



Noctule (*Nyctalus noctula*), forest bat species dwelling tree holes in summer Photo by E. Stuchlík

## Do we understand the life of our bats?

Bats seem to be the group of mammals most veiled in nonsensical superstitions and myths. Most of these superstitions are the result of insufficient knowledge about their lives, and this situation originates in the imperfection of our senses, which do not allow us to penetrate the secrets of bats' hidden nocturnal life without the help of modern equipment.

### Systematics

Bats belong to the group of Chiroptera, which is, after rodents, the most numerous group of mammals, with more than 1 000 species. Chiroptera are also the only mammals capable of active flight. Until recently, they were divided into two groups – megabats (Megachiroptera) and microbats (Microchi-



Whiskered Bat (*Myotis mystacinus*)

Photo by Z. Řehák

roptera). Today, this division is already outdated. Studies of molecular genetic features have demonstrated a phylogenetic affinity between megabats and some groups previously ranked among microbats. Based on these findings, Chiroptera have been divided into two sister groups – Pteropodiformes (Yinpterochiroptera) and Vespertilioniformes (Yangochiroptera). The first one consists besides 170 species of pteropine bats (Pteropidae) other 156 species in 5 families from former microbat group also. Our horseshoe bats belong to one of that families (Rhinolophidae). The Vespertilioniformes (Yangochiroptera) group comprises more species – all other remaining bat species (685 species).

### Bats in Europe and in the Czech Republic

Only one species of a fruit-bat – the Egyptian fruit-bat (*Rousettus aegyptiacus*) – and 5 species of horseshoe bats (*Rhinolophus spp.*) occur in Europe. From the second group of chiropterians, 34 bat species in two families live in Europe – Molossidae (with only one species, the European free-tailed bat – *Tadarida teniotis*) and Vespertilionidae (Vesperbats). This number is not final, because some

sub-species acquire the status of independent species with the development of genetic methods. New species of genus *Pipistrellus*, *Nyctalus*, *Plecotus*, as well as *Myotis*, have appeared. On the territory of the Czech Republic, the occurrence of 2 species of horseshoe bats and 22 species of (Vespertilionidae) has been confirmed. The occurrence of another species – the Greater noctule bat (*Nyctalus lasiopterus*) – hasn't been evidenced unambiguously, but it is probable. It is a rare species throughout the whole Europe. However, it has been recorded repeatedly in Slovakia in recent years. The appearance of another species is expected – the *Pipistrellus kuhlii* – which is known e.g. from Vienna, and the occurrence of which has been confirmed in Slovakia as well.

Due to genetic features, so called cryptic species, which were once considered to be one species, have been differentiated. Cryptic species are difficult to distinguish morphologically; the most reliable identification features are the molecular genetic markers exactly. Within the bat fauna of this country, there are two pairs of species previously hidden under one name – the Common pipistrelle and the Whiskered bat. One bat from the first pair originated from the Common pipistrelle kept

*We can encounter bats relatively often, as some of our species have adapted to life in human settlements or in their vicinity. The rescue station at the Brno Zoo accepts bats every year; last year, there were five common pipistrelles and two noctules that flew into a flat through an open window or people found them hidden in various parts of buildings. All bats that arrive at the rescue station are handed over to the employees of the Department of Botany and Zoology of the Faculty of Science of the Masaryk University in Brno for species identification and determination of their sex, age and condition. Specialists from the faculty register each bat and, when it is in good condition, they release it. The way of life of our bats is not very well known generally. Readers of the Zoo Report can learn more about it in an article published in this magazine. (red)*



Lactating female of Common Pipistrelle (*Pipistrellus pipistrellus*) with its suckling infant Photo by D. Horáček

its original name – the Common pipistrelle (*Pipistrellus pipistrellus*) and the other one was named the Soprano pipistrelle (*Pipistrellus pygmaeus*). Recently the *Myotis alcaethoe* was described and also recorded in our country in 2005, and this is a bat which can be distinguished reliably from a very similar bat, the whiskered bat (*M. mystacinus*), especially using genetic markers. It is interesting that all of these cases involve the smallest species of European bats. The third relatively new member of our bat fauna is another smaller species of southern origin – Savi's pipistrelle (*Hypsugo savii*). It was found for the first time in South Moravia as late as in 2002.

