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CLUSTER ANALYSIS OF THE SPRING MIGRATION OF BIRDS IN MORAVIA (CZECHOSLOVAKIA), 1881—1960

Zdeněk HUBÁLEK

Received April 11, 1984

Abstract. Nineteen species of migratory birds were evaluated for their mutual correlation in the spring arrival during 62 seasons. The matrix of product-moment correlation coefficients was subjected to two cluster analysis techniques (half-linkage, average-linkage), and several clusters (migrons) of the bird species significantly correlated in their spring migration chronology were detected: (A) *Alauda arvensis, Sturnus vulgaris, Fringilla coelebs, Columba palumbus, Motacilla alba, Vanellus vanellus, Turdus philomelos, Erithacus rubecula, Scolopax rusticola* and an "outlier" — *Ciconia ciconia;* (B) *Hirundo rustica, Jynx torquilla, Delichon urbica, Cuculus canorus, Luscinia megarhynchos* and *Streptopelia turtur;* and singletons: (C) *Apus apus,* (D) *Oriolus oriolus,* (E) *Coturnix coturnix.* According to winter quarters of the bird species involved, the migron (A) could be designated "Mediterranean" (the only exception being *C. ciconia)* while the others "African". Interestingly, these two large groups (Mediterranean and African) of migratory birds are unrelated to each other in their spring migration chronology. A variability of the annual arrival date and the effects of actual meteorological conditions in Central Europe are much larger in the birds of the Mediterranean migron than in those of the African migrons. It means that timing of the migration is due to different mechanisms in these two groups.

INTRODUCTION

Although the first report on the spring arrival of several bird species to Czechoslovakia appeared seemingly in the 18th century (Strnad 1792), the first longitudinal study was published in 1855 by Fritsch who compiled the phenological data of 29 common species birds as observed at 33 sites in Bohemia during 1828 to 1850. This monitoring had been organized by the "k.k. patriotisch-ökonomische Gesellschaft in Böhmen" and ranged among the first studies of that kind in Europe. Later on, the Meteorological Commission of the "Naturforschender Verein" in Brno, Moravia, managed even more detailed phenological observations in Moravia, starting 1881 and continuing until 1906 (Niessl 1882—1911). In that period, the first analytical studies on particular bird species also appeared, based on those data (Rzehak 1895, 1896), besides several local surveys (Čapek 1888, 1890; Zdobnitzky 1912). Next systematic observations on a nation-wide basis in Czechoslovakia were organized and published by the Agricultural Research Institutes (Novák et Šimek 1926, 1930—1938) and by the State Hydrometeorological Institute (Zítek 1953—1964) after the 1st and 2nd World War, respectively. Independently, many phenological data collected by members of the Czechoslovak Ornithological Society have been stored up but regrettably not published.

The evaluation of such a large body of ornithophenological data is still far from being exhaustive, though several comprehensive analytical studies appeared (Pikula 1972, 1974; Beklová 1975). A new approach to phenology, the cluster analysis of the spring arrival data, proved to be fruitful (Hubálek 1983) and it was therefore decided to apply this technique to a larger collection of phenological data, contained in the published series of records. Data on *Apis mellifera* (Hymenoptera) and *Melolontha melolontha* (Coleoptera) have been included as markers of a local meteorological situation.

MATERIAL AND METHODS

Observation region and periods. The observations were carried out simultaneously in many places of Moravia (Czechoslovakia), situated between 48°37′ and 50°27′ N, 15°15′ and 18°51′ E. The total area of Moravia is about 26,000 km^2; minimum and maximum elevations are 148 m and 1492 m, respectively.

Total 62 spring seasons were covered by the published observations in the period from 1881 to 1960:

(1) 26 seasons between 1881 and 1906 (Niessl 1882–1911): 12–40 (mean 28) bird observation stations per year, situated 165–762 (mean 382–396) m a.s.l., with 82% of the sites below 500 m. All the species included in this study were recorded, but *Jynx torquilla*, *Apus apus*, *Luscinia megarhynchos* and *Apis mellifera* less frequently.

(2) 13 seasons between 1923 and 1937 (Novák et Šimek 1926, 1930–1938): 14 to 355 (mean 216) ornithophenological stations peer year, situated 159–757 (mean 373–392) m a.s.l., with 78% sites below 500 m. All the species were covered, but *Fringilla coelebs* and *Luscinia megarhynchos* less frequently.

(3) 23 seasons between 1938 and 1960 (Zítek 1953–1964): 70–174 (mean 111) bird stations per year, situated 155–760 (mean 354–392) m a.s.l., with 69–82% sites below 500 m. Only the species *Alauda arvensis*, *Sturnus vulgaris*, *Hirundo rustica*, *Cuculus canorus*, *Apis mellifera* and *Melolontha melolontha* were recorded, in the years 1938–1955 moreover *Vanellus vanellus*, *Motacilla alba* and *Ciconia ciconia*, and in 1956–1960 also *Turdus philomelos*. During the occupation in 1938–1945, data from the marginal parts of Moravia were not collected.

Data processing and cluster analysis. Nineteen species of migratory birds and two species of invertebrate "markers" (honey-bee, dor-beetle) were selected, due to a sufficient number of records collected in them. When the number of observation sites for a particular species in a year did not reach three, that year was omitted. Clearly aberrant data were also excluded from the calculations. The calendar data were transformed into serial numbers, and the average arrival (appearance) days were calculated in each species for each year.

Cluster analysis of the results has been performed as previously (Hubálek 1983). Briefly, Pearson's product-moment correlation coefficient (r) was computed for each pair of the species to show the correlation amongst individual species in arrival data. The matrix of these correlation coefficients was then subjected to two techniques of cluster analysis:

(i) half-linkage clustering (Hubálek 1978);
(ii) average-linkage clustering, UPGMA variant (Sneath et Sokal 1973).

RESULTS

The long list of arrival (appearance) data of all species in each year is not shown here to save the place, but Tab. 1 gives a survey of averages of the annual data in particular species.

