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Habitat use, diet and food availability in a population of *Barbastella barbastellus* in a Swiss alpine valley

Standortnutzung, Nahrung und Nahrungsverfügbarkeit in einer Population von *Barbastella barbastellus* in einem Tal der Schweizer Alpen

Utilisation de l'habitat, régime et disponibilités alimentaires d'une population de *Barbastella barbastellus* dans une vallée alpine de Suisse

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Summary

By means of radiotracking, fecal analysis and assessment of food availability, I attempted to understand the reasons of the decline of the Barbastelle bat in western Europe. With the help of vegetation surveys on foraging grounds selected by the bats the preference for productive, richly structured forests was highlighted. The Barbastelle exhibited a very specialized diet on *Lepidoptera*, especially on *Microlepidoptera*. As its main preys possess auditory organs able to hear bat ultrasounds, the Barbastelle must have evolved calls out of moth hearing range and of lower intensity. Caterpillars of moths are the most relevant agricultural pests and thus it is likely that a wide spectrum of insecticides impoverished farming areas and probably contaminated the Barbastelle bat.

Zusammenfassung

Mittels Telemetrie, Kotanalyse und Einschätzung der Nahrungsverfügbarkeit versuchte ich, die Gründe des Rückgangs der Mopsfledermäuse in Westeuropa zu verstehen. Mit Hilfe von Vegetationsbegutachtungen auf dem auszuwählenden Nahrungsgebiet wurde bei der Mopsfledermaus die Vorliebe für produktive, reichstrukturierte Wälder hervorgehoben. Die Mopsfledermaus bevorzugt als Nahrung *Lepidoptera*, besonders die *Microlepidoptera*. Da diese wichtigen Beutetiere ein Hörorgan besitzen, das die Ultraschalltöne der Fledermäuse wahrnehmbar macht, muß die Mopsfledermaus Laute entwikkelt haben, die außerhalb der Hörreichweite der Nachtfalter liegen und auch von geringerer Intensität sind. Raupen der Nachtfalter sind die größte landwirtschaftliche Plage, und es ist möglich, daß der Einsatz einer enormen Palette an Insektiziden landwirtschaftliche Gebiete ernsthaft schädigte und vielleicht sogar die Mopsfledermäuse verseuchte.

Résumé

Par le biais du radiotracking, d'analyses fécales et de l'estimation de l'offre en nourriture, on a essayé de comprendre les causes de la raréfaction de la Barbastelle. En faisant des relevés de végétation sur les terrains de chasse sélectionnés par les chauves-souris, on a pu mettre en évidence la préférence pour les forêts très productives et structurées en différentes strates. Son régime alimentaire s'avère extrêmement spécialisé sur les Lépidoptères, particulièrement sur les Microlépidoptères. Comme ses principales proies possèdent des tympans capables d'entendre les ultrasons des chauves-souris, la Barbastelle a dû développer des ultrasons hors de la plage d'audition des papillons et de faible intensité. Les chenilles de papillons nocturnes étant les principaux ravageurs de l'agriculture, il est vraisemblable que les traitements insecticides à large spectre ont appauvri nos campagnes depuis le milieu du siècle et peut-être contaminé la Barbastelle.

Introduction

As the Barbastelle has been recognized as one of the most endangered bat species over much of Europe (STEBBINGS 1988, SCHOBER & GRIMMBERGER 1989, RYDELL & BOGDANOWICZ 1997), I attempted to understand the main reasons for this drastic decline in western Europe by investigating the ecology of a small Swiss population.

Material and methods

Study area

The study took place at Mt Chemin (46°6' N, 7°6' E) above Martigny in an alpine valley of the canton Valais (southwestern Switzerland) in 1992-1993. A dominant xeric pine forest (*Pi-*

nus sylvestris, Deschampsio-Pinetum caricetosum humilis), irregularly mixed with steppe (*Stipo-Poion*), oaks (*Quercus pubescens*) and spruces (*Picea abies*) in the coolest parts, is the characteristic vegetation (Fig. 15 F) of the continental climate prevailing in this region (OZENDA 1985, PLUMETTAZ-CLOT 1988, WERNER 1988). The main feature of the study site is the lack of a strong human pressure, and this area can be considered as quite uninhabited except the small village of Chemin-dessus. There are only a few houselamps in the village.

