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Actual records of bat ectoparasites in Bavaria (Germany)

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Records of ectoparasites of 19 bat species collected in Bavaria are presented. Altogether 33 species of eight parasitic families of fleas (Ischnopsyllidae), batflies (Nycteribiidae), bugs (Cimicidae), mites (Spinturnicidae, Macronyssidae, Trombiculidae, Sarcoptidae) and ticks (Argasidae, Ixodidae) were found. Eight species were recorded first time in Bavaria. All collected parasites are deposited in the collection of the Zoologische Staatssammlung München (ZSM).

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Introduction

There are only few reports about bat parasites in Germany and the Bavarian ectoparasite fauna is poorly investigated yet. From 1998 till 2001 we studied the parasite load of bats in Bavaria. The aim was to give an actual overview on the ectoparasite fauna of bats in Bavaria.

Most bat parasites show a high degree of host specificity, while some appear to parasitize multiple hosts (Kulzer 1998, Micherdzinski 1980, Radovsky 1967, Schmidt 1987, Stanyukovich 1997). Bat-associated parasites are well adapted and they prefer different places on their host's body: fleas, bat-flies, bugs, mites and ticks can be found in the fur. Various mite species are situated on ears, eyes or on the wings (Walter 1996). With decreasing bat populations in Central Europe, bat parasites are also endangered and some species are regarded as to be threatened by extinction in Germany.

Sampling techniques

Bats were caught either at their roosts by hand or using a net. Other were mistnetted at cave entrances, at creeks or ponds. Dead, injured or exhausted bats living in the care of humans were also examined. Altogether 342 dead and 1017 living bats were

investigated. The investigated bats belonged to the following species (number of individuals in brackets: *Barbastellus barbastellus* (7) – *Eptesicus nilsonii* (10) – *E. serotinus* (6) – *Myotis bechsteinii* (6) – *M. brandtii* (20) – *M. daubentonii* (282) – *M. emarginatus* (12) – *M. myotis* (367) – *M. mystacinus* (79) – *M. nattereri* (42) – *Pipistrellus pipistrellus* (127) – *P. nathusii* (6) – *Nyctalus leisleri* (3) – *N. noctula* (312) – *Plecotus auritus* (45) – *P. austriacus* (17) – *Rhinolophus hipposideros* (1) – *R. ferrumequinum* (1) – *Vespertilio murinus* (16).

To get information about the extent of the parasite load we compared the incidence rates and the maximum number of parasites per bat in samples of eight bat species (n=882) caught at roosts and in foraging areas (Tab. 1). We counted the number of mites visible on both sides of the wings (without the interfemoral membrane) and also located on the ears. In addition, we spent about 20 seconds for searching each bat for batflies, fleas, bugs and ticks while blowing the fur. Differences between the parasite load of the sample sites are given in Zahn & Rupp 2004. Voucher specimens of each type of parasite were preserved in 70 % ETOH and identified in the laboratory either by light microscopy or scanning electron microscopy (SEM: Philips XL 20, for detailed method see Rupp & Ludwig 2000). The identification is based on the following keys: Hopkins & Rothschild 1956 (Ischnopsyllidae), Theodor 1954 and Theodor & Rothschild 1967 (Nycteribi-

idae), Péricart 1972 (Cimicidae), Nuttall et al. 1908, 1911 and Sonenshine et al. 1962 (Ixodidae, Argasidae), Stanyukovich 1997, Rudnick 1960 and Dusbabek 1962 (Spinturnicidae), Radovsky 1967 and Stan-

yukovich 1997 (Macronyssidae: in Macronyssidae only adult females were determined), Dusbabek 1963 and Fain 1959 (Sarcoptidae) and Oudemans 1912 (Trombiculidae). When comparing the para-

Tab. 1. Sample sizes of bat species used for the estimation of the parasite load. For each sample site, the location of the bats, sampling dates and sample sizes are given: Numbers of adult males, adult females and juveniles (m/f/j). Cl: cluster at a roost, S/M: roosting solitary or in a mating group at a male roost, Ca(n): netted at a cave entrance, L(n): netted at a lake, Cre(n): netted at a creek. For male *Nyctalus noctula* in October it was not always possible to confidently distinguish between adults and juveniles. Consequently we distinguished only between males and females (m/f) for this month.

