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7. STRUCTURE OF ARTHROPOD COMMUNITY OCCURRING ON *MICROTUS ARVALIS* (PALL.) IN VARIOUS HABITATS

I. Faunistic differentiation, dominance structure, arthropod infestation intensiveness in relation to habitats and host population dynamics*

Analysis was made of changes in: arthropod communities occurring on *Microtus arvalis* (Pall.), dominance structure of arthropod community, and mean intensiveness of infestation in various habitats (meadow, pasture, crop field) and in relation to host population dynamics. The poorest arthropod community was observed in crop field, richest one – in a meadow. The infestation intensiveness was found to depend foremostly on host species. Dependences between host population number dynamics and the arthropod community were ascertained.

1. INTRODUCTION

The arthropod communities associated with small mammals are being formed and developed at a number of factors acting simultaneously and changing with time, such as nests position, substrate structure, humidity, temperature etc. They depend on mutual interactions of components inhabiting both the nest and the host as well as on qualitative and quantitative changes in the host population. There are a few papers dealing with this difficult problem and especially there is a lack of elaboration of arthropod communities in long term aspect involving processes following in subsequent months in host and its surroundings, mainly nest. V y s o t s k a j a (1967, 1978) reported on arthropod communities associated with *Microtus arvalis* (Pall.) and on the microbiocoenosis of its nests. Over 450 species of invertebrates can dwell in one nest. Only minor part of this number invades the host and it results that together with host species in the whole population of *M. arvalis* only slightly over 90 arthropod species were recorded. The data reported by V y s o t s k a j a (1967, 1978) pertain to

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lowland and submontaneous of Zakarpacie region, however, the authoress does not give any information about differentiation in arthropod community dwelling in nests and on hosts in relation to the type of habitat.

The present paper aims at tracing primarily the changes, both qualitative and quantitative in arthropod communities dwelling on *M. arvalis* in various habitats during several years of observation in relation to host population dynamics. This is the first part of planned cycle of papers. The next papers of the cycle will be devoted to dynamics of separate arthropod species as well as to the influence of the host sex and age on qualitative and quantitative features of the arthropod communities.

2. MATERIAL AND METHOD

Studies were carried out in 1976–1979 near Piotrkówek (State Centre of Animal Breeding at Przerzeczyn Zdrój near Niemcza) in Lower Silesia, mainly in temporary pastures and crop fields (pasture-mixture, wheat and alfalfa). Both mammals and arthropods were collected in spring, summer and autumn, at least 5 times per year. In addition, collections gathered from August 1978 to August 1979 (exclusive of September, January and February) from railway track elevation and narrow belts of grasses as well as road ditches, situated nearby along a spacious crop area, were included in this paper. These are terrains which have not been treated agriculturally for a score of years, except for sowing grasses on a part of the railway track elevation and a narrow belt of adjacent fallows. This elevation part that was sown with grasses was considered as a meadow, its remaining parts and ditches – as fallows. These collections form a comparative base for processes that occur in areas treated permanently (crop fields) or periodically (temporal pastures). In 1979 comparative catches were carried out for three times (April, June and October) at Magnice near Kobierzyce in the Lower Silesia Lowland. In addition, a minor collection was made in a bog at Żelowice (of 4 individuals of *M. arvalis* 39 arthropods were collected – Table 1, 2, 3). In the pastures and crop fields individuals of *M. arvalis* were captured by the method of nest flooding (these results are reported by Adamczewska-Andrzejewska, Bujalska and Mackin-Rogalska 1981); in the meadow-fallow – by snap-traps.

The arthropods were collected from *M. arvalis* after chloroform anaestesis, by combing; additionally each host was searched under stereoscopic microscope in order to collect the remaining arthropods, especially those resistant to combing, because of a strong attachment to the skin or hiding e.g. in ears. Of 501 individuals of *M. arvalis* as many as 8644 arthropods were collected representing at least 54 species (9 of which were not identified) thus forming a rich collection, indeed. Vysotskaja (1978) has reported 74 species of arthropods for Zakarpacie region which together with not identified makes 91, however they were collected from very diversified areas. In Poland the arthropod communities dwelling on *M. arvalis* were studied in Sowie Góry (Owl Mts.) (Haitlinger 1977), yielding at least 30 arthropod species from a small

collection of hosts. In Pieniny Mts., on an abundant material of *M. arvalis* at least 50 arthropod species were encountered (Haitlinger 1974a, 1974b, 1981).

The fauna of *M. arvalis* under study consists of 8 species of *Siphonaptera*, 2 of *Anoplura*, 1 of *Mallophaga*, 8 of *Trombidiformes*, 9 of *Sarcoptiformes*, 25 of *Mesostigmata* and 1 of *Ixodes* (including those unidentified) (Table 1, 2, 3).

The dominance structure and constancy indices have been elaborated using a classification system applied for mites by Rajski (1961). Eudominants – over 15% of collection, dominants – 5.1–15%, subdominants – 2.1–5.0%, recedents – 1.1–2.0%, and subrecedents – below 1.1%, were distinguished. The constancy indices were based on 4 classes of constancy: euconstants (75.1–100% of occurrence on the host), constants (50.1 - 75%), accessory species (25.1–50%), and accidental species (0 –25%).

Eudominant species in the whole collection are: *Hoplopleura acanthopus* (Burm.) (*Anoplura*) (25.1%) and *Laelaps hilaris* (Koch) (*Mesostigmata*) (24.7%); dominant species: *Glycyphagus hypuadei* (Koch) (*Sarcoptiformes*) (10.1%) and *Hyperlaelaps microti* (Ewing) (*Mesostigmata*) (8.6%); in addition, 5 subdominant species, 3 recedents and 31 subrecedents were found. *L. hilaris* (75.5%) is euconstant species, constants are lacking. There were 3 accessory species (*H. acanthopus*, *H. microti* and *G. hypuadei*) and 50 accidental species. Rather small number of dominant species (4) forms the mediocre intensiveness of infestation of *M. arvalis* and in successive seasons subdominant species (5) are also important. The remaining 45 species played a minimum role in infestation.