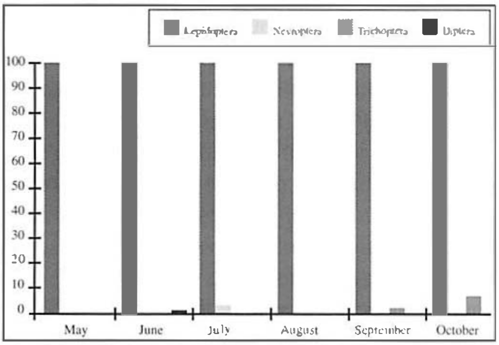

Fig. 1. Frequencies of insect orders in 174 droppings from Mount Chemin in 1992-1993

Abb. 1. Häufigkeit der Insektenarten in 174 Kotballen vom Mont Chemin von 1992-1993

Fig. 1. Fréquences des ordres d'insectes dans 174 crottes du Mont Chemin en 1992-1993

Radiotracking and habitat selection

Habitat use by the bats was determined by radiotracking. The Barbastelle bats were mist-netted at the entrance of two abandoned magnetite mines at 1150 m altitude.

They were fitted with small glue on (cyanoacrylate) radiotransmitters (0.65-0.68 g) from Holohil Systems Ltd. in Canada. Bats were tracked on foot by a single observer with a radioreceiver (Yaesu FT-290RII) and a H antenna following the homing-in on the animal method (WHITE & GARROTT 1990). The total home range prospected was delimitated with the MC Paal package (STÜWE 1985) and its minimal convex polygon. The whole surface was divided in squares of 0.25 ha and classified as „visited" (more than two minutes of flying activity) or „avoided". A night scope allowed the observation of foraging flights of Barbastelles. A small bat detector Mini II and AHLÉN's (1990) key were used to confirm visual contacts.

In order to identify habitat selection by the bats surveys of vegetation structure concerning 19 environmental variables were carried out in the areas used or avoided during foraging activity. The matrix was then submitted to a stepwise regression analysis (see SIERRO in prep.).

Diet and food availability

Diet composition was estimated through fecal analysis by collecting droppings from mist-netted bats. MCANEY's et al. (1991) key was used to identify insect fragments. Seasonal evolution of food availability was assessed by light trapping insects (type BAGGIOLINI & STAHL 1965) in the foraging habitat from April to October 1992 and 1993. To estimate food availability above canopy three small Malaise traps were affixed individually to the top of a pole (Fig. 16 F) and three others were suspended to a balloon, inflated with helium, at 8 m high (Fig. 17 F). A rope bound the installation to a big stone on the ground. The work of KALTENBACH & KÜPPERS (1987) was used to identify smaller moths and LERAUT's (1980) list for the systematic classification.

Results

Habitat use

Of the twelve radiotracked individuals, nine gave information on foraging areas during 19 nights. Mainly, the loss of signal emission was due to inaccessible rocky areas or unfavourable meteorological conditions. The Barbastelles foraged in the pine forest between 650 to 1200 m altitude (Fig. 18 F). They used the most productive pinewood characterized by a thick litter cover, a shrub layer (Fig. 19 F) and the occasional presence of oaks. They clearly avoided meadows, human settlements, pure spruce forest and the poor pinewood growing on stony grounds. In spring (June) and autumn (September-October), the Barbastelles used a wider foraging area (Table 1), especially towards the lower parts of the hill, than in summer (July-August), which is probably due to small prey number in the uppper parts. But the difference was not significant (Kruskall-Wallis test $p >$

0.05). The average home range reached 8.8 ha (SD±5.8 ha, n=8). Roost sites were discovered in rock crevices and emerging Barbastelles were seen hunting above the tree crowns at 8-10 m high from the ground. The flight was straight with deep wingbeats and sudden downwards swerves probably for preying upon an insect.