Myotis daubentonii (n=256)

Bichlersee (12°07'E, 47°40'N), Ca (n), 1999: Aug. 0/0/1
Dettendorf (11°58'E, 47°49'N), Cre (n), 1998: Apr. 4/0/0,
May 1/0/0, Aug. 3/1/0, Sept. 5/1/4
Grünbach (12°32'E, 48°12'N), Cre (n), 1998: Sept. 0/1/0
Kienstein (11°22'E, 47°38'N), Ca (n), 1998: Aug. 0/0/11
Kraiburg (12°25'E, 48°10'N), Cre (n), 1999: May 0/1/0,
Aug. 0/0/1
Lichtenberg (12°45'E, 48°24'N), Cre (n), 1998: Aug. 0/0/2
Petting (12°49'E, 47°55'N), Cre (n), 1998: June 0/16/1
Postmünster (12°53'E, 48°25'N), L (n), 1999: June 0/10/0
Spielberg (12°16'E, 47°45'N), Ca (n), 1999: Aug. 11/0/1
Türkenbach (12°53'E, 48°14'N), Ca (n), 1999: May 1/2/0,
Sept. 0/0/1
Wald (12°35'E, 48°07'N), Cl, 1999: May 1/6/0, June 3/
7/1, July: 7/2/13, Aug. 0/0/12, Sept. 5/0/6, Oct. 2/
0/21, 2000: Apr. 6/11/0, May 6/12/0, June 10/3/0,
July 7/6/1, Aug. 2/3/7, Sept. 4/1/7, Oct. 0/0/5

M. emarginatus (n=12)

Kienstein (11°22'E, 47°38'N), Ca (n), 1998: Aug. 0/1/0
Maxrain (11°59'E, 47°54'N), Cl, 1998: Jul. 0/4/2. 2001:
Sept 1/2/0
Palling (12°38'E, 48°0'N), Cl, 1998: Jul. 0/1/1

M. myotis (n=290)

Au (11°58'E, 47°47'N), Cl, 1998: 6.Apr. 0/11/0, 29.Apr.
0/11/0, 27.Mai 2/10/0, 21.Jun. 0/0/10, 31.Jun. 2/
11/7, 13.Jul. 2/6/10, 22.Jul. 0/8/14, 3.Aug. 0/11/9,
19.Aug. 0/8/11, 9.Sep. 0/2/10, 24.Sep. 1/1/13,
15.Oct. 0/0/11, 6. Nov. 0/0/6
Flossing (12°30'E, 48°13'N), Cl, 1998: 27.May 0/3/0
Großhöhenrain (11°54'E, 47°55'N), Cl, 1998: 3.Jun. 0/4/0,
32.Jun. 1/1/0, 6.Nov. 0/0/4
Litzldorf (12°03'E, 47°45'N), Cl, 9.Sep. 0/0/4
Reisach (12°10'E, 47°39'N), Cl, 1998: 3.Jun. 0/3/0, 22.Jul.0/
0/6
Rohrdorf (12°10'E, 47°47'N), Cl, 1998: 9.Sep. 0/0/3, 15.Oct.
0/0/1
Soyen (12°12'E, 48°06'N), Cl, 1998: 27.May 0/4/0
Walchsee (12°19'E, 47°39'N), Cl, 1998: 3.Jun. 0/4/0, 22.Jul.
0/7/6
Several male-roosts: S/M, 1998: 6.Apr. 1/0/0, 20.May 1/
0/0, 27.Mai 3/0/0, 3.Jun. 1/0/0, 31.Jun. 2/0/0, 3.Aug.
4/0/0, 6.Aug. 2/1/0, 19.Aug. 4/2/0, 9.Sep. 4/2/2,
24.Sep. 7/5/1, 15.Oct. 5/2/3

