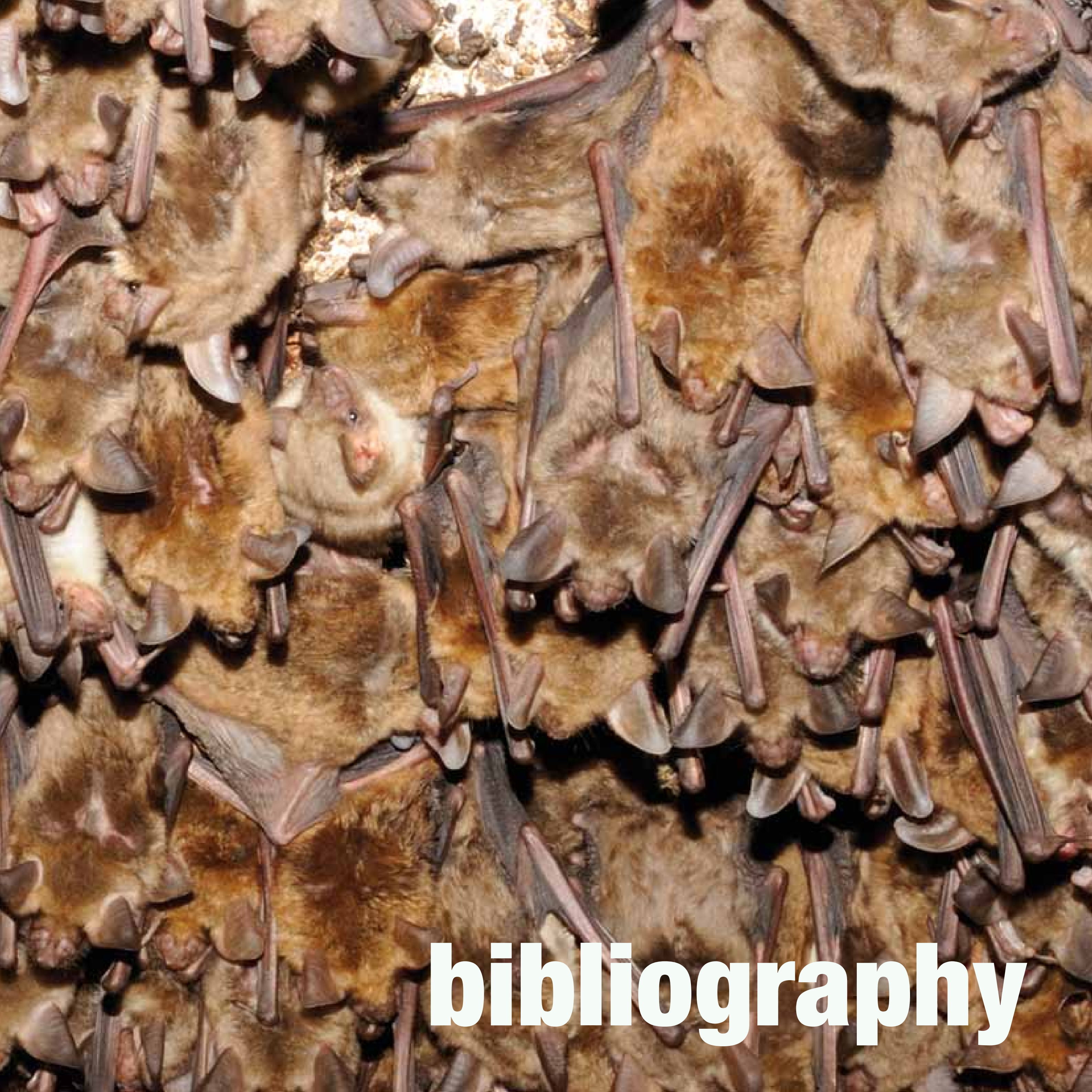

bibliography

Bibliography of Czech and Slovak bat research literature

by **Vladimír Hanák, Miloš Anděra and Marcel Uhrin**

The following pages provide almost complete list of the bibliographic references to the primary literary sources in bat research from the Czech and Slovak Republics, including the former Czechoslovakia and the earliest history of the branch in the former Austria-Hungary Empire. Most of the secondary literature, journalistic issues, popularizing articles and books were excluded of the present survey and will be published elsehere.

In the present form the list provides 1258 references to original papers, short notes and books either devoted to bats of the Czech and Slovak territories and/or produced by the students residents in these countries. Further 249 items reports the contributions presented at the international conferences in bat science as recorded by their abstracts in respective proceedings. The third part of the list covers 186 unpublished theses dealing with the bat research topics deposited in libraries of Czech and Slovak Universities. Besides diploma /master (MSc) theses, which have been obligatory prerequisite for acomplishing the university graduation (and which, hence, provide the most complete reference to the amount of education effort devoted to bats) it includes the doctoral theses referring to degree PhD / CSc., extended master theses (RNDr.) included when different from the MSc. of the respective author, the Associate Professor habilitation and D.Sc. theses (the highest degree covered by the list), and in a limited extent also bachelor (BSc./BC. theses), namely from the last 10 years when BSc. theses are obligatory step of the university graduation and are to be officially deposited in university libraries.

Although the present list is not complete in the technical sense of the word, it provides quite reliable illustration of the history and variation of the literary production devoted to biology of bats in our countries throughout last three centuries.

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M. emarginatus,
M. alcathoe,
M. mystacinus,
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M. daubentonii,
M. dasycneme,
Eptesicus nilssonii,
E. serotinus,
Hypsugo savii,
Vespertiolio murinus,
Pipistrellus pipistrellus,
P. pygmaeus,
P. nathusii,
P. kuhlii,
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