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THE ZONE OF BAT ACARINIA IN CENTRAL EUROPE

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Dedicated to Academician Bohumír Rosický on the occasion of his 50th birthday.

Abstract. The acarinium zone of bats in Central Europe is characterized and the factors causing changes in the structure of acarinia in this zone are described. Ecological assessment of members of this zone is also included and on the example of *Myotis myotis* (Borkh.) the structure of acarinia in different microbiotopes in Czechoslovakia is demonstrated.

The terms "acarinium" and "zone of acarinia" have been created by **Rosický** (1953), resulting from the vertical division of acarofauna of different ecological host groups, as terms equivalent to the term aphanipterium used in similar division of fleas within respective zones of aphanipteria. In his subsequent papers (**Mrciak** and **Rosický** 1959, **Rosický** and **Mrciak** 1967) he defined an acarinium as a group of mites, mainly of the order Parasitiformes, parasitizing warm-blooded terrestrial vertebrates and inhabiting their nests, i.e. as a special synecological unit with different food relation (haematophagous, predatory, necrophagous, saprophagous etc.), depending on the host, its activities and function in the nest, and characterized by similar requirements for microclimatic conditions. A group of acarinia associated with a certain ecological group of vertebrates, as well as certain biotope or microbiotope, usually also a certain horizon, is then called a zone of acarinia, which is consequently a higher ecological unit. One of such units in Central Europe*) is represented by the zone of bat acarinia.

Under Central-European conditions the zone of bat acarinia has some specific features which distinguish it from other zones of acarinia. They are:

1. A considerable isolation of the zone of bat acarinia with regard to other zones as the result of a relatively high bionomic and ecological isolation of bats as a host group. The contact of bats with members of other acarinia zones is very rare and may be possible only in the bat shelters, because the terrestrial feeding ground (sensu **Beklemishev** 1951) does not practically exist in the case of bats.

2. A relative stability of acarinia in this zone resulting from the permanent use of the same shelter by bats for many years (e.g. caves). Due to this fact a slow succession takes place on one hand and a seasonal microsuccession resulting from seasonal change of shelters by some bat species or subpopulations on the other.

3. A passive use of natural, microclimatically constant shelters by bats results in

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*) Central Europe in this paper is understood to be a geographical territory covering German Democratic Republic, German Federal Republic, Poland, Czechoslovakia, Hungary and Austria.

the elimination of some activities and functions of host in shelter, such as building or other arrangement of shelter, hoarding of food supplies etc. The social instinct of bats, which is reflected in their colonies, causes on the other hand promotion of passive influence of host in shelter, such as e.g. guano accumulation causing changes in microclimate of shelter, or concentration of ammonia etc. The thermoregulatory function of the nest is taken over by the hosts themselves, forming colonies ("a live nest" after **Senotrusova** 1968).

4. Spaciousness and variety of bat shelters (e.g. caves, hollow trees, house lofts), their relative microclimatic stability and increased passive influence of host in the shelter (guano accumulation) make facultative commensalism possible to a wide range of mites. This is why the bat acarinia include troglophilic, dendrophilic or guanophilic species. The commensalism of some species has already become obligatory (e.g. in Nycteriglyphinae).

5. Absolute absence of exophilia in ectoparasites in the sense of **Morel** (1964) (parasitism in feeding ground after **Beklemishev** 1951) in bat acarinia, due to lack of terrestrial feeding ground of hosts and the subsequent transition to endophilia (parasitism in shelter) in such ectoparasites as Trombiculidae and Ixodidae, which are mostly exophilic in other acarinia zones.

6. Transition of many endophilic ectoparasites to epizoic (somatic) permanent type of ectoparasitism (e.g. in Spinturnicidae and some Macronyssidae) probably due to difficult attainability of host as a source of food in relatively spacious shelters of bats.

In our concept we understand acarinium in the zone of bat acarinia in Central Europe as a group of all mites of the orders Parasitiformes and Acariformes living in any association with bats of a single colony or with a solitary specimen in its regular shelter. It follows that an acarinium includes both the epizoic (somatic) and endophilic parasites (parasites of shelter, nidicolous parasites) as well as non-parasitic forms inhabiting permanently or periodically visited bat shelters.

The structure of acarinium in the zone of bat acarinia depends on a very complicated system of relationship mite-bat-outer environment, including many trophical, topical and phoretic relationships on one hand and many influencing factors of outer environment on the other. These relationships and influences are, as a rule, reflected in the bionomy and ethology of mites as well as bats. Hence it may be said that the qualitative and quantitative structure of acarinia in the zone of Central European bat acarinia is affected primarily by the bionomy and ethology of mites and then by the bionomy and ethology of their hosts, the bats.

I. EFFECTS OF BIONOMY AND ETHOLOGY OF MITES ON THE STRUCTURE OF ACARINIA

In the bionomy and ethology of mites mainly their relationship to host as the source of food and temporary or permanent place of inhabitation is reflected. Also relationships to the outer environment inhabited by host as well as mite come into consideration; they affect the mite either directly or by means of body reactions of the host. On the basis of these relationships, which determine the presence or absence of the mite in an acarinium, the mites may be divided into the following nine groups:

1. Cavital muco-hematophagous endoparasites, whose specificity is determined by topical and trophical relationships to host. They are primarily parasites of nasal cavities (Gastronyssidae, Ereynetidae and some Trombiculidae) of which only a couple of species may be considered in Central Europe. They are forms perfectly morphologically adapted to endoparasitic way of life. Other mites, closely related to them, parasitize nasal

cavities of other groups of vertebrates, mainly rodents and birds. All the same, at least in subfamilies Gastronyssinae, Rodhainyssinae and in the genera *Speleochir* and *Neospeleognathopsis* (Ereynetidae), their relationship to host may be regarded as specific and phylogenetically dependent (cf. Fain 1963, 1966, 1967). The data on their occurrence and bionomy are fragmentary and reveal that particular species attack mostly bats of one host family (oligoxenia). Due to endoparasitic way of life the effects of outer environment on mites are manifested through the host's reactions.

