4. INVERTEBRATES ASSOCIATED WITH THE BANK VOLE

4.1. Arthropod Communities

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The number of arthropod species that permanently, periodically, or occasionally occur on *Clethrionomys glareolus* is enormous and far from being well known, particularly in the case of occasional froms.

There are many papers on this subject for central Europe, including Poland, generally dealing with representatives of a single order or even family (e. g., *Trombiculidae*). They usually contain scarce ecological information, and only some of them broadly discuss relationships among parasites, their hosts, and environmental conditions (Rosicky & Černy, 1956; Mrčiak, 1958, 1963; Daniel, 1957, 1961; Kepka, 1964; Mahnert, 1971a, 1971b; Haitlinger, 1976a, 1976b, 1977c, and others).

The number of arthropod species occurring in nests of the bank vole is even higher and the knowledge of this group is very poor (Mrčiak *et al.*, 1966; Vysotskaya, 1974). But particularly scarce data exist on the entire communities of arthropods associated with the bank vole (Vysotskaya, 1974; Haitlinger, 1977b). Arthropod communities (observed in different years over successive months) occurring on the bank vole are predominated by *Acarina*. Also the number of species is the highest in this order. For example, in the Sowie and Pieniny mountains ranges in southern Poland, where the parasites of this rodent were most intensely studied, *Acarina* can account for even more than 70% of the community (Fig. 4.1). The most abundant species of *Acarina* belong to the family *Trombiculidae* (e. g. in the Pieniny, they account for more than 50% of the arthropod community), but their numbers vary greatly from one area to another. The lowest proportion of the community is represented by *Ixodides* (Fig. 4.1). The number of arthropod species known to be associated with the bank vole in Poland is 142. They consist of 29 species of *Siphonaptera*, 7 species of *Anoplura*, and 106 species of *Acarina* (Tables 4.1 and 4.2). They differ in the degree of their dependence on

the host. They can be classified into three biological groups: host dwellers, host-nest dwellers, and nest dwellers. These groups are distinguished according to the criteria given by Vysotskaya (1967) and modified by Haitlinger (1981). The most abundant species on the bank vole belong to the group of host dwellers and host-nest dwellers, but the highest faunal diversity was recorded for the group of nest dwellers (Table 4.2).

4.1.1. The Group of Host Dwellers

In Poland, 14 species of host-dwelling arthropods were noted on bank voles inhabiting the Sowie mountains (Haitlinger, 1977b) and 12 species on bank voles in the Pieniny (Haitlinger, 1974a, 1974b, 1983). Among

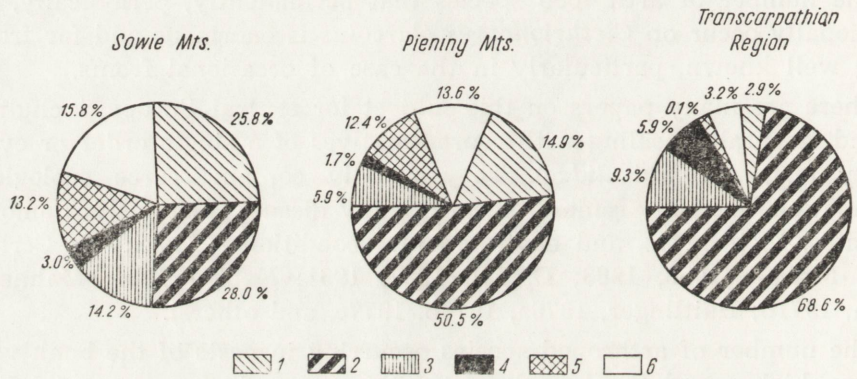

Fig. 4.1. Proportion of six groups in arthropod communities infesting bank voles in different mountain areas.
Sowie Mts. after Haitlinger, 1977; Pieniny Mts. after Haitlinger, 1974a; 1974b, and 1983; Transcarpathian Region after Vysotskaya, 1974, 1 — *Mesostigmata*, 2 — *Trombidiformes*, 3 — *Sarcoptiformes*, 4 — *Ixodides*, 5 — *Anoplura*, 6 — *Siphonaptera*.

them, typical of the bank vole are *Laelaps clethrionomydis* and *Polyplax hannswrangeli*. Some of the other species occur only on representatives of the genus *Clethrionomys* (*H. edentula*). Most of them occur only on *Microtidae*, but some are typical of the hosts of other taxonomic groups. The frequency of the occurrence of the latter species of arthropod on the bank vole is likely to correspond to the frequency of contacts with their respective hosts (mostly dead) or with their nests; *Laelaps hilaris*. or *L. agilis* is an example. This happens on rather rare occasions (Haitlinger, 1976b). Two species of the host dwellers; *Hoplopleura edentula* and *L. clethrionomydis*, usually predominate arthropod communitis and play an important part in the community dynamics (Table 4.3).

