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Food habits of northern (*Eptesicus nilssoni*) and brown long-eared (*Plecotus auritus*) bats in Sweden

Jens Rydell

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Food habits of sympatric northern and brown long-eared bats were examined by analysis of droppings collected in six maternity roosts of each species. Relatively large, nocturnal flying insects such as moths (Lepidoptera), June-beetles (Coleoptera: Scarabaeidae), crane-flies (Diptera: Tipulidae) and caddis-flies (Trichoptera), were eaten by both bat species, representing 47% (by volume) of the northern and 57% of the long-eared bat's diet. Small dipterans were important food items for the northern bat (47% of the diet) but not for the long-eared bat, which instead consumed large amounts of diurnal or predominantly non-flying taxa such as blow-flies (Diptera: Calliphoridae), earwigs (Dermaptera), spiders (Araneae) and harvestmen (Opiliones) (40% of the diet). The difference in food selection by the two species is probably due to the different foraging strategies used.

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Introduction

The 8–15 g northern bat, *Eptesicus nilssoni* (Keyserling and Blasius), and the 5–12 g brown long-eared bat, *Plecotus auritus* (L.) (Vespertilionidae), are among the most common bats in Sweden (Ryberg 1947, Ahlén and Gerell in press). Maternity colonies of both species characteristically roost in buildings in summer (Ryberg 1947). They forage in similar habitats and are frequently found in the same localities, but use strikingly different foraging techniques.

Northern bats fly continuously while foraging and catch and consume prey in the air, usually in open spaces 2–20 m above the ground (Rydell 1986, Baagøe 1987). Echolocation calls emitted during search for prey consist of shallow frequency-modulated (FM) sweeps that end in short constant-frequency (CF) portions (Ahlén 1981). The calls are rather intense, and are apparently suited for detection of insects in the open air (Simmons and Stein 1980).

The long-eared bat usually hunts within vegetation or close to the ground, flies slowly and is very manoeuvrable (Swift and Racey 1983). It takes at least some of

its prey by gleaning from surfaces (Anderson 1989), and uses feeding perches when larger prey items are consumed (Poulton 1929, Hansson 1950, Krauss 1977, Thompson 1982). The echolocation calls are usually steep FM-sweeps of short durations and with very low intensities (Ahlén 1981). Such calls are probably designed for target detection in cluttered environments (Simmons and Stein 1980).

Similarity in body size suggests that the two bat species may be feeding on similar prey items. However, foraging behaviour and echolocation call design suggest that they may exploit different zones within the habitat, and may, therefore, reduce interspecific competition by partitioning the food spectrum. This prediction was tested, by comparing the diet of the two species in an area where both were common.

Study area and methods

The study was conducted in a 450 km² area consisting of a fine-grained mixture of coniferous forests, deciduous woodlands, lakes, farmlands and small villages just

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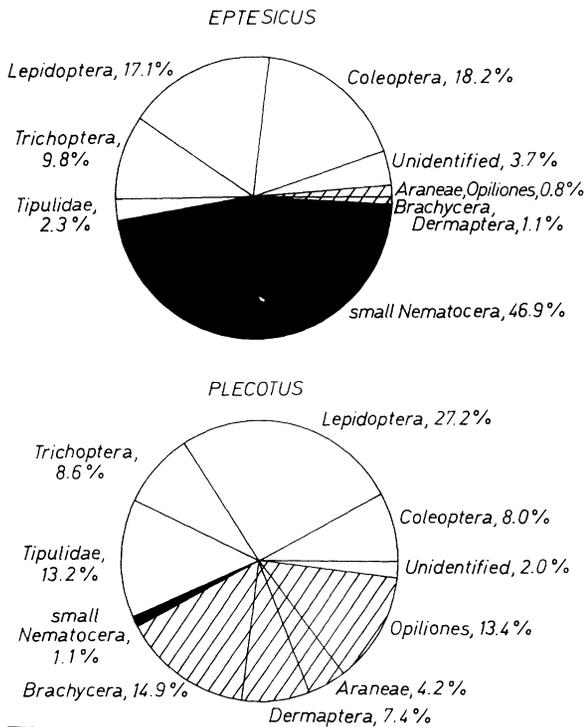


Fig. 1. Percent volume of arthropod taxa recovered in faeces from *Eptesicus nilssonii* and *Plecotus auritus*. Black areas represent small (<10 mm) dipterans. Hatched areas show taxa that are mainly diurnal or terrestrial/arboreal.

north of the town of Ulricehamn in southern Sweden (57°45'N, 13°25'E).