2. Tissue kerato-mucophagous endoparasites whose specificity is determined by topical and trophical relationships to host. Of the Central-European groups mainly the mites of the families Sarcoptidae, Demodicidae and Psorergatidae may be included in this category. They parasitize the skin, subcutaneous layer, hair follicles and mucosa of the mouth cavity of bats. These mites are morphologically perfectly adapted to the endoparasitic way of life and their physiological adaptation is also very high, on the level of oligoxenia or monoxenia, although their specificity is not as clearly defined as in epizoic haematophagous ectoparasites, apparently due to prevalent keratophagia (see below). The influence of outer environment is exerted on these mites mostly through the reactions of the host's body (Fain 1960). They are therefore to be found on hosts inhabiting most different types of microbiotopes.

3. Epizoic (somatic) ectoparasites with obligatory haematophagia or lymphophagia whose specificity is determined primarily by trophical relationships to host. They are mites belonging to the phylogenetically very old families Spinturnicidae and Myobiidae whose evolution was concurrent with the evolution of hosts (Dusbábek 1968, 1969). Morphological adaptation in them is very well pronounced. Apart from adaptation of mouth organs for piercing the host's skin and for sucking, other adaptations evolved in them which improved their attachment system and thus created their specialization for various parts of the host's body (patagium, hairs). In both families the physiological adaptation has reached the highest possible degree, when a single parasite species is specific for a single host species, less frequently also for groups of phylogenetically closely related species or genera (monoxenia to oligoxenia). This close food dependence on a single host species is apparently due to the differences in the biochemical structure of live tissues of particular host species such as blood and lymph on which these mites feed. Also the influence of defense reactions of hosts manifested mainly in these tissues is apparently revealed here. Due to such a close association of the parasite with its host the influence of outer environment is exerted upon parasites primarily through the reactions of the host's body and causes only quantitative changes in the parasite micropopulation. Therefore these mites occur in the acarinium both in the winter and summer season regardless of the way of life conducted by subpopulations of the host species in different parts of its distribution area (Table 1 and Dusbábek 1962, 1963a).

4. Epizoic (somatic) ectoparasites with obligatory kerato-kolagenophagia, whose specifity is determined primarily by topical relationships to host. They are mites of the family Labidocarpidae whose evolution also appears to be associated with the evolution of hosts (Pinichpongse 1963). These mites are morphologically well adapted to parasitization in the hair of host. The attachment system in them has reached such a high degree of specialization that most species are adapted only to a certain type of hair and specialized setae, their thickness and density, the presence of glands etc.; this is manifested by a strict topical localization on the body of the host (Ewing 1912, Lawrence 1948, 1952, McDaniel and Lawrence 1962, Dusbábek and Cruz 1966). The choice of hosts is determined rather by the possibility of attachment to the body of host than by the limited food specialization. The specificity for a group of species within the range of genus or family (oligoxenia) is most frequent, but in most Central-European species sufficient material is unavailable. Their oligoxenia has been probably

caused by a greater affinity of biochemical structure of body keratins in particular host species maintaining these mites, in comparison with the biochemical structure of their live tissues which provide food to haemato or lymphophagous organisms. The occurrence of these mites in the acarinium does not appear to be also qualitatively affected by the use of various types of shelters by particular subpopulations of host bats.

5. Endophilic ectoparasites with transition from a periodic to permanent type of parasitism with obligatory hematophagia, whose presence in the acarinium is determined, besides trophical relationships to host, also by their own requirements for biotope. In the Central-European zone of bat acarinia they are mites of the family Macronyssidae, whose evolution is also associated with that of their hosts (Radovsky 1967, 1968). The bionomy of some species reveals that the hosts are sought after by protonymphs and adults in order to feed on them, while oviposition and the stage of unsucking deutonymph as well as moulting probably take place outside the host body, somewhere in its shelter. This fact is confirmed partly by direct findings of adults outside the host body (Willmann 1936, Dusbábek 1964 and other unpublished findings), partly by laboratory experiments (Radovsky 1967, Lavoipierre and Beck 1967) or other observations (Senotrusova 1968). The morphological adaptations to the parasitic way of life are manifested in the mouth organs adapted for piercing the host's skin and for sucking. The adaptations for improving the attachment system to the host's body are not so pronounced as in the preceding groups and are evident on legs only. The feeding is mostly short and repeated. The physiological adaptation has reached different levels