Table 4.1

Check-list of the host dwelling and host-nest dwelling arthropods on the bank vole in Poland.

Host-nest dwelling arthropods

Siphonaptera

Ctenophthalmus agyrtes (Hell.)
Ctenophthalmus assimilis (Tasch.)
Ctenophthalmus congener Roths.
Ctenophthalmus uncinatus (Wagn.)
Ctenophthalmus solutus Jord., Roths.
Ctenophthalmus obtusus Jord., Roths.
Ctenophthalmus bisoctodentatus Kolen.
Peromyscopsylla fallax (Roths.)
Peromyscopsylla bidentata (Kolend.)
Peromyscopsylla silvatica (Mein)
Rhadinopsylla pentacantha (Roths.)
Rhadinopsylla integella Jord., Roths.
Megabothris turbidus (Roths.)
Megabothris walkeri (Roths.)
Megabothris rectangulatus (Wahlg.)
Amalareus penicilliger (Grube)
Amalareuls arvicolae Ioff
Palaeopsylla soricis (Dale)
Palaeopsylla similis Dampf
Palaeopsylla steini Jord.
Nosopsyllus fasciatus (Bosc)
Hystrichopsylla talpae (Curtis)
Hystrichopsylla orientalis Smit
Doratopsylla dasycnema (Roths.)
Leptopsylla segnis (Schon.)
Atyphloceras huperum (Jord.)
Monopsyllus sciurorum (Schrank)
Ceratophyllus gallinae (Schrank)
Ceratophyllus garei Roths.

Ixodides

Ixodes ricinus (L.)
Ixodes trianguliceps Bit.
Ixodes apronophorus Schul.
Dermacentor reticulatus (Fabr.)

Acarina

Mesostigmata

Androlaelaps fahrenholzi (Berl.)
Androlaelaps casalis (Berl.)
Eulaelaps stabularis (Koch)
Haemogamasus nidi Mich.
Haemogamasus hirsutus Berl.
Haemogamasus horridus Mich.
Haemogamasus hirsutosimilis Willm.
Myonyssus rossicus Breg.
Hirstionyssus isabellinus (Oud.)
Hirstionyssus sunci Wang
Hirstionyssus soricis Türk

Trombidiformes

Neotrombicula zachvatkini Schlug.
Neotrombicula inopinata (Oud.)
Neotrombicula autumnalis (Shaw)
Neotrombicula talmiensis Sching.
Neotrombicula earis Kepka
Neotrombicula japonica Tan., Kaiwa, Teram., Kag
Neotrombicula nagayoi Sasa, Hay., Sato, Miura, Asah.
Neotrombicula vulgaris Schlug.
Neotrombicula multisetosa Willm.
Cheladonta costulata (Willm.)
Ascoschoengastia latyshevi (Schlug.)
Miyatrombicula muris (Oud.)

Sarcoptiformes

Glycyphagus hypudei (Koch)
Xenoryctes krameri (Mich.)
Xenoryctes punctatus Fain
Orycteroxenus soricis (Oud.)

Host dwelling arthropods

Anoplura

Hoplopleura edentula Fahr.
Hoplopleura acanthopus (Burm.)
Hoplopleura affinis (Burm.)
Polyplax hannswrangeli Eichler
Polyplax borealis Ferris
Polyplax serrata (Burm.)
Polyplax spinigera (Burm.)

Acarina

Mesostigmata

Laelaps clethrionomydis Lange
Laelaps hilaris Koch
Lalaps agilis Koch
Laelaps pavlovskyi Zachv.
Hyperlaelaps microti (Ewing)

Trombidiformes

Radforida lemnina (Koch)
Myobia musculi (Schrank)
Protomyobia claparedei (Poppe)
Amorphacarus elongatus (Poppe)

Sarcoptiformes

Myocoptes japonensis Radf.
Myocoptes musculinus (Koch)
Trichoecius tenax (Mich.)
Listrophorus brevipes Dub.

The occurrence of *H. edentula* in Poland probably corresponds to the distribution of the bank vole (Haitlinger, 1976a; Cais, 1977). In mountain areas, the extent of invasion of bank voles by *H. edentula* ranges from 25% (the Sowie Mountains) to 34% (the Pieniny Mountains, pooled data for two years). The abundance of this parasite undergoes

Table 4.2

Check-list of the nest dwelling arthropods found on the bank vole in Poland.