Tab. 2 shows the matrix of correlation coefficients amongst all pairs of 19 species of birds and two invertebrate species, and the dendrogram of Fig. 1 is a representation of the average-linkage clustering of species, based on the coefficients from Tab. 2. The second procedure, half-linkage clustering, yielded results very similar, in fact the dendrogram was topologically identical (and therefore not shown here) with that of the average-linkage clustering. A closer inspection of the dendrogram has revealed that the value of $r = 0.35$ in both clustering techniques represents the limit below which the proportion

Tab. 1. Spring arrival of 19 species of migratory birds to Moravia, 1881–1960
(S. D., standard deviation, days)

Species	No. of years	Mean no. records per yr.	Annual average date Mean	± S.D.	Min.	Max.
Alauda arvensis L.	62	81.2	1. III.	7.72	13. II.	19. III.
Sturnus vulgaris. L.	62	73.5	5. III.	7.08	15. II.	19. III.
Fringilla coelebs L.	31	7.1	12. III.	7.51	27. II.	25. III.
Columba palumbus L.	39	25.4	14. III.	7.05	27. II.	25. III.
Vanellus vanellus (L.)	55	29.6	16. III.	6.23	28. II.	28. III.
Motacilla alba L.	57	54.3	17. III.	5.84	6. III.	29. III.
Turdus philomelos Brehm	43	25.6	17. III.	7.06	2. III.	3. IV.
Scolapax rusticola L.	38	14.7	22. III.	5.69	11. III.	3. IV.
Erithacus rubecula (L.)	23	18.0	26. III.	4.14	17. III.	2. IV.
Ciconia ciconia (L.)	53	30.9	3. IV.	4.85	19. III.	11. IV.
Hirundo rustica L.	62	83.2	15. IV.	3.33	6. IV.	24. IV.
Jynx torquilla L.	20	6.2	18. IV.	3.68	9. IV.	26. IV.
Delichon urbica (L.)	29	23.9	18. IV.	3.75	12. IV.	27. IV.
Cuculus canorus L.	62	75.7	23. IV.	3.05	15. IV.	29. IV.
Luscinia megarhynchos Brehm·	20	5.6	25. IV.	3.27	17. IV.	30. IV.
Streptopelia turtur (L.)	31	10.3	27. IV.	2.38	20. IV.	30. IV.
Apus apus (L.)	14	19.0	1. V.	1.79	28. IV.	4. V.
Oriolus oriolus (L.)	26	7.0	5. V.	3.30	28. IV.	11. V.
Coturnix coturnix (L.)	32	22.6	11. V.	3.98	3. V.	19. V.
Markers						
Apis mellifera L.	44	69.2	7. III.	9.40	18. II.	1. IV.
Melolontha melolontha (L.)	54	58.1	1. V.	5.53	15. IV.	13. V.

of significant ($P<0.01$) intragroup links in each cluster is just less than 50%. This value could be considered as a convenient stopping rule in the hierarchical agglomerative clustering. Therefore five clusters (migrons) are apparent among the birds:

Migron A (89% significant intragroup links): *A. arvensis, S. vulgaris, F. coelebs, C. palumbus, M. alba, V. vanellus, T. philomelos, E. rubecula, S. rusticola; C. ciconia* is an "outlier" of this migron.

Migron B (53% significant intragroup links): *H. rustica, J. torquilla, D. urbica, C. canorus, L. megarhynchos, S. turtur.*

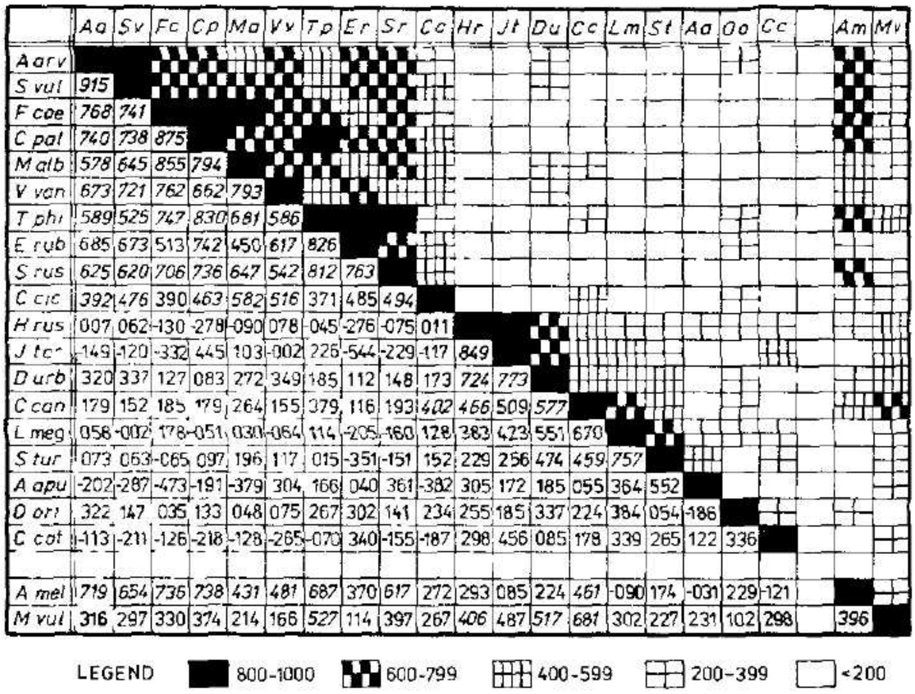
Singletons C, D and E: *A. apus; O. oriolus;* and *C. coturnix*, respectively.

The singletons (C, D, E) join the migron B at a lower level or *r*, but the migron A is clearly different from the others. *Apis mellifera*, if were included into cluster analysis, will join the migron A (at $r = 0.634$), while *Melolontha melolontha* the migron B (at $r = 0.681$, with *C. canorus*).

DISCUSSION

Generally, members of a migron formed by a clustering procedure are chronologically correlated in their spring arrival. On the other hand, the results of this study revealed that members of the migron A were in a low, if any, correlation with members of the migron B. It means that the timing of migration is different between them. A closer inspection of the migron

Tab. 2. Matrix of the coefficients of correlation (r. 1000) among 19 species of birds and two species of insects in their spring arrival (appearance).
Remarks: The coefficient values in italics are significant ($P < 0.01$). For abbreviations of the species' names, cf. Tab. 1.