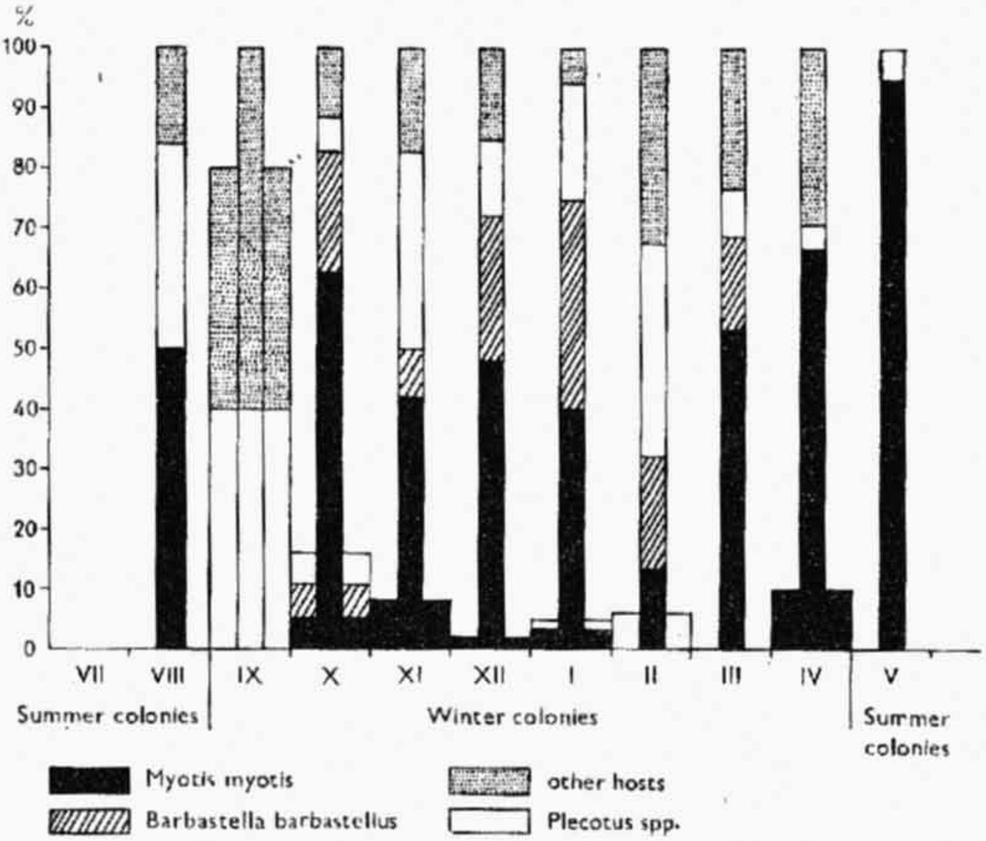

Fig. 1. Extensity of infestation of bats with *Macronyssus ellipticus* (Kol.) during the year, based on the data from 1953—1964 in Czechoslovakia. A wide column designates the percentage of infested specimens, the narrow column-the percentual representation of host species in the sample studied. The percentual value of infestation of particular host species applies to the total number of hosts examined. Among other hosts there are the following species: *Myotis daubentoni*, *M. mystacinus*, *M. nattereri*, *M. blythi* and *Eptesicus nilssoni*.

and we find here species which are monoxenic or oligo- and polyxenic; this is apparently due to the transition from endophilia to epizoic parasitism. In species with predominant epizoic parasitism [*Macronyssus corethroproctus* (Oudms.), *M. diversipilis* (Vitzh.), *Ichoronyssus scutatus* (Kol.) etc.] the trophical dependence is revealed only on a single host species (monoxenia) on which the mite occurs in different microbiotopes throughout the year. The species with predominant endophilic type of parasitism, for which oligoxenia to polyxenia are characteristic, are mostly associated ecologically with a certain type of microbiotope; thus we may distinguish dendrophilic species (e.g. members of the genus *Steatonyssus*) which infest bats inhabiting warm and dry shelters such as tree hollows, lofts of buildings etc. in summer and troglophilic species (e.g. *Macronyssus granulosus* (Kol.), *M. tinae* (Lomb.) or *M. uncinatus* (Canestr.)), which infest practically all bat species inhabiting caves throughout the year, although there is also a preference to certain host species (**Dusbábek** 1964).

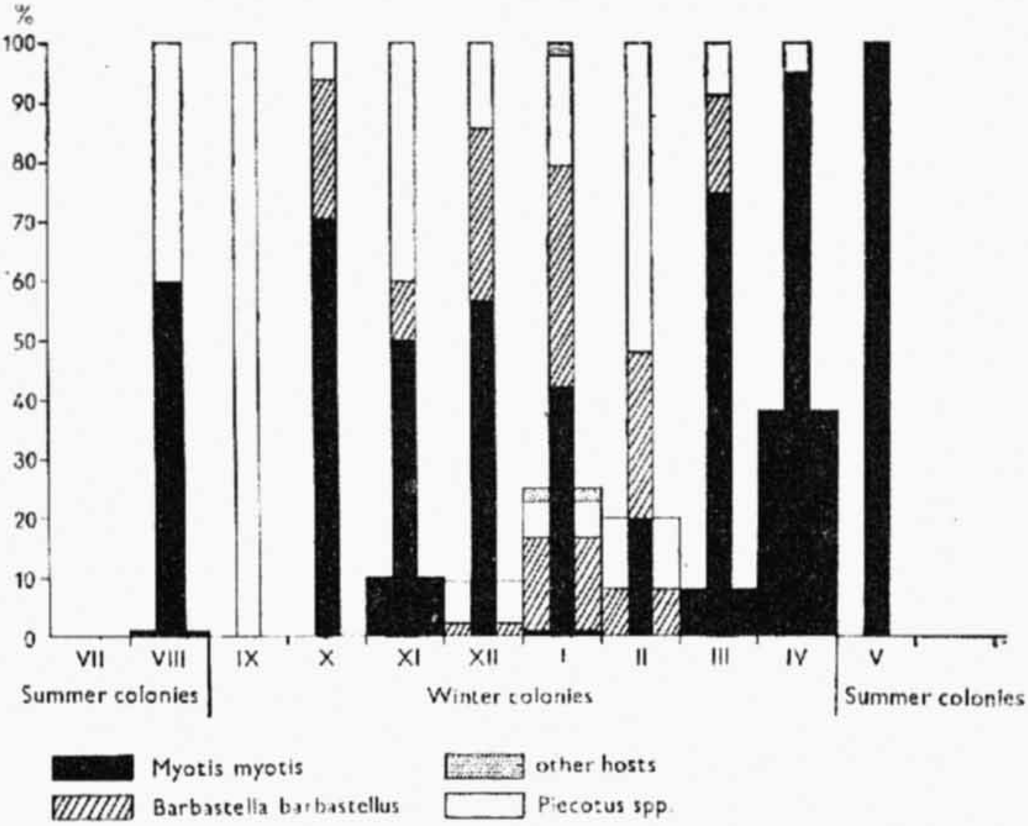

Fig. 2. Extensity of infestation of bats with *Macronyssus cyclaspis* (Oudms.) during the year, based on the data from 1953—1964 in Czechoslovakia. Explanations as Fig. 1. Among other hosts there are the following species: *Eptesicus serotinus* and *Vespertilio discolor*.

Among troglophilic species of special interest are *Macronyssus ellipticus* (Kol.) and *M. cyclaspis* (Oudms.) occurring on bats almost only in winter shelters, mostly in caves uninhabited by bats in the summer season (**Dusbábek** 1964, **Rybin** 1966, **Pintschuk** 1970). In Czechoslovak winter shelters *M. ellipticus* has been frequently found on *Myotis myotis**) (average winter extensity of infestation 8.3 %); its first winter findings, however, have been made on other host species (*Plecotus auritus*, *P. austriacus*, *Myotis daubentoni* and *M. nattereri*) and extensity of infestation of *Myotis myotis* has an upward tendency only during winter (Fig. 1). Although the summer colonies of *Myotis myotis*,

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*) **Pintschuk** (1970) reports the most frequent occurrence in Moldavia (U.S.S.R.) on a closely related species *Myotis oxygnathus* (= *M. blythi*).