Acarina

Mesostigmata

Veigaia kochi Tragh.
Veigaia nemorensis (Koch)
Macrocheles glaber (Müll.)
Macrocheles montanus Willm.
Macrocheles muscadomesticae (Scop.)
Macrocheles tridentinus (G et R. Canes.)
Geholaspis longispinosus (Kram.)
Neopodocinum mrciaki Selln.
Holoparasitus excipuliger (Berl.)
Holoparasitus intermedius (Holz.)
Holoparasitus pseudoperforatus (Berl.)
Parasitus kraepelini (Berl.)
Parasitus lunulatus (Müll.)
Parasitus remberti (Oud.)
Parasitus distinctus (Berl.)
Pergamasus alpestris (Berl.)
Pergamasus runciger (Berl.)
Pergamasus longicornis Berl.
Pergamasus crassipes (L.)
Pergamasus quisquiliarum (G. et. R. Canes)
Pergamasus runcatellus Berl.
Pergamasus brevicornis Berl.
Pergamasus septentrionalis (Oud.)
Poecilochirus necrophori Vitzt.
Cyrtolaelaps mucronatus (G. et R. Canes)
Cyrtolaelaps minor Willm.
Euryparasitus emarginatus (Koch)
Hypoaspis sardoa (Berl.)
Hypoaspis heselhausi Oud.
Alloparasitus oblongus (Halb.)
Proctolaelaps pygmaeus (Müll)
Pachylaelaps furcifer Oud.
Olopachys suecicus Selln.
Platyseius italicus (Berl.)
Ameroseius corbicula (Sowerby)
Typhlodromus meridionalis Berl.
Eviphis ostrinus (Koch)

Trombidiformes

Pygmephorus forcipatus Willm.
Pygmephorus spinosus Kram.
Pygmephorus soricis Krczal
Pygmephorus erlangensis Krczal
Pygmephorus krczali Mahun.
Bakerdania cultrata (Berl.)
Bakerdania bavarica (Krczal)
Bakerdania sellnicki (Krczal)
Bakerdania amplus (Krczal)
Eucheyletia flabellifera (Mich.)
Cheyletus eruditus (Schrank)

Sarcoptiformes

Acarus farris (Oud.)
Acarus siro (L.)
Acotyledon pedispinifer (Nesb.)
Anoetus sapramyzarum (Dufour)
Wichmannia spinifera Mich.
Belba corynopus Hern.
Belba verticillipes Nic.
Nothrus silvestris Nic.
Platynothorus peltifer Koch
Tyrophagus humerosus Oud.
Mycetoglyphus fungivorus Oud.
Bonomoia sphaerocerae Vitzt.

large annual fluctuations (Fig. 4.2). Peak numbers are reached in May, June (Haitlinger, 1974a, 1976a), and in high mountains (the Alps) in July (Mahnert, 1971a). In the other months the number of *H. edentula* varies considerably. There are few literature data on the long-term mean intensity of infestation of bank voles with *H. edentula*. In the Sowie Mountains it was 1.3 (Haitlinger, 1976a), in the Pieniny 2.0 (Haitlinger, 1974a), and in the Alps 1.8 (Mahnert, 1971a). Although this species belongs to the group of dominants, it rarely occurs in large

numbers on individual hosts. In the Sowie Mountains, the maximum number of *H. edentula* collected from single bank voles was 68, and more than 30 individuals were collected only four times; in the Alps the maximum was 54 (Mahnert, 1971a).

In the older literature, *H. acanthopus* is quoted as one of the species most frequently infesting the bank vole. The cause was that *H. edentula* and *H. acanthopus* were not distinguished at that time. Probably

Table 4.3

Check-list of dominant species in arthropod communities associated with the bank vole in different mountains.

	Sowie Mts.	Pieniny Mts.
Eudominants more than 15% of the community	*Neotrombicula zachvatkini*	*Neotrombicula zachvatkini* *Neotrombicula autumnalis*
Dominants 5.1—15% of the community	*Ctenophthalmus agyrtes* *Laelaps clethrionomydis* *Haemogamesus nidi* *Neotrombicula inopinata* *Glycyphagus hypuadei* *Hoplopleura edentula*	*Neotrombicula inopinata* *Glycyphagus hypuadei* *Hoplopleura edentula*
Subdominants 2.1—5% of the community	*Peromyscopsylla bidentata* *Peromyscopsylla silvatica*	*Ctenophthalmus agyrtes* *Megabothris turbidus* *Amalareus penicilliger* *Peromyscopsylla bidentata* *Neotrombicula talmiensis* *Leptotrombidium europaeum* *Laelaps clethrionomydis* *Haemogamasus nidi*

a large majority of the earlier records of *H. acanthopus* on the bank vole refer to *H. edentula*. But in some parts of Europe, e. g. in Hungary, *H. edentula* are absent from bank voles, instead *H. acanthopus* are noted (Haitlinger, 1973b).

There is much less information on *P. hannswrangeli* and *P. borealis*. In central Europe they occur almost exclusively in mountains, rarely in large numbers. Smetana (1962) found a high mean intensity of infestation with *P. hannswrangeli* in the Tatra Mountains, Czechoslovakia, is 1.9. Cais (1977) rather frequently recorded this parasite on bank voles living in the Polish part of the Tatras. Also *P. borealis*, which is a particularly rare species in Europe, under favourable conditions can

be rather numerous on bank voles. In the Polish Tatras, it has been proven to be more abundant than *P. hannswrangeli* (Cais, 1977).