M. mystacinus (n=44)

Dettendorf (11°58'E, 47°49'N), Cre(n), 1998: Apr. 0/8/0,
May 1/3/0, Jun. 2/0/0, Aug. 4/0/3, Sep. 1/0/3
Ergolding (12°10'E, 48°34'N), Cl, 1998: Jun. 0/2/0
Frasdorf (12°17'E, 47°48'N), Cre(n), 1998: Jun. 1/0/0
Kraiburg (12°25'E, 48°10'N), Cre(n), 1998: May 1/1/0
Frauendorf (12°29'E, 48°11'N), Cre(n), 1998: Jun. 0/1/0
Spielberg (12°16'E, 47°45'N), Ca(n), 1998: Aug. 1/3/3,
Sep.2/0/0
Türkenbach (12°53'E, 48°14'N), Cre(n), 1998: Sep. 0/0/2

M. nattereri (n=28)

Essing (11°47'E, 48°56'N), Ca(n), 1998: Oct. 7/5/6
Kerham (12°19'E, 48°14'N), Cl, 1998: Sep. 2/0/0
Mauern (11°03'E, 48°46'N), Ca(n), 1998: Oct. 3/0/0
Spielberg (12°16'E, 47°45'N), Ca(n), 1998: Aug. 2/1/2

Nyctalus noctula (n=221)

Eggenfelden (12°45'E, 48°24'N), S/M, 1998: Aug. 3/1/2
Markt Schwaben (11°52'E, 48°11'N), S/M, 1999: Oct. 3/6
Waldkraiburg (12°23'E, 48°12'N), Cl, 1998: Jun. 27/0/0,
Sep. 0/0/7, 1999: Apr. 4/7/0, May 8/4/0, Jun. 10/0/
0, Jul.12/0/0, Aug. 3/3/8, Sep. 2/0/9, Oct.16/2,
2000: Apr. 8/5/0, May 10/0/0, Jun. 15/1/0, Jul. 11/
0/0, Aug. 0/0/10, Sep. 1/0/9, Oct. 4/0
Wasserburg (12°13'E, 48°03'N), Cl, 1999: Oct. 10/0

Pipistrellus pipistrellus (n=15)

Baierbach (12°12'E, 48°25'N), Cl, 1998: Jul. 0/3/0
Buchbach (12°16'E, 48°18'N), Cl, 1998: Jul. 0/1/0
Dettendorf (11°58'E, 47°49'N), Cre(n), 1998: May 2/3/0
Türkenbach (12°53'E, 48°14'N), Cre(n), 1998: May 0/3/0
Kienstein (11°22'E, 47°38'N), Ca(n), 1998: Aug. 1/1/0,
Oct.1/0/0

Plecotus auritus (n=16)

Kienstein (11°22'E, 47°38'N), Ca (n), 1998: May 3/0/0
Mauern (11°03'E, 48°46'N), Ca (n), 1998: Oct. 1/0/0
Pfarrkirchen (12°56'E, 48°25'N), CL, 1998: Sep. 0/1/0
Spielberg (12°16'E, 47°45'N), Ca(n), 1998: Aug. 5/0/0,
Sep.1/0/3
Wargau (11°43'E, 47°49'N), Cl, 1998, May 0/2/0