Bat roosts in houses were located in the summers 1980–1987 through contact with the public, and an investigation of churches for the presence of bats (Rydell 1987) was made during the same period. Species determinations were usually made visually inside the roosts. Some northern bat colonies, however, were not visible while roosting, and species identities had to be confirmed with a bat detector (QMC S-100) during evening emergence (Ahlén 1981).

The diets of both species were determined from drop-

pings that were collected from six nurseries, situated at least 2 km apart and therefore presumably representing different foraging areas. In one case a northern bat colony (no. 5) might have foraged in the same habitat as one of the long-eared bat colonies (no. 2), as the colonies roosted only 100 m from each other.

A few hundred faecal droppings were collected from the floor under each bat roost in September 1987. Fifty undamaged droppings of roughly equal sizes from each sample were subsequently analyzed. Those attacked by fungi or insect larvae and those containing significant amounts of fur were not used. The droppings were soaked in water and teased apart under a dissecting microscope. Remains of arthropod exoskeletons were compared with whole insects and spiders caught in the study area, and classified to order or, in the case of dipterans, to suborder or family. For each dropping, the proportions (by volume) of remains representing each taxon were estimated visually. Each dropping was assumed to represent 2% of the sample, and approximate proportions of each taxon were thus estimated with reference to each bat roost.

When diet is determined through faecal analysis, there are some assumptions that do not always hold, and errors are therefore expected (Kunz and Whitaker 1983). For instance, forms with thin or soft exoskeletons tend to be underrepresented relative to thickly sclerotized ones (Belwood and Fenton 1976). Furthermore, some taxa are harder to recognize than others, particularly if diagnostic parts like wings, tarsi and abdomens (which harbour eggs) are culled by the bat before ingestion (Kunz and Whitaker 1983). This is often the case with large prey items.

Results

The northern bat colonies consisted of 10–70 individuals and roosted in tight crevices within walls and roofs of dwelling-houses. The long-eared bat colonies were usually smaller (2–25 individuals) and were found in towers and attics of churches. There was no evidence that more than one bat species occurred in any of the buildings where faeces were collected.

Tab. 1. Significance of interspecific differences in importance (% volume) of each arthropod taxon in the diets of *Eptesicus nilssonii* and *Plecotus auritus* (Mann-Whitney U-test).

Class	Order	Suborder	Family	Significance	
Insecta	Diptera	Nematocera	Tipulidae	p<0.05	
		Brachycera	Others	p<0.005	
	Trichoptera	Lepidoptera	Coleoptera	Calliphoridae	p<0.005
					p<0.05
					n.s.
					n.s.
Arachnida	Dermaptera	Araneae		p<0.005	
			Opiliones		p=0.025
					p<0.025

Tab. 2. Diversity indices of niche breadths and tests of significance of differences in niche-breadths between *Eptesicus nilssonii* and *Plecotus auritus* (Mann-Whitney U-test).

Bat species	Colony no.	No. of taxa eaten	$H = \sum p_i \ln p_i$	$D = 1/\sum p_i^2$
<i>E. nilssonii</i>	1	7	1.72	4.83
	2	7	1.64	4.63
	3	10	1.84	5.25
	4	8	1.52	3.30
	5	8	1.59	3.56
	6	10	1.61	3.78
<i>P. auritus</i>	1	9	1.69	4.23
	2	8	1.60	3.76
	3	10	1.77	4.13
	4	8	1.66	4.41
	5	9	1.71	4.44
	6	9	1.79	4.90
Significance		n.s.	n.s.	n.s.