	Aa	Sv	Fc	Cp	Ma	Vv	Tp	Er	Sr	Cc	Hr	Jt	Du	Cc	Lm	St	Aa	Oo	Cc		Am	Mv
A arv																						
S vul	*915*																					
F coe	*768*	*741*																				
C pal	*740*	*738*	*875*																			
M alb	*578*	*645*	*855*	*794*																		
V van	*673*	*721*	*762*	*662*	*793*																	
T phi	*589*	*525*	*747*	*830*	*681*	*586*																
E rub	685	*673*	513	*742*	450	*617*	*826*															
S rus	*625*	*620*	*706*	*736*	*647*	*542*	*812*	*763*														
C cic	*392*	*476*	390	*463*	*582*	*516*	371	485	*494*													
H rus	007	062	-130	-278	-090	078	-045	-276	-075	011												
J tor	-149	-120	-332	445	103	-002	226	-544	-229	-117	*849*											
D urb	320	337	127	083	272	349	185	112	148	173	*724*	*773*										
C can	179	152	185	179	264	155	379	116	193	*402*	*466*	509	*577*									
L meg	058	-002	178	-051	030	-064	114	-205	-160	128	383	423	551	670								
S tur	073	063	-065	097	196	117	015	-351	-151	152	229	256	474	*459*	*757*							
A apu	-202	-287	-473	-191	-379	304	166	040	361	-382	305	172	185	055	364	552						
O ori	322	147	035	133	048	075	267	302	141	234	255	185	337	224	384	054	-186					
C cat	-113	-211	-126	-218	-128	-265	-070	340	-155	-187	298	456	085	178	339	265	122	336				
A mel	*719*	*654*	*736*	*738*	*431*	*481*	*687*	370	*617*	272	293	085	224	*461*	-090	174	-031	229	-121			
M vul	316	297	330	374	214	166	*527*	114	397	267	*406*	487	*517*	*681*	302	227	231	102	298		*396*	

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A shows that it is composed of the bird species wintering in the Mediterranean countries, whereas the birds of the migron B and the singletons C, D, E have their winter quarters in tropical Africa. There is, however, one notable exception: White Stork, an outlier of the migron A. It is possible that the spring migration rate of *C. ciconia* is rather low, with an 'interruption of several days in the Mediterranean area. This could bring a change in the migration timing and course, compared with other birds wintering in Africa and migrating rapidly to their breeding grounds.

In addition to the species included in this survey, several other birds could also be arranged in the migron A on the basis of an evaluation of relatively numerous data and a previous study (Hubálek 1983): *Anser anser* (L.) with the mean arrival date in Moravia on 14. III. (the range of annual averages 4. III to 28. III.) and a good correlation with *V. vanellus, F. coelebs, C. palumbus* and *M. alba* (joined at $r = 0.75$), *Larus ridibundus* L. (mean arrival on 19. III., range of averages 9. III. to 27. III.) and *Corvus frugilegus* L., both correlated closely with *V. vanellus* (at $r = 0.7$). All these three species also have their winter quarters in the Mediterranean countries or central France.

A significant correlation of the spring appearance of *Apis mellifera* (as a local meteorological marker) with the arrival of most species of the cluster A indicates that the spring migration of the birds wintering in the Mediterranean area is significantly affected by the actual meteorological situation in Central

Europe, which might simply reflect overt meteorological conditions prevailing in the Mediterranean. A much lower correlation was shown between the spring migration of birds of the "African" clusters B, C, D, E and the markers of local meteorological situation, though the migration of C. *canorus*, D. *urbica* and *H. rustica* correlated significantly with the appearance of *Melolontha melolontha*. Tab. 1 shows a considerably greater annual fluctuation of the spring arrival of the birds of the Mediterranean migron A (SD = 4.14 to 7.72) compared with the species of the African migrons (SD = 1.79 to 3.98). This could mean that timing of the spring migration is affected by meteorological variables (especially by air temperature) much more in the bird species wintering in the Mediterranean than in those using the African winter quarters.

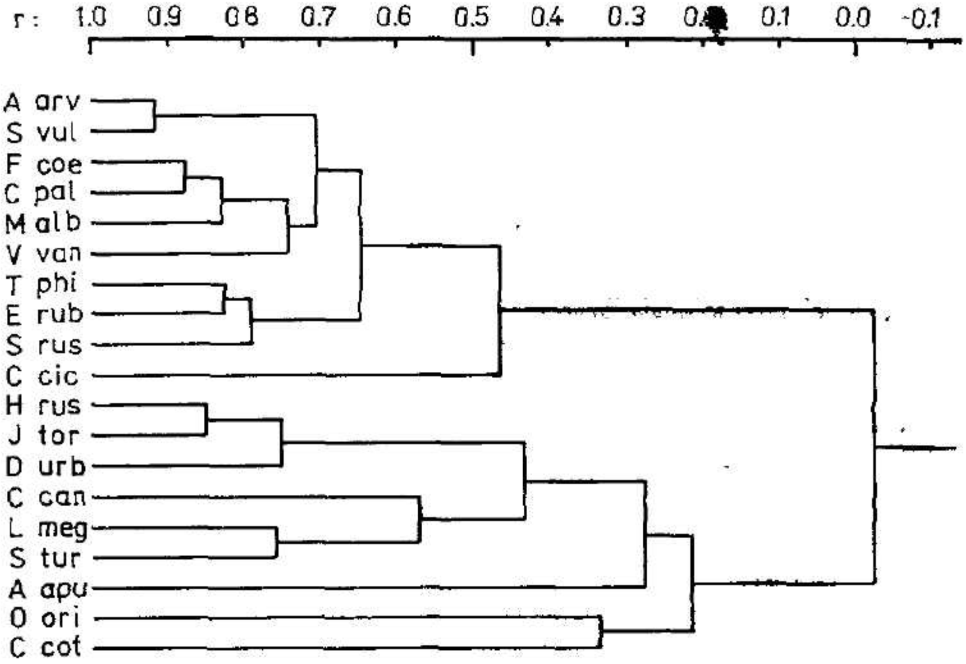

Fig. 1. Dendrogram of the average-linkage clustering of the birds' species, based on the data of Tab. 2.