So far there has been no satisfactory explanation for the relationship between the intensity of infestation and habitat type of the bank vole.

In the Alps, *H. edentula* and *P. hannswrangeli* usually occurred on the bank voles inhabiting the subalpine and alpine zones (Mahnert, 1971a). In Polish mountains (the Tatra and Sowie mountains) high

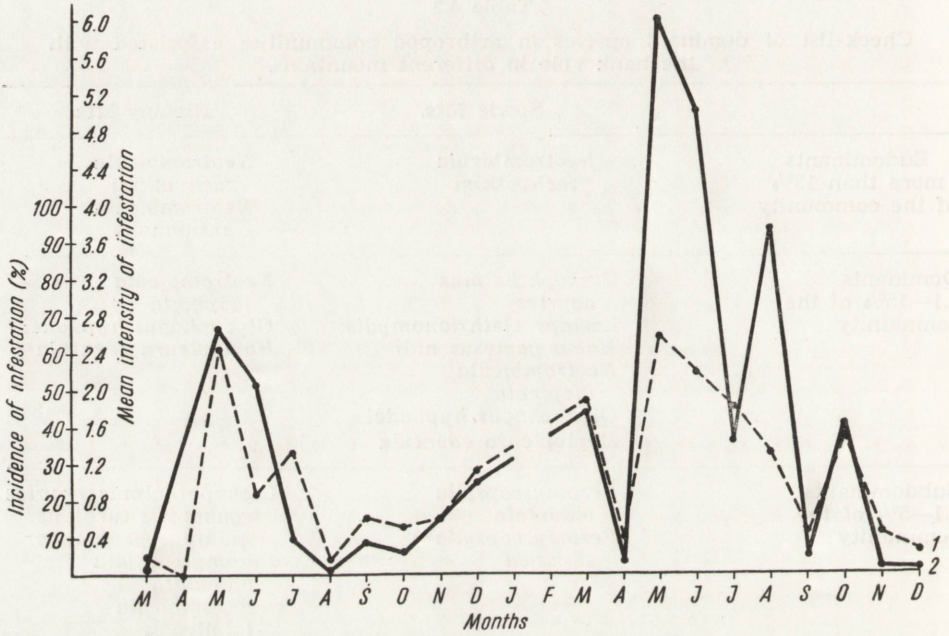

Fig. 4.2. Incidence of infestation (1) and mean intensity of infestation (2) with *Hoplopleura edentula* in a bank vole population in the Sowie Mountains (after Haitlinger, 1976).

numbers of *H. edentula* were noted in different zones (Haitlinger, 1976a; Cais, 1977).

To some extent the intensity of infestation depends on the sex of the host. The data are scarce, however, and refer to some months. For example, in the Sowie Mountains the intensity of infestation of bank voles in July and August was 3.3 for females and as much as 8.0 for males. But in May and June no differences were recorded (Haitlinger, 1976a).

In larger mountain ranges, *L. clethrionomydis* is a dominant among host dweller. This parasite of the bank vole also occurs on *Clethrionomys rufocanus* (Sund). and *Microtus gregalis* (Pall.) in some parts of

northern Europe and Siberia (Edler, 1968; Edler and Mehl, 1972). In the arthropod community living on bank voles in the Sowie Mountains, *L. clethrionomydis* is the third most numerous. It is abundant only from March to May (Mahnert, 1971b; Haitlinger 1976b) and to a lesser extent also in autumn. In low mountains, this species is sparse; in the Pieniny the mean intensity of infestation for two years was merely 0.55 (Haitlinger, 1983). In high mountains it can be more than 1.0 (Mahnert, 1971b; Haitlinger, 1976b). The abundance of this species in successive months of different years can vary greatly, even by a factor of six. It is rarely numerous on single hosts, the maximum recorded being 62.

The species of the host-dweller group significantly affect the arthropod community dynamics on the bank vole, particularly in mountains areas (the presence of *L. clethrionomydis* and some species of lice). In the Sowie Mountains they account for 26.3% of the community but in the Pieniny only for 16.9% (Haitlinger, 1974a, 1974b, 1976b, 1983).

4.1.2. Nest-host Dweller Group

The nest-host wdeller gropu generally consists of more species than the host wdeller group. For example, in the Sowie Mountains, 33 species were recorded and in the Pieniny 36 species (Haitlinger, 1974a, 1974b, 1977b, in print). *Siphonaptera* are abundantly represented on the bank vole and is more diversified than that on other rodents (Haitlinger, 1971b, 1973a, 1978; Bartkowska, 1973, 1981). At the same time, none of these species is characteristic of the bank vole, and only some are more abundant on the bank vole than on other mammals. Particularly clear difference in the flea fauna occurs between bank voles inhabiting lowland and mountain areas; the latter are dominated by mountain species, and in the Tatra Mountains also by alpine-boreal species (Bartkowska, 1973). The lowland fleas of Poland are dominated by *Ctenophthalmus agyrtes* and *Megabothris turbidus* (Haitlinger, 1977c). In the foothill region and in the mountains, also *Amalareus penicilliger* and *Peromyscopsylla bidentata* are abundant, and in some mountains *P. silvatica* (Haitlinger, 1973a; Bartkowska, 1973; Ryba *et al.*, 1975). Bank voles living in the High Tatra are heavily parasitized with *Megabothris rectangulatus* (Bartkowska, 1973).