Part of the food spectrum was utilized by both species (resource overlap $\theta = 0.41$, Southwood 1978), but there were also some consistent differences in their diets (Fig. 1). The relatively large nocturnal flying insects such as moths (Lepidoptera), beetles (Coleoptera; mainly June-beetles, Scarabaeidae), crane-flies (Diptera; Tipulidae) and caddis-flies (Trichoptera) were taken frequently by both bat species (northern bat 47%, long-eared bat 57% of the diet), and their importance as food was not significantly different (moths and beetles) or was barely so (crane-flies and caddis-flies, $0.025 < p < 0.05$) (Tab. 1). About 47% of the northern bat diet consisted of small (<10 mm body length) dipterans, insects that were seldom consumed by long-eared bats (1% of the diet). Instead about 40% of the diet of long-eared bats consisted of taxa that are either mainly diurnal such as blow-flies (Diptera, Calliphoridae) or predominantly terrestrial or arboreal such as earwigs (Dermaptera), spiders (Araneae) and harvestmen (Opiliones). The interspecific differences in utilization of these taxa was significant (Tab. 1). Niche breadths did not differ significantly between the two bat species (Tab. 2).

Discussion

The northern bat apparently feeds opportunistically on a broad range of flying insects, taking all but the smallest ones (Rydell 1986). Most bat species that forage in flight and use echolocation to detect the prey items, seem to consume different insects approximately in the proportions encountered (Anthony and Kunz 1977, Barclay 1985 a, b). Because small prey items are caught and handled rapidly by these bats, unselective feeding may, perhaps, be expected (Swift et al. 1985). According to optimal foraging theory (MacArthur and Pianka

1966, Krebs and McCleery 1984), predators should only reject a prey item that has been detected if it is energetically favourable to do so.

Earlier studies of the food habits of brown long-eared bats (Poulton 1929, Hansson 1950, Roer 1969, Krauss 1977, Swift and Racey 1983, Thompson 1982) have confirmed that they rely on moths to a great extent, but also take many other arthropods including some non-flying taxa. However, the present study suggests a higher proportion (40%) of diurnal or predominantly non-flying taxa as compared with earlier studies (frequency of about 10%, Swift and Racey 1983). As digestion is rapid in bats and many droppings are voided during flight, the diet, as determined from faeces collected in the roost, is probably biased towards those taxa ingested within the roost itself.

In contrast to open air foragers such as the northern bat, the long-eared bat is able to fly in the foliage and hover in front of surfaces, taking prey items by gleaning. This is made possible by a low wing loading and short wings (low aspect ratio) (Norberg and Rayner 1987). Long-eared bats are occasionally caught in mouse-traps (R. Gerell, pers. comm.), which suggests that they sometimes forage by crawling on the floor. Observations of captive long-eared bats showed that about half of the catches were made by gleaning and the other half were aerial captures (Anderson 1989). The flexibility of the long-eared bat foraging strategy suggests that it may be able to exploit a greater part of the resource spectrum than an aerial forager like the northern bat. However, in this study the niches of the two species were equally broad, mainly because the long-eared bat, like other gleaners (Bauerová 1978, Fenton and Bell 1979, Bauerová and Červený 1986), excluded most small dipterans from its diet.

Presumably, the prey that are encountered depends on the kind of searching method employed by the bat. Echolocation does not play the same role for gleaners, as it does for those bats that rely on aerial pursuits. Some, perhaps all, gleaning insectivorous and carnivorous bats also use passive listening (Vaughan 1976, Tuttle and Ryan 1981, Bell 1982) and/or vision (Bell 1985). The audiogram of the long-eared bat shows highest sensitivity in the 8–18 kHz frequency interval (Coles et al. in press). This is much lower than the high frequency echolocation calls most often produced, and may suggest that passive listening is sometimes used. Alternatively, it may reflect a sensitivity for communication calls or low frequency echolocation calls.

Maternity colonies of northern bats are nearly always found in crevices within the roofs and walls of homes and are typically found roosting near chimneys, which normally provide heat throughout the year. Long-eared bat colonies, on the other hand, often reside in large attics and towers of churches and similar buildings (Rydell 1987). It is tempting to speculate that the choice of the latter kind of roost depends, at least in part, on the opportunities for foraging provided there. Blow-flies,

earwigs, and harvestmen, for example, are common in most churches, and these taxa constitute a large part of the long-eared bat's diet. Foraging may occur within the roost when outdoor foraging is unfeasible, as may be the case during bad weather, in winter or during the daytime.