Table 1

List of arthropods of host-dwelling species collected from *Microtus arvalis* (Pall.) in various habitats

Species	Meadow at Błotnica	Pasture at Niemcza	Pasture at Magnice	Crop fields	Bog Żelowice
Anoplura					
Hoplopleura acanthopus (Burm.)	1926	170	22	48	7
Polyplax serrata (Burm.)	2	1			
Trombidiformes					
Psorergates dissimilis (Fain, Lukos., Hallm.)	3	33		40	
Radfordia lemnina (Koch)	17	2	5	3	
Myobia sp.					1
Acarina					
Sarcoptiformes					
Myocoptes japonensis (Radf.)	40	19	2	1	1
Trichoecius tenax (Mich.)	14	12	5	8	
Mesostigmata					
Laelaps hilaris (Koch)	724	753	339	312	7
Hyperlaelaps microti (Ewing)	484	79	133	40	11
Mallophaga					
Stachiella mustelae (Schrank)	1				

The share of groups of species in the arthropod community as to the degree of their attachment to the host, was traced. V y s o t s k a j a (1967) has distinguished three major groups: 1) host-dwelling, 2) host-nest dwelling, 3) nest-dwelling. S o s n i n a (1967) has reported on four groups: 1) constant parasites, 2) parasites present on the host for a longer time, 3) obligatory, blood-sucking nest parasites, 4) facultative, blood--sucking nest parasites. The latter classification does not include a large group of non-parasitic arthropods dwelling in the nest and periodically found on *M. arvalis.*

Even more precise classifications can be applied as that done by H a i t l i n g e r (1977) when analyzing structure of arthropods dwelling on small mammals in Sowie

Table 2

List of arthropods of nest-host dwelling species collected from *Microtus arvalis* (Pall.) in various habitats

Species	Meadow at Błotnica	Pasture at Niemcza	Pasture at Magnice	Crop fields	Bog Żelowice
Siphonaptera					
Ctenophthalmus assimilis (Tasch.)	138	134	52	31	
Ctenophthalmus congener (Roths.)		1		1	
Ctenophthalmus agyrtes (Hell.)	83	20	87	18	1
Megabothris turbidua (Roths.)	12	3		6	
Amphipsylla rossica (Wagner)	1		56		
Palaeopsylla soricis (Dale)	1				
Rhadinopsylla integella (Jord., Roths.)	1				
Rhadinopsylla pentacantha (Roths.)	5				
Trombidiformes					
Neotrombicula autumnalis (Shaw)	152	1	2	1	
Neotrombicula japonica (Tan., Kaiwa, Teram. et Kag.)	25				
Cheladonta costulata (Willm.)	116				
Acarina					
Sarcoptiformes					
Labidophorus talpae (Kram.)		20			
Orycteroxenus soricis (Oud.)	9	1			1
Glycyphagus hypudaei (Koch)	670	92	87	20	
Xenoryctes krameri (Mich.)	215	55		2	
Mesostigmata					
Haemogamasus horridus (Mich.)					1
Haemogamasus nidi (Mich.)	147	6	1		2
Haemogamasus hirsutus (Berl.)	3				
Androlaelaps fahrenholzi (Berl.)	253	93	18	14	
Hirstionyssus isabellinus (Oud.)	161	183	23	18	
Eulaelaps stabularis (Koch)	18				
Ixodidae					
Ixodes ricinus (L.)	2			1	

Góry (Owl Mts.). In the present paper somewhat modified classification by V y s o t s k a j a (1967) seems to be satisfactory. According to it the host-dwelling species are those which occur on the host during all developmental stages (Table 1). Host-nest dwelling species are those inhabiting nest or outside of it, but often present on the host in some stage of their life history, or in each stage (Table 2). Nest-dwelling species: those occurring in the nest or outside of it, not entering the host or appearing on it rarely (Table 3).

Table 3

List of arthropods of nest-dwelling species from *Microtus arvalis* (Pall.) in various habitats

Species	Meadow at Błotnica	Pasture at Niemcza	Crop fields	Bog Żelowice
Mesostigmata				
Alliphis siculus (Oud.)				1
Lasioseius berlesei (Oud.)	1			
Ameroseius corbiculus (Sowerby)	1			
Amblyseius sp.	2			
Macrocheles matrius (Hull)	49	5		
Macrocheles glaber (Müll.)	4	1		
Proctolaelaps pygmaeus (Müll.)	87			1
Uropodidae	1			
Veigaia nemorensis (Koch)	1			
Parasitus kraepelini (Berl.)	4			2
Holoparasitus excipuliger (Berl.)	1			
Poecilochirus necrophori (Vitzt.)	3			
Euryparasitus emarginatus (Koch)	1			
Hypoaspis sardoa (Berl.)	36			
Hypoaspis heselhausi (Oud.)	13			
Hypoaspis sp.	9			
Parasitidae	22	1		1
Sarcoptiformes				
Acotyledon pedispinifer (Nesb.)	7	1		
Glycyphagidae	9	7		
Oribatidae	13		2	2
Trombidiformes				
Bakerdania sp.	35			
Pygmephorus sp.		2		

Most abundant in species are groups: nest-host and nest-dwelling, 22 species in each. The host-dwelling group holds only 10 species; they are predominant constituting 60.9% of the arthropod community. Nest-dwelling species in spite of species richness form only 3.8% of the community. Large number of nest-dwelling species in the community results from various reasons. Except for *Oribatidae*, these are predatory species getting on *M. arvalis* in search for food, but there are also relationships of foretic type.

Mean intensiveness of infestation for many years amounts to 17.25. V y s o t s k a j a (1978) reported a value of 23.1 for 15 months' period of studies and H a i t l i n g e r (1977) for 2 years' period – 17.51. Multiannual indices have a special value since they involve changes in arthropod numbers, especially conspicuous in *M. arvalis* characterized with sharp fluctuation of numbers in seasonal and annual cycles. It is evident that the above listed values are different for various habitats under study.

3. QUALITATIVE AND QUANTITATIVE STRUCTURE OF ARTHROPOD COMMUNITY IN VARIOUS HABITATS

3.1. CROP FIELDS

The arthropod fauna occurring on *M. arvalis* from crop fields (i.e. pasture-mixture, alfalfa and wheat) is very scarce. Of 73 individuals of *M. arvalis* 566 arthropods were collected which represented 18 species (one unidentified inclusive). There was one eudominant (*L. hilaris*) of a high predominance of 55.1%. In addition there are 4 dominants, 4 subdominants, 2 recedents and 7 subrecedents (Table 4). The eudominant is also euconstant – 84.9%. Constant species are lacking, there are two accessory and 15 accidental species (Table 5).

Table 4

Dominance structure of arthropods occurring on *Microtus arvalis* (Pall.) in various habitats

	Crop fields	Pasture at Niemcza	Pasture at Magnice	Meadow
Eudominants	*L. hilaris* (Koch) 55.1%	*L. hilaris* 44.4%	*L. hilaris* 40.0%	*H. acanthopus* (Burm.) 34.9% (15.1% without mass occurrence)
Dominants	*H. acanthopus* 8.5%	*H. isabellinus* (Oud.) 10.8%	*H. microti* (Ewing) 15.6%	*L. hilaris* 13.1%
	H. microti 7.1%	*H. acanthopus* 10.0%	*C. agyrtes* (Hell.) 10.6%	*Gl. hypuadei* (Koch) 12.1%
	P. dissimilis (Fain, Lukos, Hall.) 7.1%	*C. assimilis* (Tasch.) 7.9%	*Gl. hypuadei* 10.6%	*H. microti* 8.0%
	C. assimilis	*A. fahrenholzi* (Berl.) 5.5%	*C. assimilis* 6.1%	
		Gl. hypuadei 5.4%		
Number of species:				
Subdominants	4	2	3	7
Recedents	2	4	–	2
Subrecedents	7	14	6	35

Table 5

Constancy structure of arthropods occurring on *Microtus arvalis* (Pall.) in various habitats

	Crop fields	Pasture at Niemcza	Pasture at Magnice	Meadow
Euconstants	*L. hilaris* (Koch) 84.9%	*L. hilaris* 76.5%	–	–
Constants			*L. hilaris* 65.9%	*L. hilaris* 74.3%
			H. microti (Ewing) 56.4%	*H. acanthopus* (Burm.) 66.9%
				H. microti 60.3%
Accessory species	*H. acanthopus* 32.9%	*H. acanthopus* 32.8%	*C. agyrtes* (Hell.) 32.9%	*Gl. hypuadei* (Koch) 47.1%
	H. microti 30.1%		*C. assimilis* (Tasch.) 30.6%	*C. assimilis* 33.8%
			Gl. hypuadei 29.4%	*C. agyrtes* 26.5%
				A. fahrenholzi (Berl.) 26.5%
Number of species:				
Accidental species	15	24	9	41
Total	18	26	14	48

The highest number was noted of nest-host dwelling species (10), lesser one of host--dwelling (7) and nest-dwelling (1) species.