M. daubentoni, *Plecotus auritus* and *P. austriacus* have been intensively investigated, *M. ellipticus* has never been found in them. Therefore it does not seem likely that the mite could be introduced in winter shelters by some host species of bats. A similar picture presents itself with *M. cyclaspis* which occurs in Czechoslovak winter shelters mostly on *Barbastella barbastellus**) (average winter extensity of infestation 30 %) and on both species of the genus *Plecotus* (25.6 %). The first and latest findings, however, have been made on ***Myotis myotis*** and the extensity of infestation of *B. barbastellus* as well as *Plecotus* spp. has a rising tendency only in winter (Fig. 2). Despite the intensive investigation of the species *M. myotis* and *Plecotus* spp. in summer colonies only one male of *M. cyclaspis* was found in August on a juvenile male of *M. myotis*. At this time, however, the summer colonies of this species disintegrate, the bats use temporary shelters and visit even winter shelters from where the mite appears to have been transported. Unfortunately, the summer colonies of *B. barbastellus* have not been parasitologically investigated, but it is highly unlikely in this case that the mite would be introduced in winter shelters by some of the above mentioned hosts, although in the case of *B. barbastellus* this possibility is not out of the question. The Figs. 3 and 4 show that intensive reproduction both of *M. ellipticus* and *M. cyclaspis* goes on in winter shelters; on the basis of the three-peak-curve of maximum occurrence of protonymphs on hosts it may be presumed that in both species there are three generations during the winter season. The peak of the first maximum of occurrence of protonymphs on hosts coincides with the period of the first mite occurrence in general. The mites *M. ellipticus* and *M. cyclaspis* in Central Europe may be therefore considered as so-called winter species, as a certain analogy to the winter species of fleas of the genus *Nycteridopsylla* reported by **K. Hůrka** (1963) and **L. Hůrka** (1965, 1967). Their reproduction period apparently coincides with the winter months, affecting their winter occurrence on hosts. The summer period with the absence of hosts in winter shelters is apparently survived by imagoes (the finding of a male *M. cyclaspis* in August in the summer

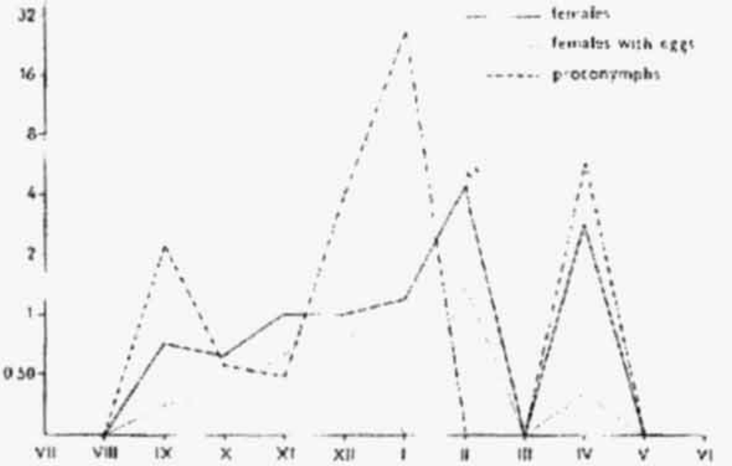

Fig. 3. Intensity of infestation of bats with females and protonymphs of the mite *Macronyssus ellipticus* (Kol.) during the year, based on the data from 1953—1964 in Czechoslovakia.

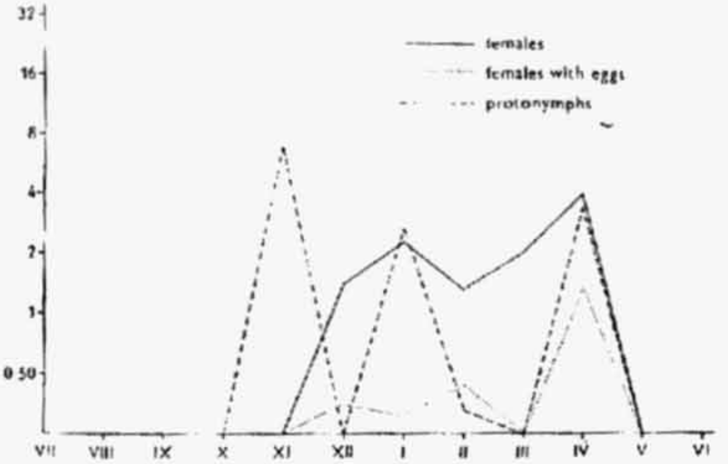

Fig. 4. Intensity of infestation of bats with females and protonymphs of the mite *Macronyssus cyclaspis* (Oudms.) during the year, based on the data from 1953—1964 in Czechoslovakia.

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*) **Rybin** (1966) reports the most frequent occurrence in Kirghizia (U.S.S.R.) on *Pipistrellus pipistrellus* and **Pintschuk** (1970) in Moldavia (U.S.S.R.) on *Eptesicus serotinus*.

colony of *M. myotis*) or even by eggs (the first peak of occurrence of protonymphs in September or October) and directly after the appearance of hosts an intensive mite reproduction takes place, evident in the first maximum of occurrence of protonymphs on hosts, as presented in Figs. 3 and 4. Beyond this scheme is the finding of one female and three protonymphs collected from *Myotis myotis* or *M. blythi* in Portugal in May, i.e. probably in a summer colony (Radovsky 1967). According to the data of the author, however, these are atypical specimens characterized by distinctly smaller dimensions, which in our opinion may be classified as members of different population, as different ecological forms or even subspecies with probably different seasonal dynamics in the southern part of its distribution area.