Investigations of buildings and cellars and inventories of selected sites with a bat detector (QMC S-100) (Rydell 1987, unpubl.) suggest that the northern bat and the brown long-eared bat are the most common bat species in the study area. Their coexistence may be facilitated by differential use of foraging habitats and, perhaps, by different roost preferences.

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References

- Ahlén, I. 1981. Identification of Scandinavian bats by their sounds. – Swedish Univ. Agric. Sci. Rep. 6: 1–56.
- and Gerell, R. In press. Distribution and status of bats in Sweden. – Proc. 4th Eur. Bat Res. Conf., Prague, 1987.
- Anderson, M. E. 1989. Sensory aspects of foraging behaviour in a foliage gleaner bat, *Plecotus auritus*. Ph.D. thesis, Univ. Aberdeen.
- Anthony, E. L. P. and Kunz, T. H. 1977. Feeding strategies of the little brown bat, *Myotis lucifugus*, in New Hampshire. – Ecology 58: 775–786.
- Baagøe, H. J. 1987. The Scandinavian bat fauna: adaptive wing morphology and free flight in the field. – In: Fenton, M. B., Racey, P. A. and Rayner, J. V. M. (eds), Recent advances in the study of bats. Cambridge Univ. Press, Cambridge, pp. 57–74.
- Barclay, R. M. R. 1985a. Long- versus short-range foraging strategies of hoary (*Lasiurus cinereus*) and silver-haired (*Lasionycteris noctivagans*) bats and the consequences for prey selection. – Can. J. Zool. 63: 2507–2515.
- 1985b. The echolocation calls of hoary (*Lasiurus cinereus*) and silver-haired (*Lasionycteris noctivagans*) bats as adaptations for long- versus short-range foraging strategies and the consequences for prey selection. – Can. J. Zool. 64: 2700–2705.
- Bauerová, Z. 1978. Contribution to the trophic ecology of *Myotis myotis*. – Folia Zool. 27: 305–316.
- and Červený, J. 1986. Towards an understanding of the trophic ecology of *Myotis nattereri*. – Folia Zool. 35: 55–61.
- Bell, G. P. 1982. Behavioural and ecological aspects of gleaner by a desert insectivorous bat, *Anthrozous pallidus* (Chiroptera: Vespertilionidae). – Behav. Ecol. Sociobiol. 10: 217–223.
- 1985. The sensory basis of prey location by the California leaf-nosed bat *Macrotus californicus* (Chiroptera: Vespertilionidae). – Behav. Ecol. Sociobiol. 16: 343–347.
- Belwood, J. J. and Fenton, M. B. 1976. Variation in the diet of *Myotis lucifugus* (Chiroptera: Vespertilionidae). – Can. J. Zool. 54: 1674–1678.
- Coles, R. B., Guppy, A., Anderson, M. E. and Schlegel, P. In press. Frequency sensitivity and directional hearing in the gleaner bat, *Plecotus auritus* (Linnaeus 1758). – J. Comp. Physiol.
- Fenton, M. B. and Bell, G. P. 1979. Echolocation and feeding behaviour in four species of *Myotis* (Chiroptera). – Can. J. Zool. 57: 1271–1277.
- Hansson, B. H. 1950. Långörade fladdermusens, *Plecotus auritus*, L., dietlista med kommentarer. – Fauna Flora 45: 1–20. (In Swedish).
- Krauss, A. 1977. Materialien zur Kenntnis der Ernährungsbiologie des Braunen Langohrs (*Plecotus auritus* L.) (Mammalia, Chiroptera). – Zool. Abh. Mus. Tierk. Dresden 34: 325–337.
- Krebs, J. R. and McCleery, R. H. 1984. Optimization in behavioural ecology. – In: Krebs, J. R. and Davies, N. B. (eds), Behavioural Ecology: an evolutionary approach, Blackwell, Oxford, pp. 91–121.
- Kunz, T. H. and Whitaker, J. O. Jr. 1983. An evaluation of fecal analysis for determining food habits of insectivorous bats. – Can. J. Zool. 61: 1317–1321.
- MacArthur, R. H. and Pianka, E. R. 1966. On optimal use of a patchy environment. – Am. Nat. 100: 601–609.
- Norberg, U. M. and Rayner, J. V. M. 1987. Ecological morphology and flight in bats (Mammalia; Chiroptera): Wing adaptations, flight performance, foraging strategy and echolocation. – Phil. Trans. R. Soc. Lond. B. 316: 335–427.
- Poulton, E. B. 1929. British insectivorous bats and their prey. – Proc. Zool. Soc. Lond. 1929: 277–302.
- Roer, H. 1969. Zur Ernährungsbiologie von *Plecotus auritus* (L.) (Mamm. Chiroptera). – Bonner Zool. Beitr. 4: 378–383.
- Ryberg, O. 1947. Studies on bats and bat parasites. – Svensk Natur, Stockholm.
- Rydell, J. 1986. Foraging and diet of the northern bat *Eptesicus nilssonii* in Sweden. – Holarct. Ecol. 9: 272–276.
- 1987. Fladdermössen behöver kyrkorna. – Fauna och Flora 82: 88–90. (In Swedish with English summary).
- Simmons, J. A. and Stein, R. A. 1980. Acoustic imaging in bat sonar: Echolocation signals and the evolution of echolocation. – J. Comp. Physiol. 135: 61–84.
- Southwood, T. R. E. 1978. Ecological methods, – Chapman and Hall, London.
- Swift, S. M. and Racey, P. A. 1983. Resource partitioning in two species of vespertilionid bats (Chiroptera) occupying the same roost. – J. Zool. Lond. 200: 249–259.
- , Racey, P. A. and Avery, M. I. 1985. Feeding ecology of *Pipistrellus pipistrellus* (Chiroptera: Vespertilionidae) during pregnancy and lactation. II. Diet. – J. Anim. Ecol. 54: 217–225.
- Thompson, M. J. A. 1982. A common long-eared bat *Plecotus auritus*: moth predator-prey relationship. – Naturalist 107: 87–98.
- Tuttle, M. D. and Ryan, M. J. 1981. Bat predation and the evolution of frog vocalization in the neotropics. – Science 214: 677–678.
- Vaughan, T. A. 1976. Nocturnal behaviour of the African false vampire bat (*Cardiaderma cor*). – J. Mammal. 57: 227–248.