The multiannual mean of infestation intensiveness is low 7.75. This pertains mostly to summer-autumnal season (August-October). Relatively low collections of the hosts and arthropods from crop fields make the estimate of invasion course in subsequent years rather difficult. The lowest abundance of *M. arvalis* was observed in 1976, in two subsequent years it was getting higher. The growth in host numbers was accompanied

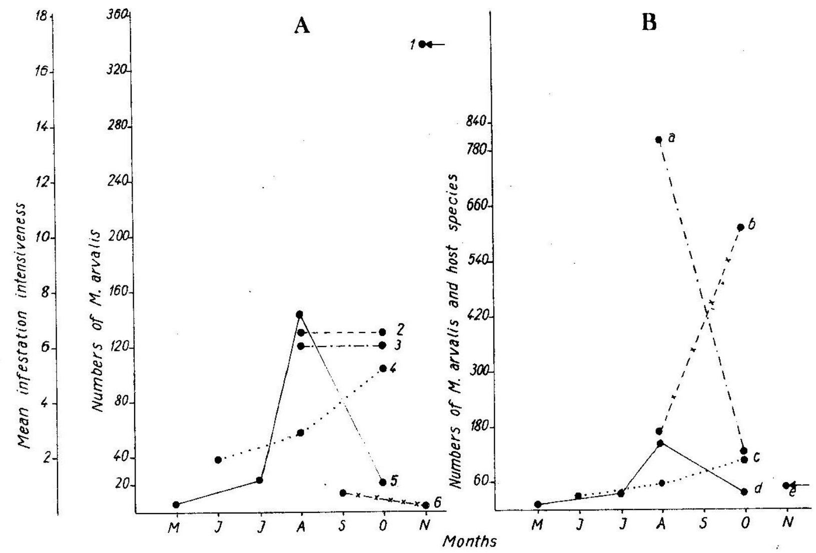

Fig. 1. Changes in numbers of *Microtus arvalis* (Pall.) per 1 hectare and average intensiveness of infestation in crop fields (*A*) as well as changes in numbers of *M. arvalis* and host species per 1 hectare in crop fields (*B*) *1* – mean infestation intensiveness in 1976, *2* – mean infestation intensiveness in 1977, *3* – mean infestation intensiveness in 1978, *4* – numbers of *M. arvalis* in 1977, *5* – numbers of *M. arvalis* in 1978, *6* – numbers of *M. arvalis* in 1976; *a* – numbers of host species in 1978, *b* – numbers of host species in 1977, *c* – numbers of *M. arvalis* in 1977, *d* – numbers of *M. arvalis* in 1978, *e* – numbers of host species in 1976

by a decrease in mean infestation intensiveness. The highest infestation intensiveness (16.90) was found in November of 1976 at numbers of 4 *M. arvalis* per 1 ha, the lowest (6.0) at different numbers of hosts (Fig. 1*A*). Such a high mean intensiveness of infestation in autumn was not recorded in other agrocoenoses.

When relating arthropod numbers to surface area of 1 ha it appeared that the changes of hosts are positively correlated with that in arthropods. For example the twofold increase in numbers of *M. arvalis* from August to October of 1977 corresponded to tripled increase of arthropod numbers (Fig. 1*B*).

3.2. PASTURE AT NIEMCZA

From a total of 204 individuals of *M. arvalis* 1695 arthropods representing 26 species (3 unidentified inclusive) were collected. One eudominant, *L. hilaris*, was found with a high predominance of 44.4%, 5 dominants forming 39.7% of collection, 2 subdominants, 4 recedents and 14 subrecedents (Table 4).

Eudominant is euconstant – 76.5%. Constant species were lacking, there were 1 accessory and 25 accidental species (Table 5). There were 12 nest-host dwelling species,

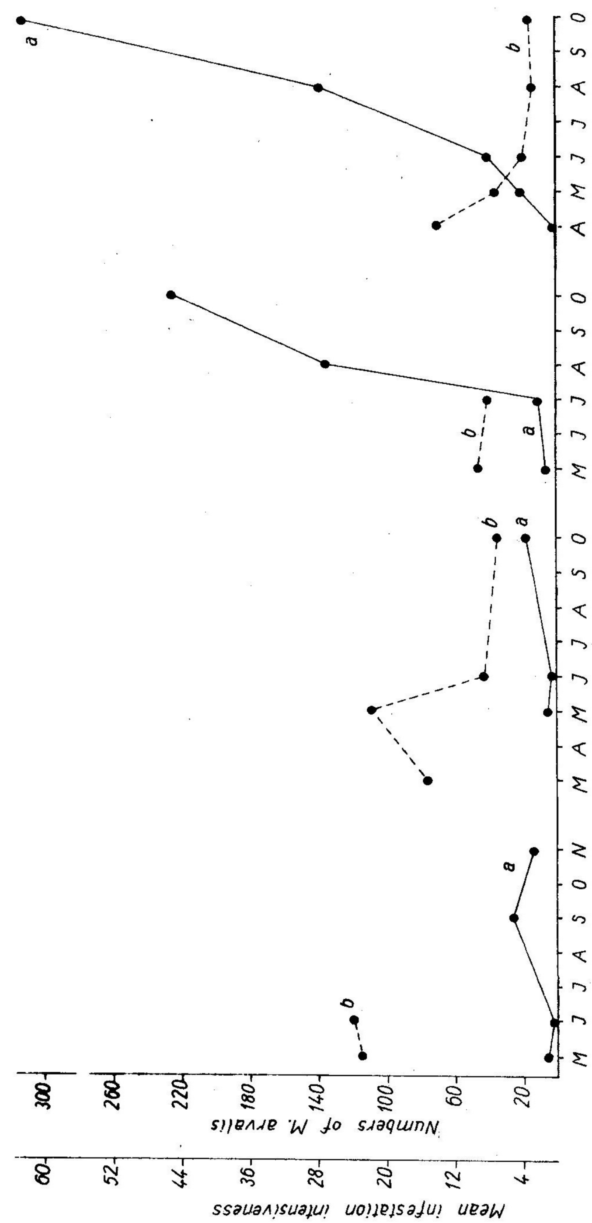

Fig. 2. Changes in numbers of *Microtus arvalis* (Pall.) per 1 hectare and in mean infestation intensiveness in pasture at Niemcza
a – numbers of *M. arvalis* per 1 ha, *b* – mean infestation intensiveness