6. Endophilic temporary or periodic ectoparasites with obligatory haematophagia in some stages, whose presence in the acarinium is determined primarily by their own requirements for microbiotope. They are members of the families Ixodidae, Argasidae and Trombiculidae, the inhabitants of natural, probably original bat shelters, strongly adapted to microclimatic conditions and their ecological valence, with the exception of *Argas vespertilionis* Latr., is therefore not too high. In Central Europe they are primarily troglophilic (Ixodidae and Trombiculidae), exceptionally also dendrophilic (*Argas vespertilionis* Latr.)*) species. The morphological adaptation of parasitic stages is limited primarily to the change of mouth organs serving not only for piercing the host's skin and for sucking, but also for the attachment of the parasite to the host's body; there is also the adaptation which makes the engorgement of a larger blood amount possible. The parasites feed mostly for long periods and without interruption. The physiological adaptation is rather low and the choice of hosts is consequently determined by a similar way of life rather than by a systematic affinity. Their presence in the acarinium depends on the type of bat shelter, i.e. on the bionomy of hosts. Despite this fact in some species within the framework of the corresponding microbiotope, a strong affinity to a certain systematic category of hosts may be observed (oligoxenic species) and also species with a clearly defined specialization (monoxenic species) are known.

7. Obligatory commensals of the genus *Nycteriglyphus* of the family Rosensteiniidae, inhabiting bat shelters, frequently found directly on bats. They are apparently species trophically quite dependent on the products of host metabolism, i. e. bat guano. Also their phoretic relationship to host must be noted These mites have been never found out of reach of bats and their shelters. They occur mostly in dry localities and some species seem to show preference to certain types of bat shelters or certain host species. The Central-European species show a tendency towards dendrophilia.

The species *Oribella cavatica* Kunst and *O. forsslundi* Moritz of the family Thyrisomidae repeatedly found in bat guano only, may be also included in this group. The former may be regarded as troglophilic, the latter as dendrophilic species.

8. Facultative commensals, i.e. free-living inhabitants of bat shelters, occurring usually also outside the zone of bat acarinia. They are schizo-, copro-, necrophagous, predacious as well as polyphagous species, either troglophilic, guanophilic, edaphic etc. Our survey includes only species recorded in association with bats of Central Europe. To these, however, a number of other species recorded by Willmann (1954), Cooreman

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*) Under Central-European conditions the main host of *Argas vespertilionis* Latr. larvae is the bat *Pipistrellus pipistrellus* whose infestation extensity in some localities is 90 % (Dusbábek 1963b). This host species in Central Europe is mostly dendrophilic and has not yet been discovered in caves even during hibernation (Feriancová-Masárová and Hanák 1965). Other bat species inhabiting caves or hibernating in them are also infested by larvae, but to a considerably less degree (extensity of infestation does not exceed 5 %). Because of the high specificity of *A. vespertilionis* for a typically dendrophilic species of host this soft tick or at least its Central-European population may be considered as dendrophilic.

(1954, 1959), **Rack** (1968), **Mahunka** (1968) etc., which are potential members of bat acarinia, should be added.

9. Parasitic mites of other host groups accidentally introduced in the zone of bat acarinia. They are mostly ectoparasites of small mammals and birds which are current transmitters of infectious agents in natural foci of disease, namely the medically important species. Under conditions of Central Europe, however, these accidental introductions seem to be quite rare (see survey) due to the marked ecological isolation of bats. According to the data of Soviet authors (**Arzamasov** and **Kurskov** 1967, **Andreyko**, **Skvortsov** and **Pintschuk** 1968, **Gadzhiev** and **Dubovchenko** 1967) these accidental transfers are more frequent in the Eastern and South-eastern Europe and it is difficult to decide whether they are due to the different bionomy of eastern and south-eastern host populations, or to different techniques of collection or other factors.

II. EFFECTS OF BIONOMY AND ETHOLOGY OF BATS ON THE STRUCTURE OF ACARINIA

The structure of acarinium is considerably affected by the interchange of various types of shelters during the year due to seasonal migrations of bats, by hibernation, different degree of synanthropisation and a number of ecological peculiarities of Central-European populations and subpopulations of bats. The ecological assessment of colonies of Central-European bats was made by **Gaisler** (1966) whose criteria may be also used for our purposes. He divides the colonies according to:

1. Season of the year: The alternation of the period of activity (connected with reproduction) with the period of torpidity in Central-European bats, depending on the season of the year results in the formation of summer and winter colonies and transient aggregations in the temporary (migrative) period. As demonstrated by L. **Hůrka** (1967) on the example of *Nycteridopsylla eusarca* Dampf the parasitation of bats in temporary shelters resembles the parasitation in winter colonies. In the winter period the extensity and intensity of infestation in acarinia is decreased, the sex ratio of mites is changed due to the decrease of nymphal stages and pregnant females, namely in the families Sarcoptidae, Spinturnicidae and Macronyssidae, this being the result of the seasonal dynamics of their reproductive cycles (**Fain** 1960, **Dusbábek** 1962, 1964, **Turjanin** 1966, 1967, **Andreyko**, **Skvortsov**, **Pintschuk** 1968). The feeding of ticks *Ixodes vespertilionis* Koch on bats mainly in winter months as recently discussed by **Beaucournu** (1967) has been also observed in Czechoslovak caves inhabited by bats throughout the year. The winter acarinium of some bat species becomes qualitatively richer by the so-called winter species of mites *Macronyssus cyclaspis* (Kol.) and *M. ellipticus* (Oudms.) mentioned above. As the seasonal migrations of many hemisynanthropic bats are mostly accompanied by a change of the shelter type, the acarinium of species hibernating in caves is also enriched by troglophilic ectoparasites of the families Ixodidae, Trombiculidae and less frequently Macronyssidae. On the other hand, the facultative and obligatory commensals in localities utilized as winter shelters are mostly missing. In localities where more than one species of bats hibernate together an accidental interchange of highly specialized ectoparasites (Table 1) may take place. The extent to which the structure of acarinium is affected by migration itself, especially its duration, has not been exactly known to date.