Many *Siphonaptera* occur seasonally. They have an important influence on the dynamics of bank vole infestation with arthropods but only during a few (sometimes 1-2) months. For example, out of 15 flea species collected in the Sowie Mountains, only six are abundant throughout the year or in some seasons of the year (Haitlinger, 1975). The reduction in the number of species is coupled with an increase in the

intensity of invasion. In spring, nine species were recorded, and the mean infestation intensity was chiefly related to the abundance of only one species, *Ctenophthalmus agyrtes*, which accounted for 62% of the flea community at that time. In summer (July-September), *Peromyscopsylla silvatica* was dominant (56.6% of fleas), and in autumn, when the unmber of species increased to 15, *P. bidentata* (43.1%) (Fig. 4.3). There may be large annual differences in the composition of dominant

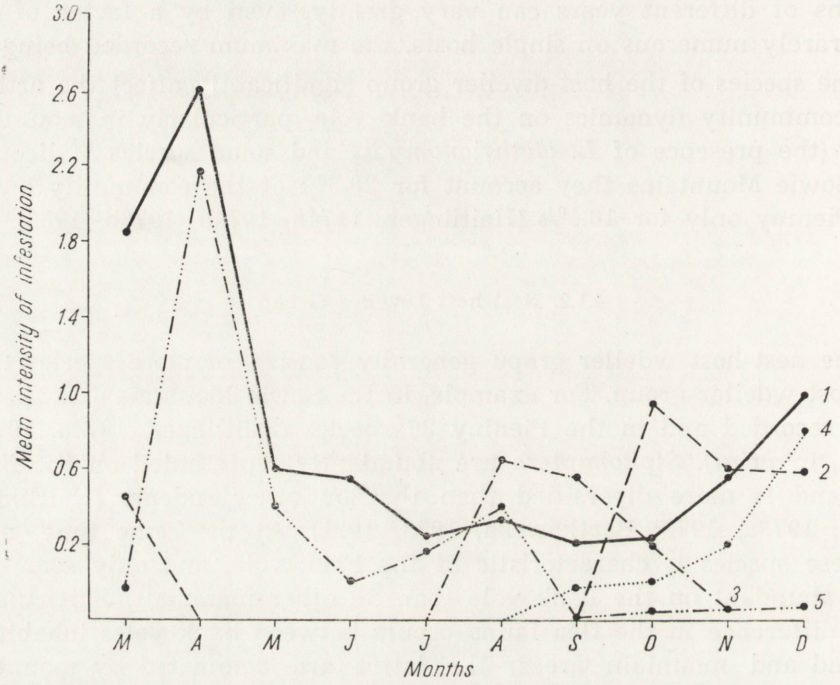

Fig. 4.3. Seasonal changes in the mean intensity of infestation of bank voles by the most common flea species.
1 — *C. agyrtes*, 2 — *P. bidentata*, 3 — *P. silvatica*, 4 — *R. integella*, 5 — *C. congener*.

species. The mean annual intensity of infestation of the bank vole with fleas is not high; in Poland it ranges from 1.0 to 2.0 (Haitlinger, 1971a, 1971b, 1973a, 1974b, 1975, 1978; Bartkowska, 1981). A highest mean value of 2.0 was recorded in urban areas (Haitlinger, 1971a). It is possible that the intensity of infestation of the bank vole declines with altitude. The mean intensity of infestation of the populations living in the western Sudetes and Żywiec Beskids, mostly between 900 and 1500 m above sea level, was 0.87 and 1.04, respectively. For the populations living in the Pieniny and Sowie mountains at an altitude of

300—900 m above sea level, it was 1.41 and 1.58, respectively. In the Western Beskids, the average for bank voles living at very different altitudes was 1.23. Species diversity increases from lowland to mountain areas, but only to about 1000 m above sea level.