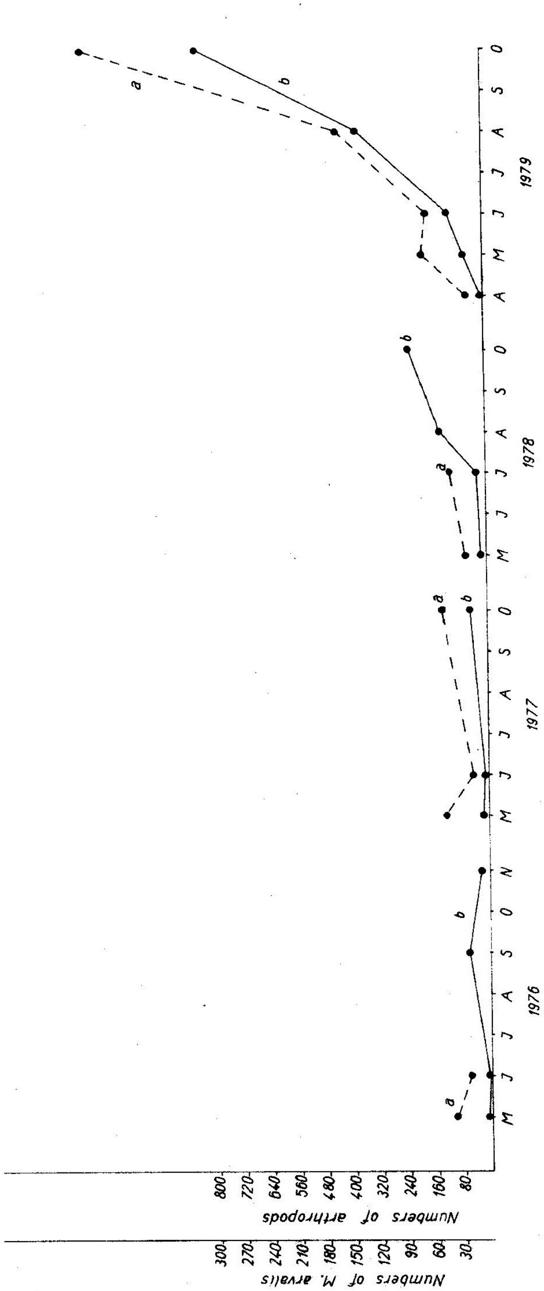

Fig. 3. Changes in numbers of *Microtus arvalis* (Pall.) and arthropods in pasture at Niemcza
a – numbers of arthropods per 1 ha, *b* – numbers of *M. arvalis* per 1 ha

8 host and 6 nest ones. The arthropod fauna occurring on *M. arvalis* of pastures was relatively poor. Multiannual mean infestation intensiveness was weak – 8.31. By comparing the growth curve of *M. arvalis* numbers and that of changes in mean infestation intensiveness it can be seen that the low level of host numbers in spring corresponds with a high infestation index; when the numbers of host were increasing this index was decreasing until autumn (in 1979 it slightly increased in autumn) (Fig. 2).

Differences were observed in the mean infestation intensiveness depending on changes in numbers of *M. arvalis* in the same months and subsequent years. The increase in numbers of *M. arvalis*, especially in 1979, was accompanied by a lower intensiveness of infestation. In the years of augmented abundance of the host the mean infestation intensiveness was lower in spring that in analagous periods in the years of the low host abundance. For example, when in May 1979 the numbers of *M. arvalis* have exceeded 4-5 times that recorded in May of previous years, the mean infestation intensiveness was lowest (Fig. 2).

Different picture of changes was observed in numbers of arthropods related per 1 ha. It turned out that only in June their numbers decreased, followed by a constant

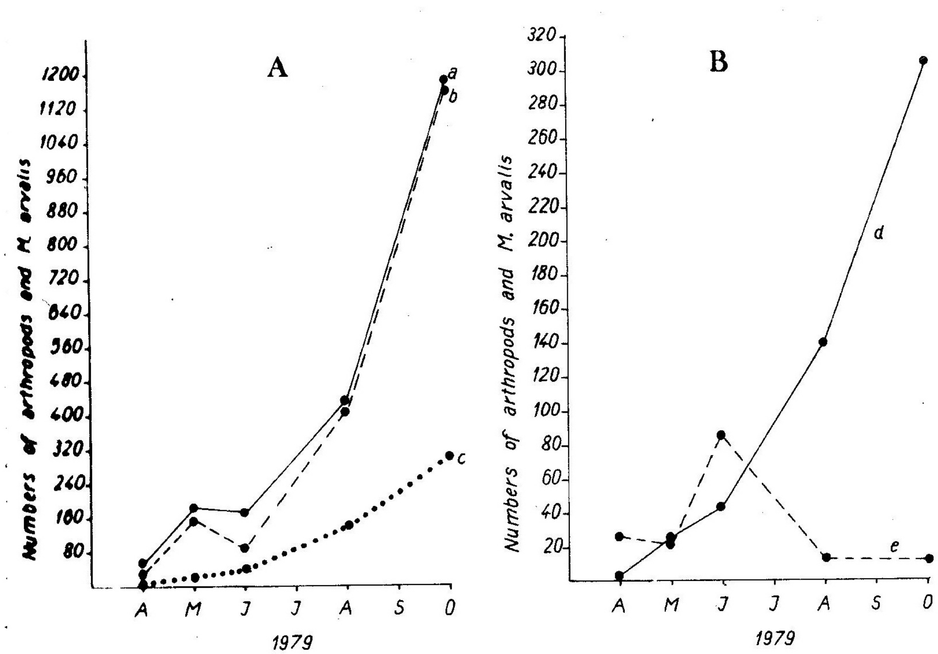

Fig. 4. Changes in numbers of all arthropods, host-dwelling species (*A*) and changes in numbers of nest-host dwelling, host-dwelling species and *Microtus arvalis* (Pall.) in pasture at Niemcza per 1 ha (*B*)
a – total numbers of arthropod on *M. arvalis* per 1 ha, *b* – numbers of host-dwelling species on *M. arvalis* per 1 ha, *c* and *d* – numbers of *M. arvalis* per 1 ha, *e* – numbers of nest-host dwelling species per 1 ha

growth. This growth, being unproportional to the increase in host numbers results in diminishing mean infestation intensiveness. This process becomes altered probably in September or as late as in November (Fig. 3). The decrease in numbers of arthropods in June occurred in all years of studies. The reason of such phenomenon should be looked for in the changed structure of the host population. Old individuals, overwintering ones and those of vernal generations, die out. The young have not accquired yet a properly numerous own arthropod fauna. Mainly the numbers of host-dwelling species are decreasing which suggest that the process of felling out the arthropods from the population associated with mortality of hosts is not fully compensated by their reproduction. The intensity of reproduction of arthropods in a later period (summer and early autumn) does not catch up with the rate of host population growth. In 1977, since June until October, the numbers of *M. arvalis* have increased 4 times, and that of arthropods related to 1 ha – three times (Fig. 3). Correspondingly the mean infestation intensiveness has decreased from 9.75 to 7.30 (Fig. 2). The infestation intensiveness is mainly resulting from the host-dwelling species (Fig. 4*A*). A considerable decrease in their numbers in June is apparent. In this month the lowest infestation intensiveness by nest-host dwelling and nest-dwelling species was stated. Their numbers on *M. arvalis* per 1 ha was then equal to numbers of the host-dwelling species (Fig. 4*B*).