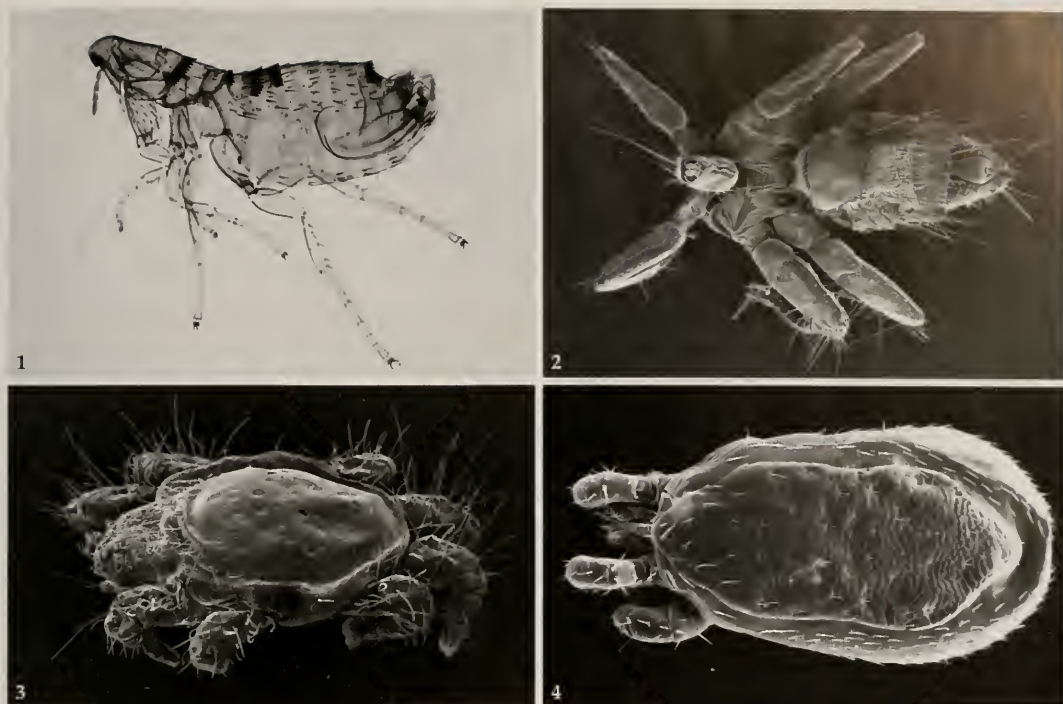


Fig. 1. Male of *Nycteridopsylla eusarca*. Bat-fleas are eyeless and spend their whole life on the bat with exception of the larval stage: their development takes place in the faeces of the bats under the roosts. Size: 1820 μm .

Fig. 2. *Nycteribia kolenatii*. The wingless bat-fly resembles more a spider than a fly. They are highly specialized in the life on bats. The larvae hatch already out of the eggs into their mothers. Only the puparium is outside of the bat. Size: 1800 μm .

Fig. 3. *Spinturnix psi*. Spinturnicidae are relatively big mites. The egg and larval stage are done inside the mother. They give birth to the finished protonymph. Size: 800 μm .

Fig. 4. Female of *Macronyssus flavus*. The small mites of the genus *Steatonyssus* and *Macronyssus* occur in the fur as well as on the wing membranes. Like Spinturnicidae is their whole life cycle on the bat. Size: 570 μm .

site load of bats we distinguished only between families (Tab. 2).

Results and Discussion

33 species of nine parasite families (insects and mites) could be found (Tab. 2). Eight species were recorded for the first time in Bavaria.

Siphonaptera, Ischnopsyllidae

Fleas were found on 12 different bat species. In Germany 13 flea species of the bat specific family Ischnopsyllidae are known, nine of them could be confirmed in Bavaria. The infestation levels were generally low (Tab. 2). The records of *Ischnopsyllus variabilis* and *I. obscurus* are the first for this area. On *Nyctalus noctula* and *Pipistrellus pipistrellus* sea-

sonal differences regarding the infestation could be observed: in wintertime (December to March) the winter-specific fleas *Nycteridopsylla eusarca* (Fig. 1) and *N. longiceps* respectively were found while during summertime (April to September) *I. elongatus* and *I. octactenus* infested the bats. Similarly the occurrence of *N. pentactena* on *Plecotus* in winter is described by Hurka (1963) and Müller (1989), but in our study all samples were obtained in summer, when *I. hexactenus* can be found. Therefore the occurrence of *N. pentactena* in Bavaria during winter can not be excluded.