Individu	Date	Aire de chasse
N 134	16.06 - 17.06.1992	0.0113 km²
N 141	22.06 - 23.06.1992	0.1337 km²
N 201	27.06 - 30.06.1993	0.0425 km²
N 133	14.09 - 16.09.1992	0.0612 km²
N 148	08.10 - 09.10.1992	0.1513 km²
Average area	June, Sept.-Oct.	0.0800 km²
N 139	31.07 - 05.08.1992	0.0425 km²
N 144	11.08 - 13.08.1992	0.1100 km²
K 592	10.08 - 13.08.1992	0.0187 km²
Average area	July-August	0.0570 km²

Table 1. Areas prospected by the 8 Barbastelles with seasonal means

Tab. 1. Gebiete untersucht an 8 Mopsfledermäusen mit saisonalen Durchschnitten

Tableau 1. Aires prospectées par les 8 Barbastelles, avec les moyennes saisonnières (juin, septembre-octobre) et l'été (juillet- août)

Diet

The analysis of 174 droppings revealed a very specialized diet on *Lepidoptera* (99% by frequency) throughout the year (Fig. 1). Only one *Diptera* was found in June, a few *Nevroptera* in July and *Trichoptera* in September and October.

Food availability

The assessment of food availability with light trap showed that the most abundant insect groups were the *Diptera* and the *Lepidoptera*. Small moths (< 30 mm wingspan) built up 69% of the *Lepidoptera*; most of them belonged to the *Microlepidoptera*. The *Pyralidae (Microlepidoptera)* and the *Arctiidae, Noctuidae, Lymantridae, Notodontidae* and *Geometridae (Macrolepidoptera)* exhibited auditory organs. *Eilema complana (Arctiidae)* is the most common *Macrolepidoptera* in the trap in July and August; it had been recorded in faeces through its typical yellow scales and leg fragments. The main moth species, and probably main preys, found in the light trap are illustrated in Fig. 20 F.

The Malaise traps gave no results probably because they have a too small intercepting area, even hung together.

Discussion

The Barbastelles preferred the forested area, especially the most richly structured with a shrub layer. They foraged above the tree canopy and the species can be considered as an aerial-hawking bat.

The very narrow trophic niche remains unique among European bat species. As most probable insect preys exhibit auditory organs allowing detection of bat ultrasounds between 20-40 kHz within a distance of 40 m (FENTON & FULLARD 1979), the Barbastelles seem to emit two different types of call at about 32 kHz and 42 kHz (AHLÉN 1981, P. ZINGG unpublished data) not easily detectable to prey. Moreover, the arctiid moth *Eilema complana* is able to produce clicking sounds, which have a large ultrasonic component (FULLARD & FENTON 1977). These sounds closely resemble the echoes of calls emitted by bats and hence appear to be defensive against bat attacks. This is consistent with the hypothesis of jamming bat echolocation (FULLARD & FENTON 1979).

The most of the probable preys of the Barbastelle are *Microlepidoptera* which have been recognised as the most significant pests in agriculture for a long time (BOVEY et al. 1979). Several noctuid and geometrid moths *(Macrolepidoptera)* are also well-known as orchards damaging species (CHARMILLOT et al. 1994).

Even if the real reasons of the drastic decline of the Barbastelle bat in western Europe remain unclear, one can imagine the high vulnerability of a such specialized moth feeder to the impoverishment of its food supply. In the 1950s, BOVEY (1954) considered the Barbastelles as fairly common in the lowlands of western Switzerland, where very intensive agricultural practices predominate nowadays. Thus, we can speculate that the widescale use of unspecific organochlorine insecticides (DDT, HEOD) in agriculture could have contaminated the Barbastelles in the vicinity of farming areas.

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