3.3. PASTURE AT MAGNICE

Of 84 individuals of *M. arvalis* 822 arthropods were collected representing 14 species. There were: one eudominant (*L. hilaris*) with a high predominance (40%) and 4 dominants, 3 subdominants, 6 subrecedents (Table 4). Euconstants were lacking but 2 constant species (*L. hilaris* and *Hyperlaelaps microti*) and three accessory and 9 accidental species were present (Table 5). There were 6 host-dwelling and 8 nest-host dwelling species, the nest-dwelling were lacking. The poverty of fauna results most probably from scarce collection restricted to three catches, in spring, summer, and autumn of one year. A species exclusively encountered in Przedgórze, *Amphipsylla rossica* Wagner (*Siphonaptera*), was recorded. General mean infestation intensiveness was low – 9.79. The numbers of arthropods underwent changes similar to those on *M. arvalis* from pastures at Niemcza in 1979, but with a higher values of mean infestation intensiveness (Fig. 5). A clear drop in numbers of arthropods was observed in June (from 419.98 on *M. arvalis* per 1 ha in April to 296.16 in June). It was accompanied by a twofold increase of *M. arvalis* numbers.

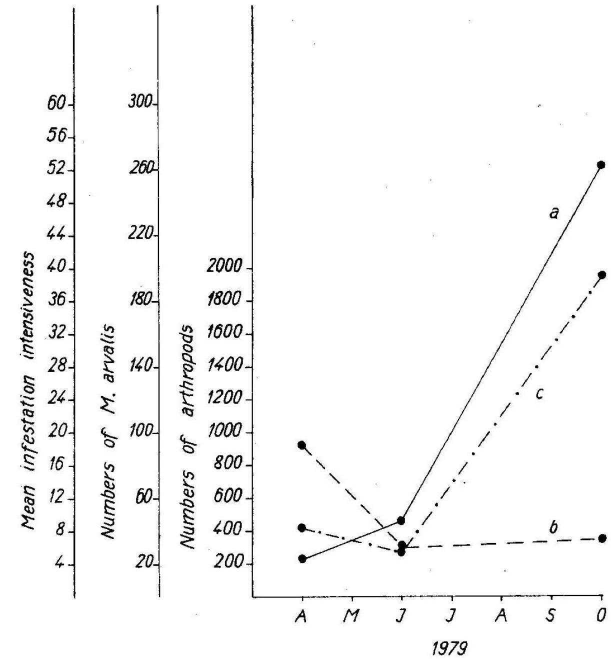

Fig. 5. Changes in numbers of *Microtus arvalis* (Pall.) and arthropods per 1 ha, and mean infestation intensiveness in pasture at Magnice
a – numbers of *M. arvalis*, *b* – mean infestation intensiveness, *c* – numbers of arthropods

3.4. MEADOW-FALLOW AT BŁOTNICA

Of 136 individuals of *M. arvalis* 5522 arthropods were collected, representing at least 48 species (7 unindentified included). Eudominant was one – *Hoplopleura acanthopus* with a low dominance (15.1%). Where the mass occurrence, 1092 individuals of *H. acanthopus* on one individual of *M. arvalis*, was taken into account, the dominance was increasing up to 34.9%. In addition there were 3 dominants, 7 subdominants, 2 recedents and 35 subrecedent species (Table 4). There were 9 host-dwelling species, 19 – nest-host dwelling and 20 nest-dwelling species. Euconstants were lacking, there were 3 constants: *L. hilaris*, *H. acanthopus* and *H. microti*; 4 accessory and 41 accidental species (Table 5).

The arthropod fauna was differentiated and rich. The abundance of nest-dwelling species is noteworthy. Annual mean of the infestation intensiveness was high – 40.60.

The collection covers 10 months of 1978–1979. In 1978, mean infestation intensiveness was slightly increasing from August to November. The peak of numbers was observed in April of 1979 (192.62 on *M. arvalis* per 1 ha). The index of infestation

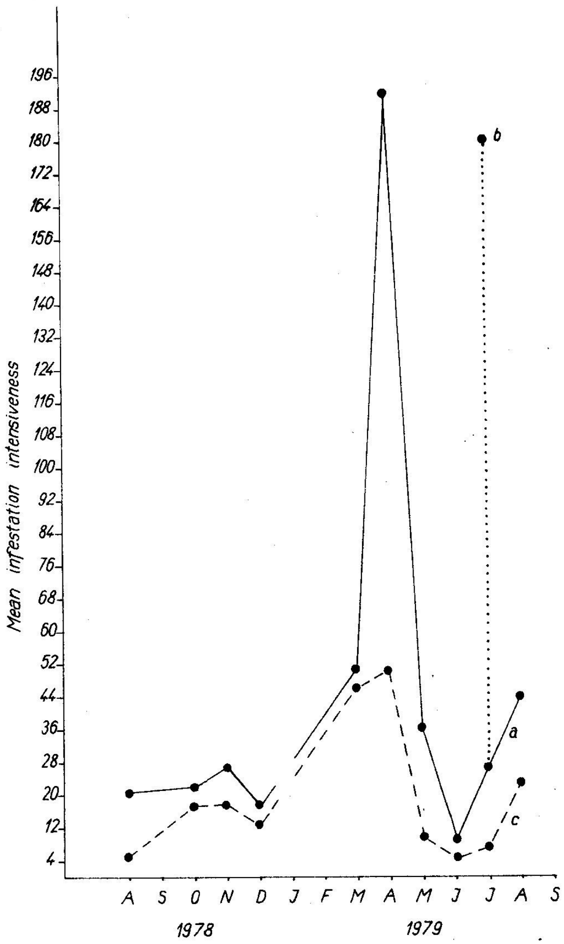

Fig. 6. Changes in mean infestation intensiveness of *Microtus arvalis* (Pall.) in meadow at Błotnica
a – mean infestation intensiveness of *M. arvalis* by all arthropods, *b* – mean infestation intensiveness including mass invasion of *Hoplopleura acanthopus* (Burm.), *c* – mean infestation intensiveness by host species