Appendix A. Frequencies (% volume) of arthropod taxa recovered in faeces collected in roosts of *Eptesicus nilssoni* and *Plecotus auritus*. Fifty droppings from each roost were analyzed.

Class	Order	Suborder	Family	<i>Eptesicus nilssoni</i> colony no.						<i>Plecotus auritus</i> colony no.					
				1	2	3	4	5	6	1	2	3	4	5	6
Insecta	Diptera	Nematocera	Tipulidae	5.0	2.0	2.0	2.0	2.0	1.0	28.6	0.0	16.0	8.6	10.0	16.0
			Others	27.0	37.4	42.0	52.6	55.4	67.0	0.8	2.6	1.0	0.0	0.0	2.0
	Trichoptera	Brachycera	Calliphoridae	0.0	0.0	0.6	1.8	1.4	1.0	2.6	39.6	4.6	21.0	15.6	6.0
			Others	10.0	8.3	5.0	11.6	12.0	12.0	4.0	5.0	2.0	1.0	36.8	3.0
	Lepidoptera			22.0	24.0	16.0	21.0	8.6	11.0	35.0	30.0	42.8	4.0	21.4	30.0
	Coleoptera			32.0	27.3	26.6	4.0	16.0	3.0	4.0	9.0	5.0	28.6	1.2	0.0
	Dermaptera			0.0	0.0	2.0	0.0	0.0	0.0	9.0	3.0	14.0	5.0	1.2	12.0
Arachnida	Araneae		0.0	1.0	0.0	0.0	0.0	1.0	14.0	0.0	5.0	2.0	1.0	4.0	
		Opiliones	0.0	0.0	2.0	0.0	0.0	1.0	0.0	8.0	7.6	29.8	8.8	26.0	
Unidentified			4.0	0.0	3.8	7.0	4.6	3.0	2.0	2.8	2.0	0.0	4.0	1.0	