CONCLUSIONS

The following conclusions could be drawn from the results of this study:

(1) Migratory birds of various species differ not only in the date of arrival from their winter quarters, but also in their mutual correlation in the migration chronology; two species which differ considerably in their arrival calendar date could nevertheless be closely correlated.

(2) The groups (clusters) of the bird species mutually related in their migration chronology (as evaluated by computation of the product-moment correlation coefficients and a subsequent cluster analysis) are called "migrons".

(3) Two large groups of unrelated migrons were detected **among the spring** migrants which differ also in their winter quarters:
(a) "Mediterranean" migron;
(b) "African" migrons (including 3 singletons).

(4) The timing mechanisms of the spring migration are different between these two groups; members of the Mediterranean migron are much more affected by actual meteorological situation in Central Europe than those of the African migrons.

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QUALITATIVE STRUCTURE OF INTESTINAL HELMINTH FAUNA OF SMALL RODENTS IN SUCCESSIVE STAGES OF SPOIL BANKS IN THE MOST BASIN (NORTHERN BOHEMIA) AND IN THEIR SURROUNDINGS

Jan JIROUŠ

Received May 31, 1984

Abstract. In total, 1497 digestive tracts of small rodents caught in the years 1979–1980 on three spoil banks after open-cast brown coal mining and in five localities outside the spoil banks were inspected. In the present paper the Shannon's species diversity index and the species evenness index for the first time were used by way of trial in order to evaluate the specific riches and balance of the helminthofauna of small rodents. The following results are to be presented: — 42, 204 intestinal helminths of the following sixteen species were found: ***Plagiorchis*** sp., ***Anoplocephaloides dentata*, *Paranoplocephala omphalodes*, *Paranoplocephala blanchardi*, *Rodentolepis fraterna*, *Rodentolepis asymmetrica*, *Heligmosomoides laevis*, *Heligmosomoides polygyrus*, *Heligmosomum costellatum*, *Aonchotheca annulosa*, *Trichocephalus muris*, *Syphacia frederici*, *Syphacia stroma*, *Syphacia nigeriana*, *Syphacia petrusewiczi*, *Aspiculuris tetraptera*.** — After migration of small rodents on the spoil banks and during the development of these spoil banks a marked rearrangement of the specific composition of helmintrofauna takes place. On a spoil bank after 25 years of natural development and on a spoil bank reclaimed by afforestation a rapid decrease of nematode species and, on the contrary, an enrichment of the helminthofauna with a number of tapeworm species.

INTRODUCTION

After the second World War the Most basin became a highly exposed territory industrially. Since then, as a result of surface lignite mining, extensive of fields and forests and some human settlements have disappeared. On the other hand, novel landscape elements have been formed: spoil banks extending over large areas of ground. These new formations consist of the original rock cover over lignite seams, predominantly grey Miocene clays with a variety of admixtures. The spoil banks are either left to their natural development or are recultivated in different ways. Soon after they have been heaped up a process of their colonization by vegetation and animals — a process of succession — begins. New niches open upon them and are gradually filled up by various species of organisms. In the course of their development the spoil banks pass through a various stages of succession that represent ever new living conditions for plants and animals communities. Is the development of organismal communities upon these spoil banks going to proceed in the same direction as in their surroundings, or will they present quite distinct situations? This is one of the many questions that await an answer in this type of place, the Most basin not excluded. The present study should contribute, in its scope, to the reply to this question.

As model organisms, small rodents and their helminth fauna have been chosen. It is of advantage that rodents and their helminths have been throughly dealt with both in Czechoslowak and foreign literature. Moreover, small rodents are at present tested as a possible bioindicator of the condition and changes of the environment (Paukert 1982, Hejlková et al. 1983, Bejček et al. 1982, etc.).

The problems of the helminthofauna of small rodents have been studied more systematically both in Czechoslovakia and abroad since the half of this century. There were investigated the questions of both faunistical (Erhardová, Ryšavý 1955, Holišová, Kočiš 1955, Furmaga 1957, Žarnowski 1960, Chiríac, Barbu 1962 etc.) and faunistically ecological character (Tenora 1967a, b, Prokopič 1970 a, b, 1971, 1972 a, Gabriel 1971, Lewis 1968 a, b, Popescu et al. 1974 Tokobaev 1976, Mas-Coma 1976, 1978, Kovalčuk 1979, Feliu 1980 etc.). The authors investigated the differences in the composition of helminthofauna in rodents coming from various geographical conditions (Prokopič, Genov 1974) and from various biotopes (Kisielewska 1970 a, Prokopič 1972 b, 1973, Tenora et al. 1973, Tenora 1976 a etc.). Until now, however, nobody has paid attention to the studies of variances in the composition of helminthfauna in the process of migration of hosts from the original biotopes to the spoil banks after brown coal open-cast mining. Our work was therefore aimed as follows:

— To investigate within the boundaries of the territory under study the development of the specific composition of intestinal helminthofauna of small rodents during the process of colonisation of spoil banks by these hosts.

— To compare the qualitative composition of the intestinal helminthofauna on the spoil banks and in sites outside them.

MATERIAL AND METHODS

In total, 1,497 specimens of small rodents caught in the course of 1979—1980 in five localities in the Most basin were investigated. They belonged to the following species: *Clethrionomys glareolus* (Pallas, 1779) — 217 specimens, *Microtus arvalis* (Pallas, 1779) — 513 specimens, *Apodemus sylvaticus* (Melchior, 1834) — 767 specimens. There were found 42,204 intestinal helminths belonging to 16 species. 1,119 specimens of them belonged to tapeworms, 41,053 to nematodes, 13 to trematodes.