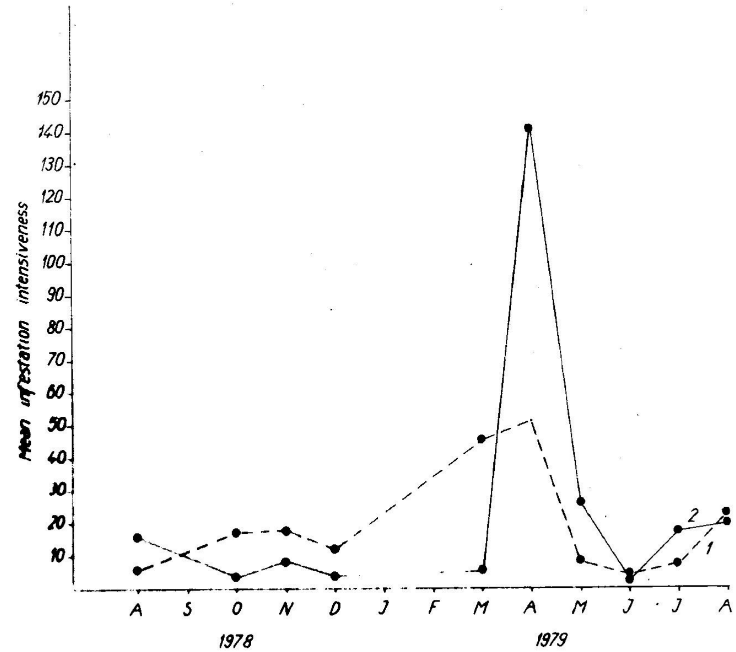

Fig. 7. Changes in mean intensiveness of infestation of *Microtus arvalis* (Pall.) with host-dwelling species, nest-host dwelling and nest-dwelling species in meadow at Błotnica
1 – mean infestation intensiveness with host-dwelling species, *2* – mean infestation intensiveness with nest-host dwelling and nest-dwelling species

showed the lowest value in June, then it increased by several times until August. Very high index in July has been brought about by a mass appearance of *H. acanthopus* on one host individual. When it is excluded from calculation the index recovers its „normal" value. In August the index value was found more than doubled as referred to that of August of 1978 (Fig. 6). It is a reverse process than that observed in the pasture. The numbers of *M. arvalis* were not assessed in the meadow, but it can be inferred that they were lower in August of 1979 than in that month of 1978, hence the increase of infestation index was adequate to the decrease of host numbers. The species of the host-dwelling group, at a proliferous both in species and in numbers groups of nest-dwelling and nest-host dwelling species, do not determine so strongly the mean infestation intensiveness as in other habitats. For example, these were mainly nest-host dwelling species which were responsible for the value of this index since April until May. Since June until August there was some altered situation and since September until March, the mean infestation intensiveness was governed foremostly by host-dwelling species (Fig. 7).

4. THE EFFECT OF ENVIRONMENTAL CONDITIONS ON THE ARTHROPOD COMMUNITY

4.1. FAUNISTIC DIFFERENTIATION OF ARTHROPODS OCCURRING ON *M. ARVALIS*

A dependence was found of faunistic composition of arthropods occurring on *M. arvalis* and the habitat it lives in. The richness of arthropod fauna on *M. arvalis* occurring in a meadow results mainly from the lack of disturbance of host nests by man in this habitat. The differences pertain mainly to the nest-dwelling group, consisting at least of 20 species on *M. arvalis* of a meadow, only 6 of a pasture and one of a crop field. Unsteady state of nests and lack of proper food conditions in them makes the occurrence of nidicoles impossible since they are dependent on nests and their supplies and not on *M. arvalis* occurrence under these conditions. In temporary pastures, maintained for 3 – 4 years, they occur in a community poorly differentiated faunistically. In a meadow the number of nest-host dwelling species was almost doubled of that found either in pasture or in crop field (19, 12, 10 respectively). These differences are probably higher since some species [*Neotrombicula autumnalis* (Shaw)] (*Trombidiformes*) were brought to pastures and crop fields by *M. arvalis* individuals which must have contacted recently the ecotone of forest, bushes, herbs, etc.

Differences found in host-dwelling group are haphazardous and result from different abilities of contacts with other mammalian species present permanently or periodically in the habitats examined such as *Mustela nivalis* L., *Talpa europaea* L., *Sorex araneus* L.

Catches from different habitats were done not always simultaneously. Hence, a high comparative value is that of collections made in the same months. In August 1978, 8 arthropod species were gathered from *M. arvalis* of pasture-mixture, and 23 species of a meadow. In October 8 and 24 species, respectively, were collected. In April 1979 six

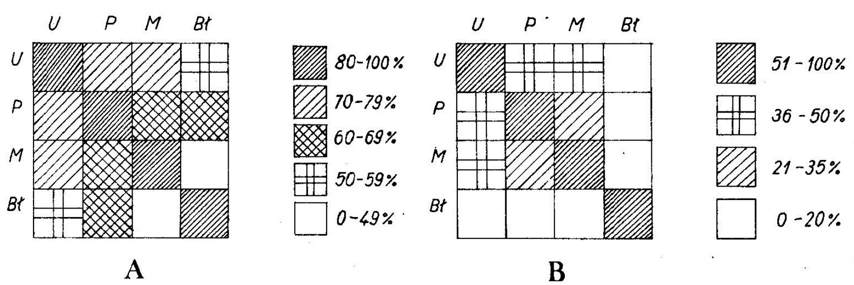

Fig. 8. Diagram of similarity of species composition of arthropods in habitats examined (*A*) and diagram of similarity as based on number of arthropods on *Microtus arvalis* (Pall.) in the habitats examined (*B*) *U* – crop fields, *P* – pasture at Niemcza, *M* – pasture at Magnice, *Bl* – meadow at Błotnica

arthropod species were collected from pasture and 31 – from the meadow, in August – 10 and 24, respectively.

Similarity of species composition of arthropods on *M. arvalis* in various habitats was assessed by Jaccard and Steinhaus' formula: $S = \frac{100 \times 2c}{a + b}$; where S – similarity index, c – sum of common species, a – number of species of surface A, b – number of species of surface B.

The results were presented as diagram (Fig. 8*A*). The highest similarity of an order of over 70% was found between arthropod fauna on *M. arvalis* from crop fields and pastures at Niemcza and Magnice. The similarity of over 60% was that between fauna of pastures at Niemcza and pastures at Magnice as well as of the meadow. The meadow fauna is most similar to that of pastures at Niemcza (62.2%).

4.2. MEAN INFESTATION INTENSIVENESS OF *M. ARVALIS*

The mean infestation intensiveness (multiannual mean), is smallest on *M. arvalis* of crop fields; higher on *M. arvalis* of pastures, attaining the highest value on *M. arvalis* of a meadow. Between *M. arvalis* of crop fields and pastures the difference is rather small but increases by ten times as compared to *M. arvalis* of a meadow. The nest-host dwelling species and nest-dwelling species affect the intensiveness of infestation mainly in spring and summer, when many of them are eudominants and dominants in successive months, which is most apparent in the meadow.

In order to characterize fauna of chosen habitats a use was made of the method of estimation of similarity basing on class of abundance according to K o s t r o w i c k i (1963). The estimate is presented as a diagram (Fig. 8*B*). The highest similarity was between crop field and pasture at Niemcza and between crop field and pasture at Magnice, and lesser one between the two pastures. The similarity between these habitats and the meadow is insignificant.