Both intensity and extensity of flea infestation can depend on the sex of the host. Generally males are more heaviely parasitized than females (Brinck, 1966; Mahnert, 1972; Brinck-Lindroth, 1968). For example, in the Sowie Mountains the mean annual extensity of infestation of male bank voles with fleas was higher than that of females by 11.7% (Haitlinger, 1975). Also the intensity of infestation was higher

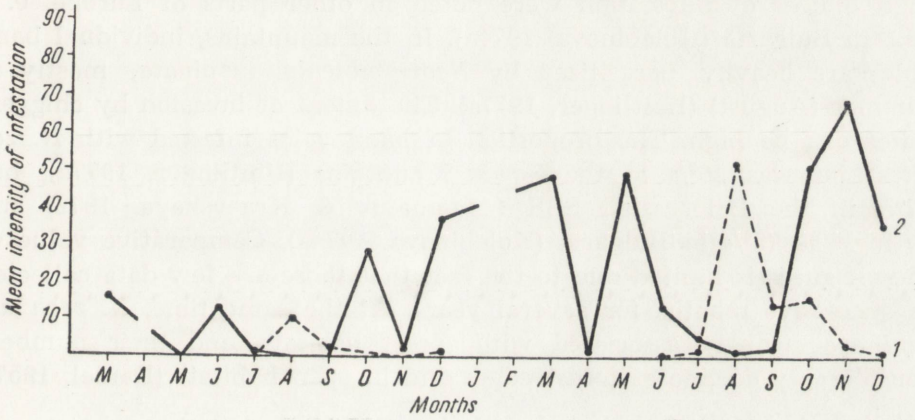

Fig. 4.4. Sasonal changes in the mean intensity of infestation with *Neotrombicula inopinata* (1) and *N. zachvatkini* (2) for bank voles in the Sowie Mountains (after Haitlinger, 1977a).

for males. But these relations can vary from one month to another (Haitlinger, 1975). The extent and intensity of infestation and also the composition of flea communities vary with the age of the bank vole (George & Corbet, 1959; Ulmanen & Myllymäki, 1971). In Poland, these relationships were analysed for two age groups distinguished by body weight for males and females separately. In the Sowie Mountains, the mean annual intensity of infestation was 1.8 for old and 1.2 for young bank voles; the respective figures in the Pieniny Mountains were 1.7 and 0.9 (Haitlinger, 1974b, 1975). In Poland, the most frequent mites of the nest-host dweller group occurring on the bank vole consist

of *Eulaelaps stabularis, Haemogamasus nidi, Hirstionyssus isabellinus, Neotrombicula zachvatkini, N. inopinata, N. talmiensis, Leptotrombidium europaeum, Glycyphagus hypuadei,* and *Xenoryctes krameri.* Some of them are abundant only in certain regions of Poland (e. g. *N. talmiensis* and *L. europaeum* in south-eastern nad eastern parts). Of all these species. *N. zachvatkini* and *G. hypuadei* have an important effect on the dynamics of arthropod communities in the lowland and mountain areas, as does *N. inopinata* in the mountains. In particular, chigger-mites (*Trombiculidae*) have specific environmental requirements. In forests of Poland there are mass appearances of *Neotrombicula zachvatkini* in spring and summer (Fig. 4.4). In the Sowie Mountains the mean intensity of infestation for two years was 2.0 (Haitlinger, 1977a). Particularly high indices of infestation were noted in other parts of Europe, e. g. 40.1 in Bulgaria (Kolebinova, 1974a). In the mountains, individual bank voles are heavily parasitized by *Neotrombicula inopinata,* mostly in summer (August) (Haitlinger, 1977a). The extent of invasion by chigger-mites can be high. The proportion of bank voles infested with *N. zachvatkini* was 26% in the Sowie Mountains (Haitlinger, 1977a), but 57% in the Belorussian SSR (Arzamasov & Kraevskaya, 1972) and as high as 75% in Bulgaria (Kolebinova, 1974a). Comparative value of these figures is limited due to the fact that there are few data collected in successive months for several years. At the same time, *N. zachvatkini* are strongly associated with forest habitats, and their numbers considerably decline at forest edges and in open habitats (Daniel, 1957).

4.1.3. Nest Dweller Group

This group of arthropods contains the greatest number of species. Occasionally some of them can be found on the host. Their appearance on the host is usually based on phoretic alliances. For example, in the Sowie Mountains, 42 species of this group were recorded from the host, and in the Pieniny, 23 species. Obviously, the number of mite species in the nest itself is much higher (Vysotskaya, 1974). Two species of the family *Parasitidae* are rather often found on bank voles. These are *Parasitus kraepelini* nad *P. lunulatus* and, quite frequently, unidentified deutonymphs of different species (Haitlinger, 1977a). The number of nest dwelling arthropods recorded from the bank vole continue to increase with growing research effort. The total abundance of these mites on bank voles is low and does not account much for fluctuations in the mean intensity of infestation of these rodents by the entire arthropod community.