Diptera, Nycteribiidae

Ten species of bat-flies were reported from Germany (Hurka 1971), but only *Nycteribia kolenatii* (Fig. 2) and *Penicillidia monoceros* (preferably on *Myotis daubentonii*) as well as *Basilina nana* (on *M. bechsteinii*)

Tab. 2. Parasites and their hosts found in Bavaria. In species where larger samples were taken (Tab. 1) the incidence rate in % of the bats and the maximum numbers of parasites (max.) are listed. xx=main host, x=casual host; underlined species: new record for Bavaria. *=recorded for Germany in literature, but sample place unknown. In the case of *Myotis myotis*, *Nycteribiidae* and *Cimicidae* were only found in the roost of a colony but not on the bats. Not included are *M. emarginatus*, *Rhinolophus ferrumequinum* and *Rh. hipposideros*. In *M. emarginatus* 12 individuals were investigated, but just one of them had a single, undetermined mite of the genus *Steatonyssus*. In *Rhinolophus ferrumequinum* (n=1) the tick *Ixodes vespertilionis* was found and in *Rh. hipposideros* also one bat was investigated, but no parasite was found.

could be found (Tab. 2). The records were new for Bavaria. In literature *Nycteribia kolenatii* is the most common bat-fly in Germany (Dietz & Walter 1995, Hurka 1964, 1971, Hutson 1984, Kock 1973, 1994, Müller 1989, Nowosad 1974, Theodor 1954, Walter 1985, 1996). This observation is also confirmed for Bavaria. The record of *P. monoceros* is the most south-east in Europe until now (Rupp 1999).

Heteroptera, Cimicidae

In some roosts of *Myotis myotis* and *Nyctalus noctula* bugs were found. Roosts of *M. myotis* were infested with as well bed-bugs (*Cimex lectularius*) as bat-bugs (*C. dissimilis*). For *N. noctula* only the latter species could be confirmed. For *M. myotis* no bugs were observed on the bats, but *Nyctalus noctula* sometimes carried bugs when they were caught leaving their roost in the evening.

Acari, Mesostigmata, Spinturnicidae

These very specific mites exist only on bat wings and many of them are highly host specific (Fig. 3). In Germany seven species are common, all of them could be confirmed in Bavaria occurring on 11 different bat species (Tab. 2). *Spinturnix myotis* was most frequently found. This species is parasitizing multiple hosts. The infestation levels in the colonies of its main host *Myotis myotis* were relatively high compared with the infestation levels of other Spinturnicidae and their hosts (Tab. 2).

Acari, Mesostigmata, Macronyssidae

These small mites occur in the fur as well as on the wing membranes (Fig. 4). Due to the missing of literature about this family, only adult females could be determined. Six species of the genus *Steatonyssus* and *Macronyssus* were found. The record of *Steatonyssus noctulus* (on *Nyctalus noctula*) in Bavaria is the first outside the former USSR (Rupp & Ludwig 2000).

Acari, Astigmata, Sarcoptidae

Nycteridocoptes poppei was mainly found on *Myotis myotis* and *M. daubentonii* (Tab. 2). The females and larvae live in the patagium and ears, where they build white ulcers.

Acari, Prostigmata, Trombiculidae

Trombicula russica was occasionally found on different bat species (Tab. 2). The larvae of these presumptive predatory mites are parasites on bats. They suckle lymph preferred on the margin of the ears.