4.3. DOMINANCE AND CONSTANCY STRUCTURES OF ARTHROPOD COMMUNITY ON *M. ARVALIS*

There is one species as eudominant occurring on *M. arvalis* of all habitats but its dominance extent varies. The highest dominance is that in community rather poor in species (except for Magnice – scanty material), the lowest in the richest community. The differences in the degree of dominance are almost fourfold (taking into account single mass occurrence of *H. acanthopus*). *L. hilaris* was eudominant in poor communities and *H. acanthopus* – in rich one. Mean (multiannual) intensiveness of infestation of *M. arvalis* by *L.hilaris* leads to a conclusion that numbers of this mite do not depend on faunistic differentiation of the arthropod community. In the pasture and crop field the intensiveness of infestation of *M. arvalis* by *L.hilaris* varied in a minimum

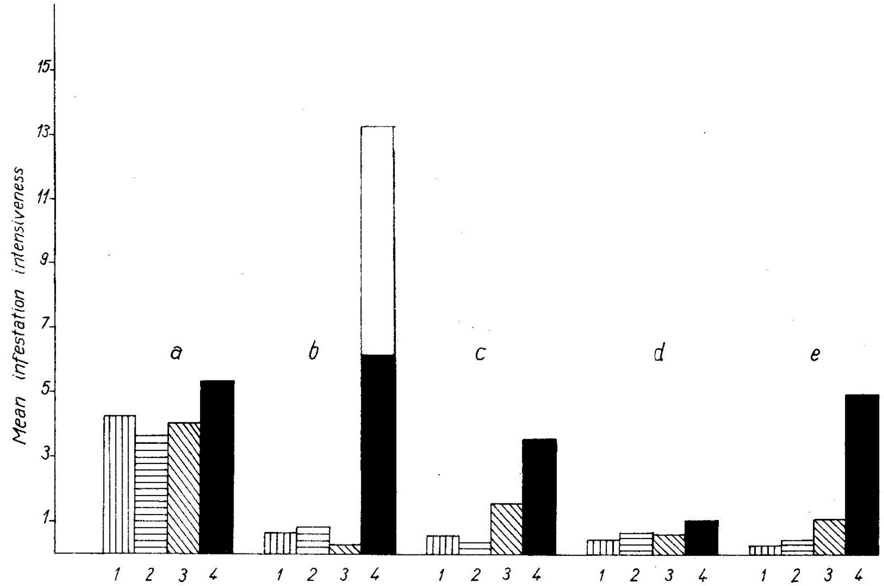

Fig. 9. Mean many years intensiveness of infestation of *Microtus arvalis* (Pall.) by some most abundant arthropods in various habitats

1 – crop field, *2* – pasture at Niemcza, *3* – pasture at Magnice, *4* – meadow, *a* – *Laelaps hilaris* (Koch), *b* – *Hoplopleura acanthopus* (Burm.), *c* – *Hyperlaelaps microti* (Ewing), *d* – *Ctenophthalmus assimilis* (Tasch.), *e* – *Glycyphagus hypuadei* (Koch)

range during several years, and it was highest on *M. arvalis* of the meadow, where the share of *L.hilaris* in the arthropod community was lowest (Table 4).

Four species (two of the host-dwelling and two of nest-host dwelling groups) have been chosen in order to trace the differences in mean infestation intensiveness depending on the habitat (Fig. 9). *Hoplopleura acanthopus* – minimum differences are present between *M. arvalis* of crop fields and pastures at Niemcza and those of pastures at Magnice. On all the individuals of *M. arvalis* apart from meadow, the mean infestation intensiveness was low. *Hyperlaelaps microti* – infestation intensiveness was low on individuals from the crop fields and the pasture at Niemcza, almost 3 times higher at Magnice and 7–9 times higher in the meadow. *Ctenophthalmus assimilis* – infestation intensiveness in crop fields and pastures was low, almost two times higher in the meadow. *Glycyphagus hypuadei* – infestation intensiveness was low in crop fields and the pasture at Niemcza, 2–4 times higher on *M. arvalis* at Magnice and 5 to 16 times higher in the meadow.

The mean intensiveness of infestation of *M. arvalis* from meadow by eudominant and dominants was clearly higher than on hosts from other habitats. The reason of different intensiveness of infestation by host-dwelling species should be looked for in

population processes of the host (changes in population structure, an intense exchange of generations). This points to the steady state of occurrence. The highest constancy was that of eudominant occurring on *M. arvalis* of crop fields (84.9%), the lowest one on *M. arvalis* at Magnice (65.9%). The difference between hosts of the crop fields and the meadow, as regards *L.hilaris*, reach the value of 10%. They are even higher between *M. arvalis* of the crop fields and those of the meadow as regard, e.g. *H. acanthopus* (by 34% on *M. arvalis* of the meadow) and *H. microti* (by 30.2% on *M. arvalis* of the meadow).

5. INTENSITY OF OCCURRENCE OF ARTHROPODS AND DYNAMICS OF HOST POPULATION NUMBERS

Infestation intensiveness is to a greater degree dependent on changes in host numbers. Especially host-dwelling species respond to such changes. Low numbers of host population in spring correspond with high infestation intensiveness. Since April or May a sharp decrease in infestation intensiveness is observed corresponding to the increase in host population numbers. It lasts until June or August, or even through October (pasture 1977). The curve of infestation intensiveness depicts changes of numbers occurring in *M. arvalis* during annual cycle but data are lacking on numbers of the host population which makes difficult the determination of the reason of this process. When indices of infestation intensiveness are changed to absolute numbers it turns out that June is a critical point in arthropod community development of the host-dwelling group. It is the month of real decrease in numbers. In the remaining months the numbers are increasing but unproportionally to the rate of host population growth, resulting in a decreasing infestation intensiveness. One should assume that in that time (May, June) the arthropods of host-dwelling group undergo a critical period as a result of natural selection and short life-span of existing host generations. Late summer and autumn are the time of restitution of host-dwelling species with the rate of increase in numbers of those species exceeding the rate of host population growth not earlier than in late autumn (in 1979 the infestation intensiveness index was increasing as late as in October). The infestation intensiveness was then found to increase until spring (data for meadow), which results from unrestricted abilities to increase on long-lived individuals (8–9 months and more) and it undergoes lowering as a result of recruitment of young to the population of *M. arvalis* and dying out the old ones.

The comparison of arthropod numbers increase against the increase in host population numbers during subsequent years is difficult because of lacking materials. Similar states of *M. arvalis* numbers are characteristic for the years 1976 and 1977. In 1978 and 1979 – the numbers of *M. arvalis* increased many times (data for pasture at Niemcza). At the maximum numbers of *M. arvalis* per 1 ha (20 in October of 1977), the mean infestation intensiveness amounted to 7.30. In corresponding period of 1979 this index was two times lower but numbers of *M. arvalis* about 15 times higher. It is reasonable that total numbers of arthropods on host individuals as calculated per 1 ha were about 8 times higher in 1979.