The small rodents were caught once a month simultaneously in all localities under study. For catching the snap traps of common type were used. The individuals caught were dissected, their digestive tracts were taken out and put into test tubes with 80 % ethylalcohol. The material fixed in this way was preserved in a refrigerator until the time of elaboration. The digestive tracts were then taken out from the fixation liquid and inspected in the common helmintological way. The helminths found were counted and further processed for determination. Some nematodes, before determined, were made transparent in a mixture (1 : 5) of glycerine and water (genera *Heligmosomoides*, *Aonchotheca*), others were embedded in chloralhydrate medium according to Novák et al. (1969) (genera *Heligmosomum*, *Syphacia*, *Trichocephalus*, *Aspiculuris*). The tapeworms were stained with borax-carmine and embedded in Canada balsam. In the cases where the number of helminths belonging to one genus did not exceed 20 individuals in one host, all individuals were determined. If the number of helminths belonging to one genus exceeded 20, 20 individuals were chosen at random for the determination to species. In the case that all these individuals belonged to the same species, all the other individuals undetermined were added to the same species. The helminths were determined according to the following sources: nematodes — Ryžikov et al. (1979), Tenora, Meszáros 1975, Tenora 1980b, ;tapeworms and flukes — Ryžikov et al. 1978, Baer, Tenora 1970, Tenora, Murai 1980.

The helminthofauna was evaluated in the rodents from five localities situated in three development stages of spoil banks, from a natural wood and from a mixed locality, which arose by joining of four catching sites outside the spoil banks. The localities were chosen so as to include the typical biotopes for individual host species, and their distance from the spoil banks under study was as short as possible.

To compare the helminth fauna of hosts at the different localities, the following quantitative characteristics of invasion were used: extensity of invasion (EI), or the percentage of infested host individuals out of the total captured; mean intensity of invasion (MI), or the mean helminth count per invaded host; relative density (RD), or the mean helminth count per host trapped; dominance (Do), or the percentage amount of specimens of one species out of the total number of helminths.

In this study the 1979 and 1980 results were evaluated together. This combination furnished richer material for each locality and thus contributed to a greather representativeness of the comparisons made. To discover of species diversity of intestinal helminhofauna was used Shannon index (Odum 1977, Rejmánek 1973)

$$H' = -\frac{N_i}{N}\log_2\frac{N_i}{N}$$

N_i — number of helminths of one species;
N — number of all heminths
To discover of species equitability was used equitability index:

$$E = \frac{H'}{\log_2 S}$$

H' — Shannon index
S — number of species

Description of localities studied

Small rodents were trapped in the following localities:

Locality I: Forest of Osek

Trapping areas were selected in a part of the forest that can be characterized as an acidophilic oak stand. The herbaceous story coverage amounts to 80 %, shrubbery about 40 % and forest vegetation 90 %. The estimated age is 150 years.

Locality II: A combined locality made up of the following four trapping sites (see Material and methods)

a) The vicinity of brook near the village of Libkovice, specifically the banks of brook carrying trees (willows, alders etc.) and shrubs (golden elder) typical of a flooded forest area. The herbaceous story consist of nettles and grasses and gives a coverage of 0—100 %.

b) A meadow near Libkovice: a hayfield situated between agricultural fields on a gentle slope some 200 m distant from the previous trapping sites. On one side it is bounded by a broad balk carrying morello cherries and hip-rose shrubs. The herbaceous amounts up to 100 %.

c) A meadow near the village of Černice: a hayfield among agricultural fields, on one side bounded by a thin small wood, some 600 m distant from the foot of Albrechtice spoil bank (=locality IV). The herbaceous story coverage is more or less 100 %.

d) A meadow near the village of Mariánské Radčice: a hayfield bounded by a shrub belt on one side, a march on another and the body of the Růžodolská spoil bank (= locality III). The herbaceous cover reaches 100 %.

Locality III: Růžodolská spoil bank (Fig. 1, 2)

The spoil bank occupies over 700 ha. It possesses a patchy vegetation, which especially in depressions includes many species. The vegetation coverage was 10—50 % at the time of the study. Age of areas under observation: 2—6 years after dumping.

Locality IV: Albrechtická spoil bank (Fig. 3)

Area about 300 ha. The spoil bank is under going natural (spontaneous) development. Its vegetation mainly consist of thick grasses with a predominance of *Calamagrostis epigeios* and *Agropyron repens*. The herbaceous story coverage is up to 100 %. In some places there are trees growing singly or in small groups (birch, maple, morello cherry, elder etc.). The age of the dump is 25 years.

Locality IV: Kopistská spoil bank (Fig. 4)
Area about 300 ha. Rodents were trapped in afforested (recultivated) places. The herbaceous story coverage is 50—90 % and consist of reed grass (*Calamagrostis epigeios*) and other herb species. The shrubby story coverage is 10—50 % and in its younger portion the story mainly consist of young planted trees (alder, ash, maple, polar, aspen). The older parts of the spoil bank surface already carry a forest story with a coverage of up to 90 %. Trapping-site age was 8 years (younger part) to 20 years (older part) after afforestation.

Section through succession of vegetation and hosts

The colonisation of newly formed spoil banks by plants and animals initially proceeds in a very atormy manner. During the first to fourth year the vegetation species are highly varied and the coverage is thin (about 5 %). Right from the beginning of this stage the spoil banks are visited by individuals of the first invasive species, *Apodemus sylvaticus*. In the third and fourth year the first signs of population stability occur (females at advanced stage of pregnancy or lactating). After the fourth or fifth year the vegetation begins to be characterized chiefly by tall herbs (*Atriplex nitens*, family Asteracae). Coverage increases up to 60 %. There also begin to occur accessory patches of grasses, in which the first represetatives of the second invasive species, *Microtus arvalis*, can be cought. More or less stable populations of this rodents begin to form in harmony with the development of the grassy communities by the end of the eight year Under natural development of a spoil bank, some 20 years after its heaping up persistent grasses (*Calamagrostis epigeios, Agropyron repens* etc.) become the predominant vegetation, but there is also a sparse growth of woody plants (*Sambucus nigra, Betula* sp. etc). A characteristic feature of such biotopes are populations of *Microtus arvalis*, which forms the dominant compont of small-rodent cenoses. *Apodemus sylvaticus* is prevalent on a much lesser scalle. During these stages of natural development woody plants exert no essential influence on the coverage of the herbaceous story. An essentially different picture presents itself if there has been afforestation. Planting of trees is followed in less than 20 years by closure of the shrubby and forest stories and some measure of liquidation of herbage Planted are mainly decidous trees such as ash, maple, poplar etc. Such afforested spoil banks exhibit highly varied biotopes that permit the habitation of some further small-rodent species. *Microtus arvalis* populations are gradually reduced, while the value of *A. sylvaticus* domination increases and the typical forest species of *Clethrionomys glareolus* makes its appearance (Bejček 1981).