Acari, Metastigmata, Ixodidae & Argasidae

We found four species of ticks on different bat species (Tab. 2). The bat-specific *Argas vespertilionis* was often found, sometimes in high numbers especially on *pipistrelles*. This species seems to be the most common bat-tick in Germany (Walter 1985). *Ixodes vespertilionis* prefers cave-dwelling bats (Dusbabek 1972, Schulze 1929). Their population is regarded as to be endangered in Germany (Kock 1994, Walter 1992). *A. reflexus* and *I. ricinus* are not bat-associated and parasitize just casual on bats.

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	<i>Barbastellus barbastellus</i>	<i>Eptesicus nilsonii</i>	<i>E. serotinus</i>	<i>Myotis bechsteinii</i>	<i>M. brandii</i>	<i>M. daubentonii</i>	<i>M. myotis</i>	<i>M. mystacinus</i>	<i>M. nattereri</i>	<i>Nyctalus leisleri</i>	<i>N. noctula</i>	<i>Pipistrellus nathusii</i>	<i>P. pipistrellus</i>	<i>Plecotus auritus</i>	<i>Pl. austriacus</i>	<i>Vespertilio murinus</i>
n	7	10	6	6	20	282	367	79	42	3	312	6	127	45	17	16
Bat-fleas (Ischnopsyllidae)						2% (2)	12% (3)	45% (6)	54% (4)		19% (3)		40% (3)	13% (2)		
<i>Ischnopsyllus hexactenus</i>							x							xx	x	
<i>I. intermedius</i>		x				xx							x			
<i>I. elongatus</i>			x								xx					
<i>I. simplex</i>					xx			xx	xx						x	
<i>I. obscurus</i>																xx
<i>I. octactenus</i>									x				xx			
<i>I. variabilis</i>											x					
<i>Nycteridopsylla eusarca</i>										xx						
<i>N. longiceps</i>													x			
Bat-flies (Nycteribiidae)						66% (8)	0% (1)				<1% (1)					
<i>Basilia nana</i>				xx												
<i>Nycteribia kolenatii</i>					xx	xx	x									
<i>Penecillidia monoceros</i>						x					x					
Bugs (Cimicidae)							0% (4)				15% (4)					
<i>Cimex lectularius</i>							xx									
<i>Cimex dissimilis</i>							xx				xx					
Spinturnicidae						65% (20)	90% (95)	51% (10)	7% (3)		52% (10)			19% (3)		
<i>Sp. punctata*</i>		xx														
<i>Sp. acuminatus*</i>											xx					
<i>Spinturnix myoti</i>					x		xx		x				x			
<i>Sp. mystacinus</i>								xx					x		x	
<i>Sp. plecotinus*</i>														xx	xx	
<i>Sp. carnifex*</i>			xx													
<i>Sp. andegavinus*</i>						xx										
Macronyssidae						69% (78)	69% (230)	7% (8)	50% (8)		98% (178)		67% (45)			
<i>Steatonyssus spinosus*</i>		x					xx									
<i>St. noctulus</i>											xx					
<i>St. periblepharus*</i>		x			x			x					xx			x
<i>St. occidentalis*</i>			x													
<i>Macronyssus flavus</i>								x	x	xx	xx			x		
<i>M. kolenatii*</i>													x			
Sarcoptidae						5% (3)	8% (2)				5% (12)					
<i>Nycteridocoptes spec. (N. poppei)</i>						xx	xx				x		x			
Trombiculidae							1% (2)		18% (12)		1% (13)			13% (1)		
<i>Trombicula spec. (T. russica)</i>	xx		x				x	x	x		x		x	x		x
Ticks: Ixodidae							3% (2)		2% (2)							
<i>Ixodes ricinus</i>		x					xx									x
<i>Ix. vespertilionis*</i>									x							
Ticks: Argasidae							2% (9)	1% (10)	1% (2)		2% (6)		33% (7)			
<i>Argas vespertilionis</i>		x	x		x		x	x	x		x		xx	x		x
<i>A. reflexus</i>		x														

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