6. CONCLUSIONS

1. *Microtus arvalis* individuals inhabiting in unafforested surfaces possess diversified and rich arthropod fauna but it differs in populations living in different habitats. If we accept as a norm the state on *M. arvalis* from sites without agrotechnical treatment we conclude that the arthropod fauna on *M. arvalis* of pastures and to a greater extent of crop fields becomes poorer. This follows due to elimination of nest-dwelling species which are practically not encountered in crop fields and to a lesser degree of nest-host dwelling species. The arthropod fauna of *M. arvalis* occurring in crop fields is poorer by 62.5% than that of arthropods occurring on this host of the meadow and by 30.8% than the fauna on the host of the pasture at Niemcza.

2. The above given differences result from disturbance and destruction of host nests together with their fauna during agrotechnical treatments and because of floristic poverty of cultivated fields. To such conclusion lead results for pastures. The pastures are out of cultivation for 3–4 years, time long enough for faunistic restitution of nests, but such restitution follows in a limitted range.

3. Infestation intensiveness is differentiated in *M. arvalis* populations of habitats examined, being about 5 times higher on *M. arvalis* of the meadow that on those of crop fields. The increase in faunistic differentiation of the arthropod community is associated with the increase in intensiveness of infestation.

4. The mean infestation is governed mainly by host-dwelling species and to a lesser degree by nest-host dwelling ones. In faunistically poorer communities *Laelaps hilaris* is eudominant, in the richest community – *Hoplopleura acanthopus*. The dominance is decreasing together with increased faunistic differentiation of the community. The difference in arthropod community dominance between *M. arvalis* of crop fields and the meadow reaches about 40%.

5. All dominant species show higher intensiveness of infestation of *M. arvalis* with the richest fauna of arthropods (from meadow). One should presume that it results from a longer average life-span in *M. arvalis* of the meadow that those of other habitats. This is proved by a high mean intensiveness of infestation of *M. arvalis* by *H. acanthopus*, immobile species, for which longer time is necessary than for other host-dwelling species to attain such infestation intensiveness (almost 8–10 times higher than in *M. arvalis* of crop fields and pastures).

6. In communities most strongly differentiated in arthropod fauna a significant or major role is played by nest-host dwelling species responsible for the extent of infestation intensiveness in some months (April, May).

7. The highest constancy of occurrence on *M. arvalis* of all habitats is that of *L. hilaris*. It is highest on *M. arvalis* of crop fields (higher by 10.6% than on *M. arvalis* of the meadow). All the remaining species occurring more abundantly show much higher constancy of occurrence on *M. arvalis* of the meadow.

8. Infestation intensiveness depends on host population numbers. Low numbers of *M. arvalis* correspond with high intensiveness of infestation. Yearly changes are characterized by the curve decreasing from April towards the autumn. In successive years and in various habitats the onset of increasing infestation index can begin in July.

9. The highest decrease in numbers of arthropod communities was observed in June, especially of the host-dwelling species. It results from the changes in host population structure, an intense substitution of generation which eliminates the majority of individuals belonging to the host-dwelling species.

10. Low mean infestation intensiveness in the autumn results from unproportional rate of host population and arthropod numbers increase. The rate of increase in numbers of arthropods representing host-dwelling group exceeds the rate of host population increase in late autumn.

11. The mean infestation intensiveness was found to increase until spring (data for the meadow) as a result of high reproductive abilities of arthropods on *M. arvalis* that have lived for 8–9 months.

12. Using absolute numbers (number of arthropods on *M. arvalis* as related to one hectare), the abundance of host-dwelling species (dominants) increases in two phases since March or April until May, it decreases in June, and rises up again since July until November-December, followed by a decrease until March-April of the following year. It is a reversed picture of changes as compared to that formed by infestation intensiveness index.

13. The increase in numbers of host population corresponds with general increase in numbers of arthropods but at a decreasing index of infestation intensiveness. For example, at a maximum numbers of *M. arvalis* per 1 ha – 20, the infestation index amounted to 7.30, at 15 times higher numbers of *M. arvalis* in 1979 – the index decreased by half.

14. In general, the arthropod fauna of *M. arvalis* in examined habitats consists of, at least, 54 species of arthropods (43 identified), leading to a relatively high multiannual mean intensiveness of infestation – 17.25.

15. There are differences of quantitative nature between arthropod fauna on *M. arvalis* occurring in pastures of submontaneous and lowland regions.

7. STRESZCZENIE

W trzech różnych środowiskach: uprawie, pastwisku i łące na Dolnym Śląsku przeprowadzono w latach 1976–1979 odłowy *Microtus arvalis* (Pall), uzyskując z 501 norników 8644 stawonogi należące do 54 gatunków. Stwierdzono, iż norniki z powierzchni niezalesionych mają faunę stawonogów bogatą, szczególnie na łące. Fauna stawonogów z upraw jest uboższa o 62,5% od fauny stawonogów z łąki i 30,8% od fauny z pastwisk. Różnice te mają związek z naruszaniem i niszczeniem gniazd w agrocenozach często poddawanych zabiegom technicznym. Średnia intensywność zarażenia jest około pięciokrotnie większa na nornikach z łąki niż na nornikach z upraw. Wzrostowi zróżnicowania faunistycznego zgrupowań stawonogów towarzyszy wzrost intensywności zarażenia.

Intensywność zarażenia kształtują przede wszystkim gatunki żywicielskie stawonogów i w mniejszym stopniu gniazdowo-żywicielskie. Najczęściej eudominantem jest *Laelaps hilaris* (Koch) i *Hoplopleura acanthopus* (Burm.). Różnica w dominacji stawonogów między nornikami z upraw i łąki sięga 40%.

Gatunki dominujące wykazują większą intensywność zarażenia na nornikach o najbogatszej faunie stawonogów. W niektórych miesiącach (kwiecień, maj) największą rolę w kształtowaniu intensywności zarażenia odgrywają gatunki gniazdowo-żywicielskie.

Największą stałość występowania na nornikach z wszystkich powierzchni wykazuje *L. hilaris*, a szczególnie na nornikach z upraw.

Średnia intensywność zarażenia zależy od liczebności żywiciela. Niskiej liczebności żywiciela odpowiada duża intensywność zarażenia. Punktem krytycznym w rozwoju zgrupowań stawonogów, szczególnie żywicielskich, jest czerwiec. Niskie wskaźniki zarażenia w jesieni wynikają z innego tempa wzrostu populacji żywiciela i stawonogów. Tempo wzrostu liczebności stawonogów grupy żywicielskiej przewyższa tempo wzrostu populacji żywiciela późną jesienią. W wyniku dużych możliwości reprodukcyjnych na nornikach żyjących najdłużej (8–9 miesięcy) wskaźnik zarażenia wzrasta aż do wiosny.

W liczbach bezwzględnych (liczba stawonogów na nornikach w przeliczeniu na 1 hektar) liczebność pasożytów stałych (dominantów) wzrasta dwufazowo: od marca lub kwietnia do maja, spada w czerwcu i rośnie od lipca do listopada-grudnia, a następnie maleje do marca-kwietnia.

Wzrostowi liczebności żywiciela odpowiada wzrost liczebności stawonogów, ale przy malejącym wskaźniku zarażenia. Istnieją różnice natury ilościowej między składem faunistycznym stawonogów na nornikach z pastwisk podgórskich i nizinnych.

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