Of the two critically endangered horseshoe bats with typical horseshoe-shaped membranous flaps of skin surrounding the nostrils, the Lesser horseshoe bat (*Rhinolophus hipposideros*) can be encountered the most frequently, while the other one, the Greater horseshoe bat (*R. ferrumequinum*) flies onto our territory very rarely. Only the first species reproduces here commonly, and it is one of the species, whose population size has been increasing significantly over the last two decades. Our other bat species do not have flaps around their nostrils, but they do have a fleshy projection which covers the entrance of the ear – the tragus. Some of these bats can be found in a variety of places – not only in the countryside but also in human dwellings. After watching Fruit-bats in the zoo or on TV, the general public believes bats to be large animals. However, the wingspan of our largest species – the Greater Mouse-eared bats (*Myotis myotis*) – measures only up to 43 cm and the length of its body, including the tail, does not exceed 14 cm. The majority of our species are significantly smaller.

### Food and Foraging Strategies of Bats

Except Egyptian fruit-bat all European bats feed on insects and other small arthropods,

which they forage at night, with a few exceptions. Bats have developed a wide range of morphological adaptations that enable them to use a variety of foraging strategies and thus to hunt a wide range of prey. Our bats are typical feeding opportunists and they hunt for food that is easily available and easy to catch at a given time. It isn't true, of course, that every species is able to catch everything. Foraging abilities depend on the construction of the wing apparatus, which affects flying ability, and, together with the means of prey detection, governs the success of the hunt. For example, the Greater mouse-eared bat (*Myotis myotis*) forages small ground beetles in such a way that it collects them from the ground surface. On the other hand, another big species – the noctules (*Nyctalus noctula*) – often hunt air "plankton" at great heights. You can often observe it even in daylight, hunting above meadows, forest clearings or ponds. Another big species, the Serotine bat (*Eptesicus serotinus*), similarly to

the previous species, starts foraging still in daylight. You can often see it foraging around street lamps. Other species, such as e.g. the Brown long-eared bat (*Plecotus auritus*), the Lesser horseshoe bat (*Rhinolophus hipposideros*) etc. forage in complete darkness, in thick entanglements of bushes and in the crowns of trees, where they catch insects in flight using elegant maneuvers. The Natterer's bat (*M. nattereri*) or the Geoffroy's bat (*M. emarginatus*) can manage to glean their prey from a leaf surface with the help of their tail membrane. Many fishermen, who sit near water in the evening, have certainly met the plentiful Daubenton's bat (*M. daubentonii*), which trawls small insects, like chironomids, from the water surface with the help of its tail membrane or hind paw while flying close above it.