RESULTS

The development of helminthofauna in individual host species

Clethrionomys glareolus (Table 1, 4)

This species was investigated in three types of localities: in a natural forest (locality I), along a water course (spreading corridor of this species — locality II), and on a spoil bank reclaimed by afforestation (locality V).

In the natural forest only four nematode species are to be found. The markedly infestation extensity shows the species *A. annulosa* (56 %). Four times less individuals were infested by *H. laevis* (Table 4). The list of species is supplemented by *T. muris* and *H. polygyrus* found in several host specimens only. In the surroundings of the water course 5 nematode species and 2 tapeworm species were found. In the nematode *A. annulosa* a relativelly high value of invasion extensity (11 %) is still observed, a higher value was found only in *A .tetraptera* (13 %). In comparison with the natural forest, the following species occur here in addition: *S. petrusewiczi, S. stroma* and *H. costellatum*. More host individuals were infested by the tapeworm *P. blanchardi* (4 %) than by

Tab. 1. Species composition of the helminthofauna of *Clethrionomys glareolus*

Species	No animals	No invaded	No helminths	All localities total			
				EI	MI	RD	Do
Heligmosomoides laevis	217	9	26	4	2.9	0.1	2
Heligmosomoides polygyrus	217	3	17	1	5.7	0.08	1
Heligmosomum costellatum	217	1	1	0.5	1.0	0.01	
Aonchotheca annulosa	217	39	1047	18	26.8	4.8	87
Syphacia petrusewici	217	5	81	2	16.2	0.4	7
Syphacia stroma	217	3	5	1	1.7	0.02	
Aspiculuris tetraptera	217	9	11	4	1.2	0.05	1
Trichocephalus muris	217	16	21	7	1.3	0.1	2
Anoplocephaloides dentata	217	10	17	5	1.7	0.08	21
Paranoplocephala omphalodes	217	26	56	12	2.2	0.3	69
Paranoplocephala blanchardi	217	5	8	2	1.6	0.04	10

P. omphalodes (2 %). Most nematode and tapeworm species, however, are to be found on the spoil bank reclaimed by afforestation. Six nematode species and three tapeworm species are to be found here. All nematode species para-

Tab. 4. Species composition of the helminthofauna of *Clethrionomys glareolus*

Species	No animals	No invaded	No helminths	All localities total			
				EI	MI	RD	Do
Locality I							
Heligmosomoides laevis	57	8	25	14	3.1	0.4	2
Heligmosomoides polygyrus	57	2	15	4	7.5	0.3	1
Aonchotheca annulosa	57	32	989	56	30.9	17.4	96
Trichocephalus muris	57	3	3	5	1.0	0.05	1
Locality II							
Heligmosomum costellatum	54	1	1	2	1.0	0,02	1
Aonchotheca annulosa	54	6	19	11	3.2	0.4	17
Syphacia petrusewici	54	4	76	7	19.0	1.4	70
Syphacia stroma	54	3	5	6	1.7	0.1	5
Aspiculuris tetraptera	54	7	8	13	1.1	0.1	7
Paranoplocephala omphalodes	54	1	1	2	1.0	0.02	17
Paranoplocephala blanchardi	54	2	5	4	2.5	0.1	83
Locality V							
Heligmosomoides laevis	106	1	1	1	1.0	0.01	1
Heligmosomoides polygyrus	106	1	2	1	2.0	0.02	3
Aonchotheca annulosa	106	1	39	1	39.0	0.4	57
Syphacia petrusewici	106	1	5	1	5.0	0.05	7
Aspiculuris tetraptera	106	2	3	2	1.5	0.03	4
Trichocephalus muris	106	13	18	12	1.4	0.2	26
Anoplocephaloides dentata	106	10	17	9	1.7	0.02	23
Paranoplocephala omphalodes	106	25	55	24	2.2	0.5	73
Paranoplocephala blanchardi	106	3	3	3	1.0	0.03	4

siting in the bank vole in both foregoing localities occur here, only with exception of *S. stroma*. Most host individuals infested by *T. muris* (12 %). The other nematode species were found mostly in one host specimen only. The tapeworm species *P. omphalodes* and *P. blanchardi* we observed in the bank vole in the surroundings of the water course. Here, on afforested spoil bank, the helminthofauna of tapeworms is still enriched with the species *A. dentata*. Most host individuals were infested with *P. omphalodes* (24 %), less frequent was the infestation with *A. dentata* (9 %) and *P. blanchardi* (Table 4).

The species diversity index of intestinal helminths showed the lowest value in the individuals caught in the natural forest (H' = 0,304), in the surrounding of the water course the value of the index was five time highers (H' = 1,590). A further increase of the index value was to be seen on the spoil bank reclaimed by afforestation (N' = 2,324). An analogous trend is also to be observed in the species evenness index, where in the natural forest E = 0,152, in the surroundings of brook E = 0,566 and on the afforested spoil bank E = 0,774.

Microtus arvalis (Table 2, 5)

This species was studied in four types of localities: meadow outside the spoil bank (locality II), freshly heaped spoil bank (locality III), spoil bank ofter 25 years of natural development (locality IV), and spoil bank reclaimed by afforestation (locality V).