2. Shelter type of host: The Central-European bats are usually divided into two ecological groups, namely the cave bats and the bats inhabiting trees and crevices. Because many species in Central Europe in the process of synanthropization gradually inhabit secondary biotopes, the division of **Gaisler** (1966) who divides the Central-

European species into "space bats" and "fissure bats", seems to be more true to nature. The original summer shelters of spatial bats were apparently spatious caves which have been later replaced by extensive lofts of old buildings etc. The fissure bats originally inhabited hollow trees and rock crevices and later moved over to secondary shelters, i.e. fissures in human buildings, smaller lofts where they could squeeze between rafters etc. Therefore we may distinguish two types of original (primary) summer shelters, i.e.

Table 1. Composition of acarinia in Czechoslovak colonies of *Myotis myotis* in different types of shelters, in different seasons during 1957—1959

Ecological group	Mite species	Summer colony in the loft of a rectory at Dobřichovice	Summer colony in the loft of a church at Dobříš	Summer colony in the cave at Drienovec*)	Winter colony in abandoned galleries at Srbsko near Beroun	Winter colony in abandoned galleries at Karlštejn
II.	*Nycteridocoptes poppei* Oudms.	×	×	×		
III.	*Spinturnix myoti* (Kol.)	×	×	×	×	×
	Spinturnix psi (Kol.)			o		
	Eyndhovenia euryalis (Canestr.)			o		
	Acanthophthirius myoti (Dusb.)	+	+	×	×	×
	Acanthophthirius klapaleki (Dusb.)			×		
	Pteracarus tibialis Dusb.			o		
V.	*Ichoronyssus scutatus* (Kol.)	+	×	×	×	×
	Steatonyssus spinosus Willm.	+	×	+	+	+
	Macronyssus granulosus (Kol.)			+		
	Macronyssus tinae (Lomb.)			×		
	Macronyssus uncinatus (Canestr.)			o		
	Macronyssus cyclaspis (Oudms.)				×	×
	Macronyssus ellipticus (Kol.)				×	×
	Macronyssus diversipilis (Vitzth.)				o	
VI.	*Ixodes vespertilionis* Koch			×	+	
	Trombicula (T.) russica (Oudms.)			+	×	×
	Chiroptella (O .) muscae (Oudms.)				×	
VII.	*Coproglyphus stammeri* (E. Türk et F. Türk)	×				
VIII.	*Parasitus niveus* (Wankel)			+		
	Cyrtolaelaps mucronatus (Canestr.)			×		
	Proctolaelaps sp.		+	+		
	Hypoaspis sp.		+	+		
	Euryparasitus sp.		×			
	Uropolyaspis sp.		+			
	Pseudouropoda sp.		×			
	Leiodinychus sp.		×			
IX.	*Neotrombicula japonica* (Tanaka et al.)				o	

*) Together with colonies of *Rhinolophus euryale* and *Miniopterus schreibersi*.

× — abundant, + — rare, o — accidental

Table 2. The classification of mites in the acarinia zone of bats in Central Europe and their relationships to the environment and hosts.

Family, genus, species	Relation to the environment and host	
I. Cavital muco-haematophagous endoparasites		
Gastronyssidae		
Rodhainyssus myotis Fain	oligoxenic	*Myotis myotis* *Nyctalus noctula*
R. eptesici Fain	? monoxenic	*Eptesicus serotinus*
R. miniopteri Fain	? monoxenic	*Miniopterus schreibersi*
Opsonyssus striatus Fain	? monoxenic	*Rhinolophus hipposideros*
Ereynetidae		
Neospeleognathopsis bastini Fain	monoxenic	*Myotis myotis*
Trombiculidae		
Doloisia synoti Oudms.	oligo-polyxenic	*Berbastella barbastellus* *Plecotus auritus* *Myotis dasycneme*
II. Tissue kerato-mucophagous endoparasites		
Sarcoptidae		
Nycteridocoptes poppei Oudms.	oligoxenic	*Myotis myotis* *Myotis daubentoni*
N. eyndhoveni Fain	oligoxenic	*Rhinolophus euryale* *Rhinolophus ferrumequinum*
N. miniopteri Fain	monoxenic	*Miniopterus schreibersi*
Chirnyssus myoticola Fain	monoxenic	*Myotis myotis*
Notoedres chiropteralis (Trt.)	oligo-polyxenic	*Eptesicus serotinus* *Pipistrellus pipistrellus* *Nyctalus noctula*
N. plecoti Fain	monoxenic	*Plecotus auritus*
N. miniopteri Fain	monoxenic	*Miniopterus schreibersi*
Demodicidae		
Demodex chiropteralis Hirst	? monoxenic	*Plecotus auritus*
D. soricis Hirst	? accidental	*Plecotus auritus*
D. aelleni Fain	? monoxenic	*Myotis duabentoni*
Stomatodex corneti Fain	? oligoxenic	*Barbastella barbastellus*
S. corneti myotis Fain	oligoxenic	*Myotis myotis* *Myotis dasycneme*
Psorergatidae		
Psorergates rhinolophi (Fain)	oligoxenic	*Rhinolophus ferrumequinum* *Rhinolophus hipposideros*
P. kerivoulae (Fain)	polyxenic (? monoxenic)	*Plecotus auritus* in Europe
III. Epizoic obligatory haematophagous or lymphophagous ectoparasites		
Spinturnicidae		
Spinturnix emarginatus (Kol.)	monoxenic	*Myotis emarginatus*
S. mystacinus (Kol.)	monoxenic	*Myotis mystacinus*
S. a. acuminatus (Koch)	monoxenic	*Nyctalus noctula*
S. a. barbastelli (Kol.)	monoxenic	*Barbastella barbastellus*
S. acuminatus ssp.	monoxenic	*Pipistrellus pipistrellus*

Table 2 (continued)