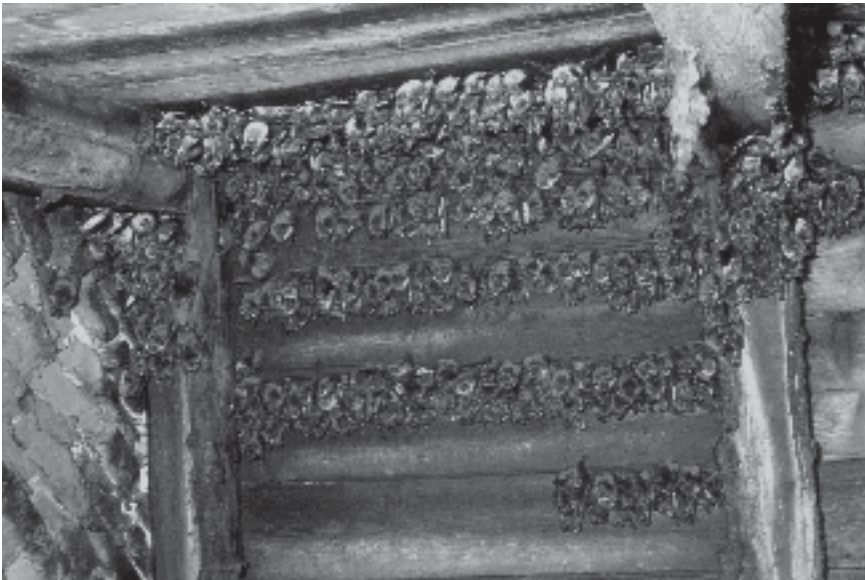
### Echolocation

Apart from an efficient flying apparatus, bats need detection equipment for hunting and spatial orientation, which enables them to avoid obstacles or register suitable prey in complete darkness. This can take place with the help of what is known as echolocation, which can be observed by other mammals as well, e.g. dolphins, although bats have brought this navigation system to perfection. It consists in the ability to emit an ultrasound signals with its vocal apparatus and then register its reflection from obstacles with its hearing. The brain then analyzes the obtained information with great speed, because the bat is able to avoid obstacles, even of a cobweb's width, very briskly or attack its prey in a flash. In the light of this information, the superstition about bats getting entangled in long hair sounds absurd. Today, the echolocation signals of bats have been examined relatively thoroughly. Specialists are not only able to identify many species of bats with the help of ultrasound detectors,



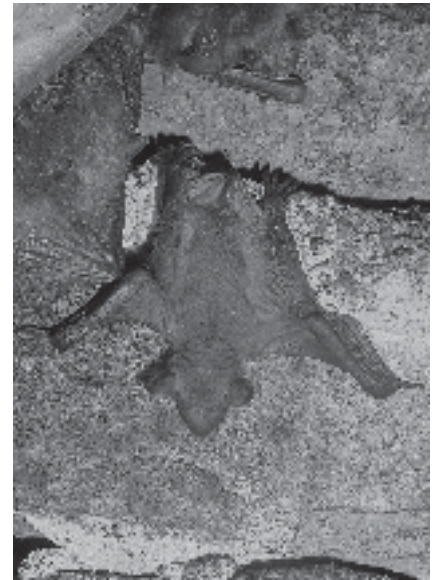
Winter cluster of barbastelles (*Barbastella barbastellus*) hibernating in galleries near Malá Morávka (Jeseniky Mts) Photo by M. Józsa





Nursery colony of large mouse-eared bats (*Myotis myotis*) on the loft

Photo by D. Horáček



Unfledged juvenile of Large Mouse-eared Bat

Photo by D. Horáček

but can also find out, what the bat is doing during its flight, i.e. whether it is looking for prey or attacking it at that moment. The diversity of echolocation signals is influenced by the habitats, where the bats are moving at the moment. Apart from their outstanding hearing, other senses of bats, including sight, are well developed as well.

### Annual Cycle

In order to understand the lives of these nocturnal animals, it's necessary to know their annual cycle. At the end of the summer and in the autumn, some bat species set off on a journey, similarly to insect-eating birds, and gradually move to their winter roosts, driven by the lack of food and unfavourable climatic conditions. During these migrations, they can overcome a distance of even several hundreds of kilometres; rarely, migrations exceeding 1000 km have been recorded. Migration is typical mainly for tree species that normally don't visit underground spaces. It is the case of e.g. the Leisler's bat (*Nyctalus leisleri*) or the Nathusius's pipistrelle (*Pipistrellus nathusii*). Not all individuals from a given migratory species seem to migrate to the south; part of the population survives the winter even in central European conditions. In recent years, this is typical e.g. for the noctule (*N. noctula*), which also hibernates in tower blocks in housing estates. Movements to winter roosts are usually shorter. The majority of our species simply move during the autumn to nearby hibernacula, which offer appropriate conditions for hibernation.