4.1.4. Seasonal Occurrence of *Acarina*

The occurrence of many mites is seasonal. As a result, there are quantitative and qualitative differences in the infestetion of bank vole populations from month to month (Fig. 4.5). Invasions of arthropods, as measured by the mean intensity of infestation, are highest in spring. This is related to low host numbers at that time and to particularly abundant appearance of some mite species. In the Sowie Mountains, *Mesostigmata* occurring on bank voles were dominated by *L. clethrionomydis* and *H. nidi* in spring and autumn (in May by *H. isabellinus).* The other mites were dominated by *N. zachvatkini* in spring and autumn, and by *N. inopinata* in August and September. This picture can vary in

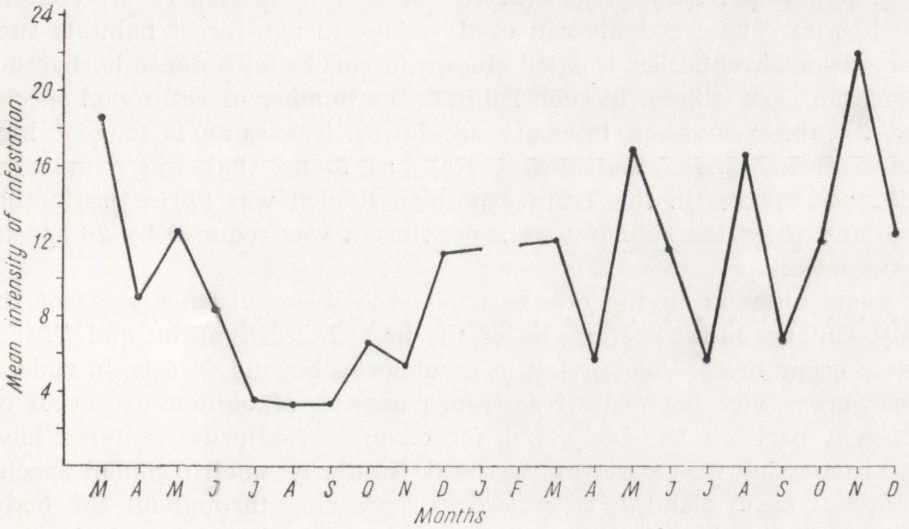

Fig. 4.5. Seasonal changes in the mean intensity of infestation of bank voles with the total arthropod community in the Sowie Mountains (after Haitlinger, 1977b).

particular years; in some months dominant species can be different. For example, *I. triangulíceps* may be dominant in April, and *G. hypuadei* in addition to *N. zachvatkini* can dominate from August to December (Haitlinger, 1976b, 1977a). The dominant species may be different in particular parts of Poland (mountains) and Europe. These differences can also be seen on adjacent areas. For example, in the submontane zone of the Sowie Mountains, *I. ricinus* and *G. hypuadei* dominated in spring, while *N. zachvatkini* in the montane zone. In summer and autumn *G. hypuadei* dominated in the submontane zone, while *N. inopinata* (summer) and *N. zachvatkini* (autumn) in the montane zone. The highest mean intensity of infestation of the bank vole, that is 13.3 (with the species of the suborder *Mesostigmata),* was recorded in March (Sowie

Mountains), and minimum numbers in early autumn (0.8 in August, September) (Haitlinger, 1976b).

The peak of mean intensity of invasion by *Trombidiformes* and *Sarcoptiformes* jointly was noted in December (3.8), and in November of 1972, when the infestiation was as high as 18.1. The value of this index is largely influenced by changes in numbers of three species: *N. zachvatkini, G. hypuadei,* and *N. inopinata.* The extent of vole infestation was high in early spring. In the Sowie Mountains in March and April more than 80% of the population was infested with *Mestostigmata* and 60% with *Trombidiformes.* In August and September infestation with *Mesostigmata* considerably declined (Haitlinger, 1976b, 1977a). The arthropod fauna associated with the bank vole is largely affected by the habitat. These rodents can easily adapt to non-forest habitats such as roadside shrubberies, isolated clumps of shrubs with dense herbaceous vegetation, and others. In such habitats the number of arthropod species and the mean invasion intensity are lower. The same is true of high mountain habitats. Vysotskaya (1974) has found that the number of arthropod species in the Transcarpathian Region was 58 in the foothill zone and 18 in the submontane zone, thus it was reduced by 26 species in the latter.

Some mites occurring on the bank vole select distinct parts of the body. Chigger-mites prefer ears of the host; *N. zachvatkini* and *N. inopinata* occur there. Voles living in shrubberies beyond forests, in ruderal urban areas, etc., have ears free from parasites. *Myobiidae* can occur on different parts of the body, but for example *Radfordia lemnina* have preferences for fore parts of the head. Similarly, such common species as *Ixodes ricinus* and *I. trianguliceps,* occurring throughout the body, prefer upper parts of the ears and settle on both sides and the anal region. Most mite species do not show preferences for particular parts of the body.