Family, genus, species.	Relation to the environment and host	
S. psi (Kol.)	monoxenic	*Miniopterus schreibersi*
S. myoti (Kol.)	oligoxenic	*Myotis myotis*
		Myotis blythi
		Myotis capaccini
		Myotis dasycneme
		Myotis daubentoni
		Myotis nattereri
S. kolenatii Oudms.	oligoxenic	*Eptesicus serorinus*
		Eptesicus nilssoni
S. plecotinus (Koch)	oligoxenic	*Plecotus auritus*
		Plecotus austriacus
Eyndhovenia euryalis (Canestr.)	oligoxenic	*Rhinolophus ferrumequinum*
		Rhinolophus euryale
Paraperiglischrus rhinolophinus (Koch)	oligoxenic	*Rhinolophus ferrumequinum*
		Rhinolophus euryale
		Rhinolophus hipposideros
Myobiidae		
Neomyobia rollinati (Poppe)	monoxenic	*Rhinolophus ferrumequinum*
N. slovenica Dusb.	monoxenic	*Rhinolophus euryale*
N. chiropteralis (Michael)	monoxenic	*Rhinolophus hipposideros*
Calcarmyobia rhinolophia (Radf.)	monoxenic	*Miniopterus schreibersi*
Acanthophthirius myoti (Dusb.)	mono-oligoxenic	*Myotis myotis*
		Myotis blythi
A. klapaleki (Dusb.)	monoxenic	*Myotis myotis*
A. emarginatus (Dusb.)	monoxenic	*Myotis emarginatus*
A. mystacinalis (Radf.)	monoxenic	*Myotis mystacinus*
A. etheldredae Perkins	monoxenic	*Pipistrellus pipistrellus*
A. poppei (Trt.)	monoxenic	*Pipistrellus nathusii*
A. noctulius (Radf.)	monoxenic	*Nyctalus noctula*
A. pantopus (Poppe et Trt.)	monoxenic	*Barbastella barbastellus*
A. plecotius (Radf.)	monoxenic	*Plecotus auritus*
A. bohemicus (Dusb.)	monoxenic	*Plecotus austriacus*
Pteracarus pipistrellius (Radf.)	monoxenic	*Pipistrellus pipistrellus*
P. submedianus Dusb.	oligoxenic	*Plecotus auritus*
		Plecotus austriacus
P. minutus (Radf.)	oligoxenic	*Myotis daubentoni*
		Miniopterus schreibersi
P. tibialis Dusb.	oligo-polyxenic	*Myotis myotis*
		Nyctalus noctula
IV. Epizoic obligatory keratophagous ectoparasites		
Labidocarpidae		
Alabidocarpus megalonyx (Trt.)	? monoxenic	*Rhinolophus ferrumequinum*
A. minor (Berl. et Trt.)	? monoxenic	*Rhinolophus ferrumequinum*
A. balcanicus Beron	? monoxenic	*Rhinolophus ferrumequinum*
A. calcaratus Lawr.	oligoxenic	*Myotis blythi*
Olabidocarpus belsorum (Eyndh.)	? monoxenic	*Myotis myotis*
Labidocarpus rollinati Trt.	oligoxenic	*Rhinolophus hipposideros*
		Rhinolophus ferrumequinum

Table 2 (continued)

Family, genus, species	Relation to the environment and host	
V. Endophilic obligatory haematophagous ectoparasites with transition from periodic to permanent type of parasitism		
Macronyssidae		
Ichoronyssus scutatus (Kol.)	monoxenic	*Myotis myotis*
Macronyssus diversipilis (Vitzth.)	monoxenic	*Myotis daubentoni*
M. corethroproctus (Oudms.)	monoxenic	*Myotis dasycneme*
M. barbastellinus Dusb. et Pintsch.	monoxenic	*Barbastella barbastellus*
M. kolenatii (Oudms.)	dendrophilic, oligoxenic	*Pipistrellus pipistrellus*
M. flavus (Kol.)	dendrophilic, oligoxenic	*Nyctalus noctula*
M. granulosus (Kol.)	troglophilic, polyxenic	Bats inhabiting caves
M. tinae (Lomb.)	troglophilic, polyxenic	Bats inhabiting caves
M. uncinatus (Canestr.)	troglophilic, polyxenic	Bats inhabiting caves, mainly *Rhinolophus* spp.
M. cyclaspis (Oudms.)	troglophilic, polyxenic	Bats wintering in caves
M. ellipticus (Kol.)	troglophilic, polyxenic	Bats wintering in caves
Steatonyssus spinosus Willm.	dendrophilic, polyxenic	Bats inhabiting buildings
S. periblepharus Kol.	dendrophilic, oligoxenic	mainly *Pipistrellus pipistrellus*
S. occidentalis (Ewing)*)	dendrophilic, mono-oligoxenic	*Eptesicus serotinus*
VI. Endophilic obligatory haematophagous temporary or periodic ectoparasites.		
Ixodoidea		
Ixodes simplex Neum.	troglobiont, monoxenic	*Miniopterus schreibersi*
I. vespertilionis Koch	troglobiont, polyxenic	Bats inhabiting caves, mainly *Rhinolophus* spp.
Argas vespertilionis (Latr.)	mainly dendrophilic mono-oligoxenic	mainly *Pipistrellus pipistrellus*
Trombiculidae		
Toritrombicula (C.) komareki (Dan. et Dusb.)	troglobiont, ?monoxenic?	*Plecotus auritus*
Trombicula (T.) russica (Oudms.)	troglobiont, polyxenic	Bats inhabiting caves, mainly *Barbastella barbastellus*
Chiroptella (O.) muscae (Oudms.)	troglobiont, polyxenic	Bats inhabiting caves
VII. Obligatory commensals		
Rosensteiniidae		
Nycteriglyphus stammeri (E. Türk et F. Türk)	dendrophilic, guanobiont	Guano of bats inhabiting buildings
N. tuerkorum Dusb.	dendrophilic, guanobiont–phorotic	Guano in hollow trees *Nyctalus noctula* *Pipistrellus pipistrellus* *Myotis myotis*
N. verrucosus Mahunka	dendrophilic, guanobiont	Guano of bats inhabiting buildings
Thyrisomidae		
Oribella forsslundi Moritz	dendrophilic, guanobiont	Guano in hollow trees
O. cavatica Kunst	troglophilic, guanobiont	Guano in caves

*) This species has been recorded in the Palearctic region for the first time by Evans and Till (1966) from *Eptesicus serotinus* in Great Britain and recently it has been found on the same host also in Czechoslovakia and the U.S.S.R. (Kirghizia) (in litt.).

