Ecological factors affecting the distribution of the sibling bat species *Pipistrellus pygmaeus* and *Pipistrellus pipistrellus* in Switzerland

Thomas Sattler, Fabio Bontadina and Raphaël Arlettaz

Division of Conservation Biology
Zoological Institute, University of Bern
Baltzerstrasse 6, 3012 Bern, Switzerland
thomas.sattler@student.unibe.ch

Introduction

Only recently Jones and van Parijs (1993) raised the question whether the bimodal distribution of echolocation calls in the Common Pipistrelle bat *Pipistrellus pipistrellus* (Schreber 1774) may reflect the existence of two cryptic bat species. Ecological differences (e.g. in diet, Barlow 1997) supported this hypothesis.

Molecular confirmation for two species was given by Barratt et al. (1997). Therefore Jones and Barratt (1999) proposed the name *Pipistrellus pygmaeus* (Leach 1825). There is no secure morphological distinction but DNA analysis and echolocation call analysis are reliable.

In the last years *P. pygmaeus* was found in many European countries, including Switzerland. While e.g. in the UK many records have been made, in Switzerland observations remained very rare with only a single roost found until spring 2002.

Questions

1. Where do the sibling bat species *P. pipistrellus* and *P. pygmaeus* occur in Switzerland?
2. What ecological parameters affect their distribution?

Methods

Transects
In 2002, 20 transects distributed all over Switzerland at elevations below 1500m asl were controlled, one in the reproduction and one in the post-lactation period of the species. One transect of 40km per night was surveyed by car.

Recording and analysis of echolocation calls
Using a Pettersson S980 bat detector, search calls were recorded on a tape recorder with Time Expansion mechanism. They were analysed as sonograms with the program Canary. Species recognition was based on the studies of Zingg (1990). Distinction of the two species was based on their different frequency of maximum energy: For *P. pipistrellus* at 45kHz and for the slightly smaller *P. pygmaeus* at 55kHz. Additional observations outside transects and by other bat researchers were used for the Ecological Niche Factor Analysis (ENFA) of *P.pygmaeus*.

Habitat Suitability analysis (HS)
We used ENFA applying the GIS-software 'Biomapper' which performs well when only presence data is available. ENFA aims at summarising a large number of variously correlated ecogeographical variables into a small number of independent, ecologically meaningful factors which contain the major part of the habitat information (Hirzel et al. 2002). The set of all cells of the study area defines a cloud of points in the environmental space, whilst the cells where the species has been observed are some subset of this cloud. Factors are calculated until all information is extracted. At the end, the number of factors is the same as the number of ecogeographical variables but 1) they are uncorrelated and 2) the major part of the information is contained within the first factor (100% of the marginality and some part of specialisation) and a few of the first-ranked specialisation factors (remaining specialisation, indicating the species' dependence on a specific variable). Based on these factors a habitat suitability map is modelled based on hectare grid cells. The suitability defines the probability that a given cell is inhabited by the species. 25 ecogeographical variables were included into the analysis. Nine of them did not have a significant influence on the distribution of either species and therefore they are not listed in Tab.1.

Results

The relation of observations of *P. pygmaeus* : *P. pipistrellus* on transects was 1 : 32.8, which means that *P. pygmaeus* is much rarer than its sibling species in Switzerland.

	P. pygmaeus	*P. pipistrellus*
Number of records on transect	29	952
Additional locations beside transects	80	-
Number of locations for ENFA analysis	109	873
Frequency of single buildings	+++	+++
Frequency of bushes	++	+++
Elevation	- - -	- -
Amount of forest edges	- -	*0*
Frequency of open forest	+	++
Frequency of unclassified forest	+++	+++
Frequency of grass	-	++
Distance from rivers > 12m	- - - -	- - -
Frequency of lake borders	++	++
Frequency of meadows	- -	-
Frequency of pastures	- - -	- - -
Frequency of railways	+++	++
Frequency of riparian forest	+	++
Frequency of riparian bushes	+	+++
Frequency of towns	+++	*0*
Frequency of villages	+	++++
Marginality	0.772	0.589
Specialisation (S)	1.407	1.05
Tolerance (1/S)	0.711	0.952

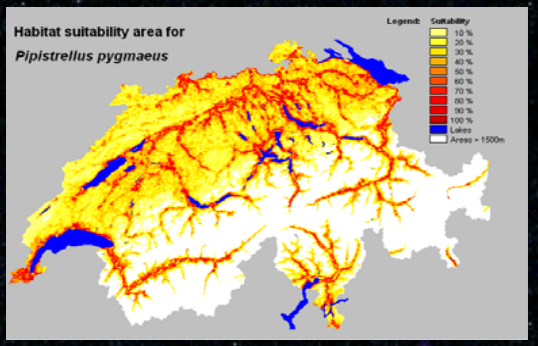
Tab. 1. Marginality factors of *P. pipistrellus* and *P. pygmaeus*. The symbol + means that the species was found in locations with a higher value than the average of all hectare cells (the reverse for -). The greater the number of symbols, the higher the correlation. 0 indicates a very weak correlation. The most important factors (positive and negative) affecting the distribution are highlighted (red for *P. pygmaeus* and green for *P. pipistrellus*). Factor in italics means that there is a relevant difference between the two species.

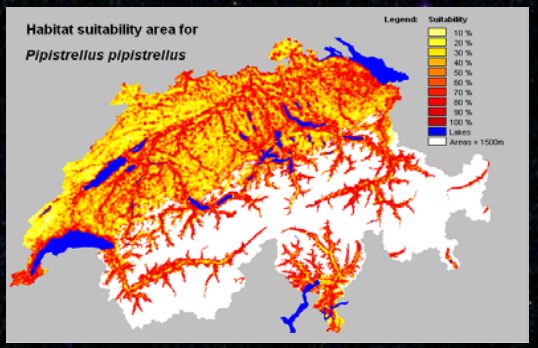
Conclusions

The low marginality value and the high tolerance value of *P. pipistrellus* indicate that this species is not particularly exigent on those ecogeographical variables it prefers. This means it is able to use a wide variety of habitat types and therefore can be called a ubiquitous species.

In contrast, *P. pygmaeus* is more specialised: it very much depends on towns and single buildings near rivers and lakes in the lowlands. Thus, its distribution remains patchily.

From these results we expect *P. pygmaeus* to occur in more areas in Switzerland where it had been overlooked in the past. Its foraging habitats do not seem to be threatened at the moment but due to its scarcity *P. pygmaeus* is a potentially endangered species. Its presence in high probability areas should be confirmed and known populations need to be monitored carefully.





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