In the meadow biotopes outside the spoil bank six nematode species — which is the highest number of all localities under study — and two tapeworm species were found. The highest extensity of infestation among the nematodes was observed in *H. costellatum* (50 %), a half value is achieved in *H. laevis* (27 %). With the other nematode species rather less hosts were infested (Table 5). As regards the tapeworms, more hosts were infested with *A. dentata* (27 %) than with *P. omphalodes* (16 %). On the freshly heaped spoil bank almost the same species spectrum of both nematodes and tapeworms as in the meadow biotopes outside the spoil bank was found. Only the species *A. annulosa* and *S. stroma*

Tab. 2. Species composition of the helminthofauna of *Microtus arvalis*

Species	No animals	No invaded	No helminths	All localities total			
				EI	MI	RD	Do
Heligmosomoides laevis	513	103	413	20	4.0	0.8	20
Heligmosomoides polygyrus	513	2	76	0.4	38.0	0.1	4
Heligmosomum costellatum	513	144	1014	28	7.0	2.0	49
Aonchotheca annulosa	513	2	5	0.4	2.5	0.01	0.5
Syphacia nigeriana	513	20	335	4	16.8	0.7	16
Syphacia stroma	513	1	3	0.2	1.5	0.01	0.5
Aspiculuris tetraptera	513	18	168	4	9.3	0.3	7
Trichocephalus muris	513	36	70	7	1.9	0.1	3
Anoplocephaloides dentata	513	156	449	30	2.9	0.9	53
Paranoplocephala omphalodes	513	120	322	23	2.7	0.6	38
Paranoplocephala blanchardi	513	17	67	3	3.9	0.1	8
Rodentolepis asymetrica	513	1	3	0.2	1.5	0.01	1

Tab. 5a. Species composition of the helminthofauna of *Microtus arvalis*

Species	No animals	No invaded	No helminths	All localities total			
				EI	MI	RD	Do
Locality II							
Heligmosomoides laevis	213	57	237	27	4.2	1.1	14
Heligmosomum costellatum	213	107	954	50	8.9	4.5	58
Aonchotheca annulosa	213	2	5	1	2.5	0.02	0.5
Syphacia nigeriana	213	11	297	5	27.0	1.4	18
Syphacia stroma	213	1	3	0.5	3.0	0.01	0.5
Aspiculuris tetraptera	213	12	107	6	8.9	0.5	7
Trichocephalus muris	213	14	38	7	2.7	0.2	2
Anoplocephaloides dentata	213	58	128	27	2.2	0.6	67
Paranoplocephala omphalodes	213	34	63	16	1.9	0.3	33
Locality III							
Heligmosomoides laevis	37	13	53	35	4.1	1.4	18
Heligmosomoides polygyrus	37	2	76	5	38.0	2.1	26
Heligmosomum costellatum	37	13	60	35	4.6	1.6	21
Syphacia nigeriana	37	9	38	24	4.2	1.0	13
Aspiculuris tetraptera	37	5	60	14	12.0	1.6	21
Trichocephalus muris	37	2	2	5	1.0	0.05	1
Anoplocephaloides dentata	37	6	20	16	3.3	0.5	63
Paranoplocephala omphalodes	37	9	12	24	1.3	0.3	37

were lacking; on the other hand, *H. polygyrus* acceded. Most host individuals were equally as in the surrounding meadow biotopes — infested with the nematode *H. costellatum* (35 %); the same value, however, also *H. laevis* achie-

Tab. 5b. Species composition of the helmintofauna of *Microtus arvalis*

Species	No animals	No invaded	No helminths	All localities total			
				EI	MI	RD	Do
Locality IV							
Heligmosomoides laevis	174	30	119	17	4.0	0.7	84
Trichocephalus muris	174	14	23	8	1.6	0.1	16
Anoplocephaloides dentata	174	48	113	28	2.4	0.6	30
Paranoplocephala omphalodes	174	56	192	32	3.4	1.1	51
Paranoplocephala blanchardi	174	17	67	10	3.9	0.4	18
Rodentolepis assymetrica	174	1	3	0.5	3.0	0.02	1
Locality V							
Heligmosomoides laevis	89	3	4	3	1.3	0.04	33
Aspiculuris tetraptera	89	1	1	1	1.0	0.01	8
Trichocephalus muris	89	6	7	7	1.2	0.08	59
Anoplocephaloides dentata	89	44	188	49	4.3	2.1	77
Paranoplocephala omphalodes	89	21	55	24	2.6	0.6	23

ves here. More host individuals than in the meadows outside the spoil bank were infested with *S. nigeriana* (24 %), less frequently were the hosts infested with the other nematode species (Table 5). On this spoil bank, in contradistinction to the meadow biotopes, more host individuals were infested with the tapeworm *P. omphalodes* (24 %) than with *A. dentata* (16 %). A radical change of the species spectrum has taken place on the spoil bank after 25 years of natural development. Of the originally seven nematode species, only two have remained here. On the contrary, the number of tapeworm species has increased from original two to four. Of the two nematode species, more host individuals were infested with *H. laevis* (17 %) than with *T. muris* (8 %). As regards the tapeworms, the highest intensity of infestation was found, analogously as on the freshly heaped spoil bank, for the species *P. omphalodes* (32 %), lower again for *A. dentata* (28 %). The further tapeworm species occurred less frequently (Table 5). On the spoil bank reclaimed by afforestation only one nematode species more was found in comparison with the spoil bank with the natural development. Of the tapeworms only two species occured here, like in two localities mentioned before (localities II, III). With nematodes only few host individuals were infested. The highest extensity of infestation was found for *T. muris* (7 %). More host individuals were infested with the tapeworm *A. dentata* (49 %) than with *P. omphalodes* (24 %) – an analogous situation like in the meadow biotopes surrounding the spoil banks.

The species diversity index of intestinal helminths achieved in the meadow biotopes outside the spoil banks a relativelly high value (H' = 2,122), which on the freshly spoil bank rose even more to the highest value found (H' = 2,655) and on the spoil bank with natural development it sank again to the level of value of the meadow biotopes (H' = 2,118). The lowest value of species diversity was found on the spoil bank reclaimed by afforestation (N' = 1,070). A similar trends was also noted in the species evenness index. In the meadow outside the spoil banks we registered the value E = 0,669, on the freshly heaped spoil bank E = 0,885, on the spoil bank with natural development E = 0,819 and on the spoil bank reclaimed by afforestation E = 0,461.

Apodemus sylvaticus (Table 3, 6)

This species was studied in five types of localities: in the natural forest (locality I), along the water course (locality II), on the freshly heaped spoil bank (locality III), on the spoil bank after 25 years of natural development (locality IV) and on the spoil bank reclaimed by afforestation (locality V).