4.1 5. The Effect of Host Sex and Age on Infestation by Some Mites

The relationship between the rate of infestation and the sex of the host is still unclear. Many factors are probably involved here, and they should be analysed each acarid species separately in successive months of the year. For example, in the Sowie Mountains more of males than females were infested with *I. trianguliceps, I. ricinus, N. zachvatkini,* and *G. hypuadei* over the year. Individual males were more heavily infested with *N. zachvatkini* and *N. inopinata,* while females carried *I. trianguliceps* and *G. hypuadei.* Different relations were observed in

various seasons. A higher proportion of females than males was infested with *N. zachvatkini* in autumn and winter (October-December) and in summer (July-September). *G. hypuadei* infested a higher proportion of males than females in all the seasons.

The effect of host age (sometimes measured by host body surface) on the intensity of infestation of bank voles with with mites in not known. Edler (1973) found that subadult bank voles were infested with mites in the highest proportion. Haitlinger (1976b) noticed that the intensity of infestation with *Mesostigmata* in spring (March-June) was highest for the smallest voles. The intensity of infestation of bank voles 80—95 mm long was more than twice as high as that of larger voles. Among the *Mesostigmata* the main parasite of the bank vole in the Sowie Mountains is *L. clethrionomydis,* which is particularly abundant in March. This suggests that this mite is mostly associated with younger (smaller) voles. Similar results were also noted for other mite species. For example, *I. trianguliceps* and *N. inopinata* are most often caught on juvenile males.

4.1.6. Dynamics of Arthropod Communities

Parasitological studies usually consider some selected groups of organisms infesting a host. Studies of whole parasite communities or

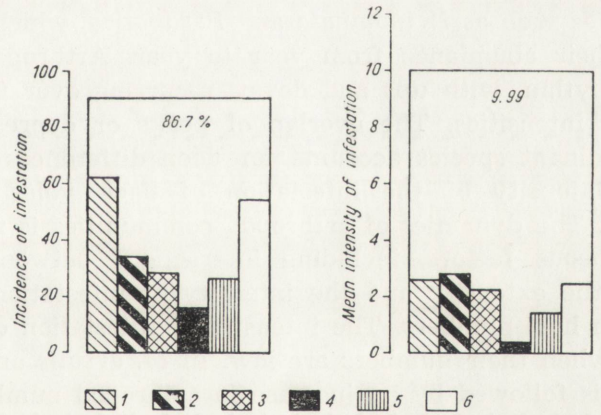

Fig. 4.6. Long-term incidence of infestation and mean intensity of infestation of bank voles in th Sowie Mountains with the total arthropod community: 1 — *Mesostigmata,* 2 — *Trombidiformes,* 3 — *Sarcoptiformes,* 4 — *Ixodides,* 5 — *Anoplura,* 6 — *Siphonaptera* (after Haitlinger, 1977b).

even ectoparasite communities are extremely rare. Hence the knowledge of the dynamics of arthropod communities on the bank vole is very poor. It is known, however, that more than 80% of the bank voles

living in best habitats are infested with arthropods (Fig. 4.6). Only in marginal habitats (e. g. in ruderal urban areas) the extent of invasion can be lower (Haitlinger, unpubl. data). In such cases the mean intensity of infestation is also lower. The mean intensity of infestation of bank voles by the entire arthropod community can be compared only for three regione: the Sowie Mountains (Haitlinger, 1977b), the Pieniny Mountains (Haitlinger, 1974a, 1974b, 1983) and the Transcarpathians (Vysotskaya, 1974). There are no comparable data for lowland habitats. In mountain areas the long-term mean intensity of infestation with arthropods of all possible kinds reaches 10.0 (Fig. 4.6) in the Sowie Mountains (Haitlinger, 1977b), 16.6 in the Pieniny (Haitlinger, 1974a, 1974b, 1983), and as much as 67.5 in the Transcarpathian Region (Vysotskaya, 1974). There are clear fluctuations in numbers within and between years. For example, one year in the Sowie Mountains there were two peaks of arthropod numbers on the bank vole, one in March (18.5) and the other in December (11.2), with a low point in August-September (3:3); in the following year four peaks were observed: in March (12.0), May (16.7), August (16.6), and November (22.1), separated by deep depressions in April (5.7), July (5.8), and September (6.9) (Fig. 4.5) (Haitlinger, 1977b). This pattern should be considered as typical in the areas with diversified arthropod communities. It is an effect of rapid monthly changes in numbers of abundant but only seasonally occurring species such as *N. inopinata* and *P. silvatica*, which also markedly change their abundance from year to year. Arthropod dynamics has its own rhythm, with ups and downs recurring over the year but with different intensities. The overlap of peaks or depressions particularly of dominant species accounts for deep differences in both incidence and intensity of the infestation of bank voles within and between years. The dynamics of arthropod communities is regulated by many simultaneous factors, including interactions betwen component species. Both the extensity and the intensity of infestation of rodents also depend on host numbers. The intensity of infestation of individual voles is high when their numbers are low. In *M. arvalis* an increase in host numbers is followed by an increase in arthropod numbers coupled with a decline in the intensity of infestation of individual voles (Haitlinger, 1981). There may be a similar relationship for the bank vole, but so far there are no data available.