During the period of autumn movements, bats show high foraging activity. This is quite understandable. The flight itself is energetically very demanding and it requires large supplies of food. Bats that hibernate in the cold conditions of Central Europe have to create sufficient supplies of fat to help them cover their energy consumption during the whole winter.

In late summer and in autumn, the bats "think about the future". They visit temporary roosting places, where sexually active individuals mate. The males of certain species lure females into their shelters either acoustically or by "display" flights. Temporary harem formations are created in this way – one male shares a common shelter with several females for a short time. However, promiscuous behaviour is also common for females, who can visit the mating roosts of several males during these mating season. However, this "rutting season" doesn't lead to immediate fertilization, because the young would be born during a climatically, and therefore also food-wise, very unfavourable period. This is prevented by so-called "delayed fertilization", which is typical of all our native species. The female stores the sperm after mating inside her reproductive tract and the actual fertilization, i.e. the fusion of sperm and egg, takes place after her waking from hibernation and leaving hibernaculum in spring after leaving their winter roost.

In some of our towns, you can observe a unique phenomenon in the late summer – invasions of sometimes relatively large numbers of young common pipistrelles (*Pipistrellus pipistrellus*) flying into human dwellings, often even in daylight, for reasons which are not completely known. If they can find their way out, they leave after few days. This phenomenon has been observed over several years in Brno, but it is known from other towns as well, and not only in our country.

Bats that spend the winter in our country inhabit various types of hibernacula mostly underground. Often, large numbers of bats gather in suitable winter roosts having arrived from relatively large areas. The regular annual censuses of hibernating bats give us an idea about the size of bat populations and its changes. Caves are chiefly important winter mass roosts. Abandoned mines also offer appropriate conditions

for hibernation, i.e. a constant temperature within an optimum range of 4–8 °C and relative humidity approaching 100%. Certain species can even hibernate outside, particularly in deep rock crevices. You can also often see bats in towns. The mentioned noctule (*N. noctula*), otherwise a common forest species dwelling tree hollows during the summer, visits housing estates in the winter and hides in gaps behind concrete panels and in ventilation shafts, often in large numbers.

During the winter period, bats fall into a deep lethargic state that is called hibernation. During hibernation, the level of their metabolism decreases to minimum, which, naturally, decreases energy expenditure considerably. This energy-saving measure is accompanied by decrease of pulse and breathing frequency. For example, the pulse frequency, which ranges from 500–800 pulses per minute during flight, decreases to a value of 4 pulses per minute during hibernation, which is up to 200 times less. Also the body temperature, which affects the speed of metabolic processes, decreases from 37° C during the active period to a temperature approximating the winter roost, which can be only a few degrees above freezing point. This prevents unnecessary heat loss. It would be wrong to think that bats sleep through the whole winter. They often wake up, move to different parts of their roost, or just have a short flight and return to their original place; sometimes, they even fly out and move to other nearby hibernacula. Bats have a good memory for the specific shelter, where they hibernate in the winter. There are also known cases that the same individual hibernated in the same place for years. When the winter is too long or when the bats are woken up forcibly and frequently, their energy supplies can run out at a time, when there is no food available outside. This leads to increased mortality, which affects mainly the juveniles that didn't reach such

mastery during their autumn hunting training as to be able to create sufficient fat supplies for the winter. In addition to that, they don't have enough experience to choose the most suitable winter roost for hibernation.