Table 2 (Continued)

Family, genus, species	Relation to the environment and host	
VIII. Faculative commensals		
Parasitus niveus (Wankel)	troglophilic, detricolous	Guano in caves
P. kobyi (Schweizer)	troglophilic, guanophilic	Guano in caves
P. kraepelini Berl.	detricolous	Guano in caves
Veigaia nemorensis (Koch)	troglophilic, detricolous	Guano in caves
V. kochi (Trägard)	troglophilic, detricolous	Guano in caves
Geholaspis alpinus Berl.	detricolous	Guano in caves
G. mandibularis Berl.	detricolous	Guano in caves
Euryparasitus sp.	?	Guano in buildings
Proctolaelaps sp.	?	Guano in buildings
Hypoaspis sp.	?	Guano in buildings
Cyrtolaelaps mucronatus (Canestr.)	detricolous	Guano in caves
Uropolyaspis sp.	?	Guano in buildings
Pseudouropoda sp.	?	Guano in buildings
Leiodinychus sp.	?	Guano in buildings
Trichouropoda orbicularis (Koch)	detricolous, coprophilic	Guano in buildings
Dinychura rackei (Oudms.)	detricolous	Guano in caves
Epicrius mollis (Kramer)	edaphic	Guano in caves
Phaulodiaspis advena (Trägard)	troglophilic, ? guanobiont	Guano in caves
Pygmephorus spinosus (Kramer)	coprophilic	Guano in caves
Neopygmephorus meszarosi Mahunka	guanophilic	Guano in buildings
Acarus farris (Oudms.)	eurybiont, phoretic	Guano in buildings *Myotis daubentoni*
Calvolia romanovae Zachv.	eurybiont, phoretic	*Myotis emarginatus*
Calvolia miniopteri Dush.	?, phoretic	*Miniopterus schreibersi*
Glycyphagus domesticus (Degeer)	eurybiont	Guano in buildings
IX. Parasitic mites of other host groups accidentally transferred to acarinia zone of bats.		
Neotrombicula japonica (Tanaka et al.)	parasite of small mammals	*Myotis myotis*
Neotrombicula autumnalis (Shaw)	parasite of small mammals	*Myotis myotis*
Hyperlaelaps microti (Ewing)	parasite of rodents	*Myotis myotis*
Androlaelaps fenilis Mégnin	parasite of rodents and birds	*Myotis myotis* Guano in buildings

caves inhabited by spatial bats and hollow trees and natural crevices inhabited by fissure bats. The secondary summer shelters of both bat groups are microclimatically very similar and therefore we speak about one type of secondary summer shelters. The winter shelters are usually common to both ecological bat groups and they may be divided into primary (caves) and secondary (galleries, cellars, old churches etc.) ones. The bat acarinia of both groups are qualitatively and quantitatively richer in primary than in secondary shelters, because the ecological valence of many ectoparasite species is relatively low. This becomes evident especially in troglophilic parasites, both temporary and periodical (Trombiculidae and Ixodidae), while in permanent ectoparasites this is not the case (Table 1). Of the family Macronyssidae a relatively low ecological valence is revealed by the species *Macronyssus uncinatus* (Canestr.), *M. tinae* (Lomb.) and *M. granulosus* (Kol.), the original ectoparasites of spatial bats which occur together with their hosts only in original cave microbiotopes (troglophilic species). A higher ecological valency seems to be characteristic of the species which may be designated as original ectoparasites of fissure bats (species of the genus *Steatonyssus* and *Argas vespertilionis* Latr.), i.e. dendrophilic species which have inhabited, together with their hosts, microclimatically similar secondary microbiotopes and in limited numbers spread even to dry caves.

3. Colony composition: From this aspect the colonies of the Central-European bats are divided into monospecific and polyspecific colonies. The polyspecific colonies in the sense of Gaisler (1966) are rare in Central Europe, but the occurrence of several monospecific colonies of different species in one shelter, e.g. cave, is more frequent. In the polyspecific colonies the acarinium is very rich because each host species brings into it its specific parasites. The structure of acarinium in monospecific colonies of different species in a common shelter does not undergo many changes, but the number of species may be increased due to an accidental interchange between individuals of different colonies and also the number of commensals may become larger due to the additional number of hosts and their passive influence in shelter (Tab. 1).

From the aspect of sex ratio or the ratio of adults and juveniles the summer colonies of some species may be divided into male and female colonies, or even juvenile colonies which however remain in contact with the colonies of their mothers. The males and subadult specimens of most Central-European species form only small colonies or live individually, sometimes in company of other bat species (Feriancová-Masárová and Hanák 1965); this fact may affect the structure of acarinia to a certain extent. The extensity and intensity of infestation as well as the number of parasite species is usually somewhat higher in females and juveniles than in males and subadult specimens. Although these effects have been studied in acarinia only occasionally, we are of this opinion because we observe analogous conditions in bat aphanipteria as discussed by K. Hůrka (1963). In winter shelters when both sexes as well as subadult specimens occur together, these differences become negligible.

4. The size of colony affects the structure of acarinium quantitatively. Acarinia of small colonies or solitary specimens are usually poorer than those of large colonies.

5. The effects of different degrees of contact among members of each colony have been only occasionally studied under Central-European conditions. A very poor acarinium, especially from the quantitative aspect, is met with in non-contact species *Rhinolophus hipposideros*. However, it is difficult to decide whether such a low parasitation is caused by the fact, that this species forms non-contact and relatively small colonies, or by specific resistance or defensive adaptation against parasite infestation. Acarinia of the closely related species *Rhinolophus euryale*, which also forms non-contact, but large colonies, do not differ at all in the number of species in acarinia or in the extensity or intensity of infestation from the species forming contact colonies.

ЗОНА АКАРИНИУМОВ ЛЕТУЧИХ МЫШЕЙ В УСЛОВИЯХ СРЕДНЕЙ ЕВРОПЫ

Ф. Дусбабек

Резюме. В статье излагается характеристика зоны акариниумов летучих мышей в Средней Европе и дана оценка влияния факторов, вызывающих изменения в структуре акариниумов в этой зоне. Работа также содержит экологическую оценку членов этой зоны и на примере вида *Myotis myotis* (Borkh.) показана структура акариниумов в разных микробиотопах на территории Чехословакии.

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