Bats leave their winter roosts after it gets warmer in the spring. Before they reach their summer "residence", they often move between several temporary roosts. In this period, the females activate their "stored" sperm and ovulation takes place, followed by fertilization. Pregnant females then gather in their refuges, where they form numerous "summer colonies". They give birth in them after approximately 2 months of pregnancy and rear their young afterwards. Births take place in June and in the first half of July. After 4 to 6 weeks of suckling, the young become independent and as early as in the middle of July, they emerge from the roost of maternity colony in search for food. Their development and growth is so fast that they are only a little smaller than their mothers when they gain independence. During August, they already reach adult size and are often hard to distinguish from adult bats. For some species, from several hundred up to a thousand females congregate in the summer colonies. In the Bracken Cave (USA), up to 20 million Brazilian free-tailed bats (*Tadarida brasiliensis*) gather every year. In our conditions, however, the females form reproduction colonies in large underground spaces only exceptionally. Most frequently, they look for lofts in houses, where they can hang freely in groups under the roof vault, or hide between the beams or under the roof covering. Forest species that avoid human dwellings in the summer inhabit tree hollows. The size of the aggregations of females and their babies is obviously limited by the capacity of the roost. It is logical that the largest colonies are found in towers and large lofts of churches, castles etc. The most numerous and also the most

obvious colonies in our country are formed by the Greater mouse-eared bat (*M. myotis*). The males and young specimens of both sexes, who are still not involved in reproduction, can only rarely be encountered in the colonies of females with young; the males usually lead solitary lives during this period. Only the males of the Parti-coloured bat (*Vespertilio murinus*) form more numerous 'men's clubs'.

### **Bats and Their Habitats Are Both Protected by Law**

Similarly as in the winter roosts, there is a high concentration of animals in summer colonies, which can bring about a serious threat to the bats from the side of humans. Bats have a different reproductive strategy in comparison with similarly large rodents. Rodents are able to eliminate high losses by the offspring overproduction, several births a year and a rapid attaining of sexual maturity. On the other hand, they live to a lower age than bats. Bats only rarely begin reproducing in the first year of their lives; females give birth to only one young in the majority of cases, and not even every year. A higher frequency of twins is encountered only for certain species, e.g. the noctule (*N. noctula*) or bats of the genus *Pipistrellus*; females of the Parti-coloured bats (*V. murinus*) twin regularly. When you add the high mortality rate among the young in the first year of their life, it is logical, due to this strategy, that there is no danger of bats' "outbreak", as by the small rodents. Even though respectable age records have been registered (over 37 years), the average longevity of bats is about 3-5 years, and one female of most of our native species only gives birth to 3-5 young on average. It can be concluded from this that any negative human intervention against the summer colonies or destruction of winter mass roosts can cause a drastic decline of the

population of certain species, and the return of these populations to their original state can take a very long time.

However, humans often help many bat species, often unknowingly, by letting them inhabit unused parts of their dwellings, which can serve as alternative summer or winter roosts for them. These places are often even better for bats than the natural roosts, which have disappeared in central Europe in many cases. The village environment, which has a higher air temperature than the surroundings, is advantageous for bats also for the reason that insects can accumulate there and serve as an easily accessible prey. For example, the proof of this is the high activity of certain species in the vicinity of street lamps. The UV component of the light is irresistibly attractive for certain groups of insects.

To finish with, it is necessary to point out that 13 of our bat species are protected by the still valid ordinance No. 395/1992 Coll. of law 114/1992 Coll. regarding the conservation of nature and landscape. According to article 5 of the mentioned law, other bat species are also protected. Their roosting places are also protected. The Czech Republic is a signatory of the Agreement on the Conservation of Bats in Europe (called EUROBATS). According to this agreement, all species of bats are protected. Also the directives of the European commission are binding for the Czech Republic. Directive No. 79/409/EC on the conservation of natural habitats of wild fauna and flora concerns bats as well; in its supplementary materials, there are 11 species of bats living on the territory of the Czech Republic. The Czech Bat Conservation Trust (CBCT) is engaged in the bats' protection and bat-research in the Czech Republic; its internet pages ([www.ceson.org](http://www.ceson.org)) give a complete information service.

Zdeněk Řehák, Ph.D.



Winter colony of lesser horseshoe bats (*Rhinolophus hipposideros*) in the Na Turoidu cave Photo by J. Chytil



Hibernating Lesser Horseshoe Bat (*Rhinolophus hipposideros*) wrapped in its wing membranes Photo by D. Horáček