In the natural forest only four nematode species were found; of them the highest extensity of infestation showed *H. polygyrus* (52 %), a little less *A. annulosa* (42 %). The other two species were found in one host individual only. Along the water course and in the meadow biotopes also four nematode species and one tapeworm species were found. Most host individuals were infested again with the nematode *H. polygyrus* (71 %), which was in the natural forest found only in one host individual. On the contrary, the species *A. annulosa* was found here in two host individuals only, whereas in the natural forest it occupied the second place. In the same number of host individuals (2 specimens) the nematode *T. muris* was found, whereas *S. frederici* was not found here. As a new species the tapeworm *R. fraterna* appeared. In the hosts on the freshly heaped spoil bank the same species spectrum of nematodes is to be seen as in

Tab. 3. Species composition of the helminthofauna of *Apodemus sylvaticus*

Species	No animals	No invaded	No helminths	All localities total			
				EI	MI	RD	Do
Heligmosomoides polygyrus	767	593	27413	77	46.2	35.7	72
Aonchotheca annulosa	767	18	995	2	55.6	1.3	3
Syphacia frederici	767	66	2930	9	29.9	3.8	8
Syphacia stroma	767	98	6434	13	65.7	8.4	17
Trichocephalus muris	767	2	4	0.2	2.0)	0.01	
Anoplocephaloides dentata	767	16	27	2	1.7	0.04	14
Paranoplocephala omphalodes	767	5	5	0.7	1.0	0.01	3
Rodentolepis assymetrica	767	1	1	0.1		1.0	0
Rodentolepis fraterna	767	25	164	3	6.6	0.2	83
Plagiorchis sp.	767	4	16	0.5	4.0	0.02	100

the natural forest, i. e. four species and in addition the tapeworm *R. fraterna* as in the meadow biotopes outside the spoil banks. On the freshly heaped spoil bank only one species occurs more frequently, see *H. polygyrus* (82 %), whereas the other three species along with *R. fraterna* only in a few host individuals were found (Table 6). In a single host individuals the trematodes *Plagiorchis*

Tab. 6a. Species composition of the helmintofauna of *Apodemus sylvaticus*

Species	No animals	No invaded	No helminths	All localities total			
				EI	MI	RD	Do
Locality I							
Heligmosomoides polygyrus	31	16	247	52	15.4	8.0	20
Aonchotheca annulosa	31	13	989	42	76.1	31.9	78
Syphacia frederici	31	1	2	3	2.0	0.06	
Syphacia stroma	31	1	28	3	28.0	0.9	2
Locality II							
Heligmosomoides polygyrus	117	83	3452	71	41.6	29.5	38
Aonchotheca annulosa	117	2	2	2	1.0	0.02	
Syphacia stroma	117	78	5678	67	72.8	48.5	62
Trichocephalus muris	117	2	4	2	2.0	0.03	
Rodentolepis fraterna	117	17	145	15	8.5	1.2	100
Locality III							
Heligmosomoides polygyrus	320	263	12977	82	49.3	40.6	95
Aonchotheca annulosa	320	1	1	0.2	1.0	0.01	
Syphacia frederici	320	7	82	2.0	11.7	0.3	1
Syphacia stroma	320	12	609	4	50.8	1.9	4
Rodentolepis fraterna	320	8	19	3	2.4	0.06	100
Plagiorchis sp.	320	1	4	0.3	4.0	0.01	100

Tab. 6b. Species composition of the helminthofauna of *Apodemus sylvaticus*

Species	No animals	No invaded	No helminths	All localities total			
				EI	MI	RD	Do
Locality IV							
Heligmosomoides polygyrus	71	49	2113	69	43.1	29.8	100
Anoplohaloides dentata	71	9	16	13	1.8	0.2	89
Paranoplocephala omphalodes	71	1	1	1	1.0	0.01	5
Rodentolepis assymetrica	71	1	1	1	1.0	0.01	6
Locality V							
Heligmosomoides polygyrus	228	182	8624	80	47.4	37.8	74
Aonchotheca annulosa	228	2	3	1	1.5	0.01	
Syphacia frederici	228	57	2846	25	49.9	12.5	24
Syphacia stroma	228	7	119	3	17.0	0.5	2
Anoplocephaloides dentata	228	7	11	3	1.6	0.05	73
Paranoplocephala omphalodes	228	4	4	2	10.	0.01	27
Plagiorchis sp.	228	3	12	1	4.0	0.05	100

sp were found. On the spoil bank after 25 years of natural development no other nematode species occur any more besides *H. polygyrus*, which was regularly found in a rather high percentage of host individuals (69 %). On the other hand, three species of tapeworms are to be found which did not occur in *Apodemus sylvaticus* caught in the previous localities. In the highest percentage (13 %) the host individuals were infested with *A. dentata*. A quite different picture presents the helminthofauna of the host on the spoil bank reclaimed by afforestation. The highest number of species of intestinal helminths occurs here. There are present four nematode species (known from the natural forest), two tapeworm species we met in this host species on the naturally developing spoil bank; furthemore, in three host individuals the trematode *Plagiorchis* sp. were found, which occured also on the freshly heaped spoil bank. The highest extensities of infestation with nematodes were found for the species *H. polygyrus* (80 %) and *S. frederici* (25 %). More host species (3 %) were infested with *A .dentata* than with *P. omphalodes* (2 %).

The species diversity index of intestinal helminths in the natural forest showed a relativelly high value (H' = 0,877), in the surroundings of the water course it achieved the highest value found (H' = 1,067), on the freshly heaped spoil bank its value sank to one third (H'=0,325). After 25 years of the natural development of the spoil bank, the species diversity index was lowest of all localities at all (H' = 0,080). On the contrary, on the spoil bank reclaimed by afforestation the second highest value of the index was found. *A. similar* trend may be observed in the species evenness index, too: in the natural forest the value E = 0,439, in the surroundings of the water course E = 0,460, on the freshly heaped spoil bank E=0,126, on the naturally developing spoil bank E=0,040, and on the spoil bank reclaimed by afforestation E=0,323 was found.

DISCUSSION

In the course of migration of small mammals onto the spoil banks the species spectrum of intestinal helminths and the percentual representation of individual helminth species are subject to changes. After the migration of host onto the freshly heaped spoil bank we noted the extinction of more rare helminth species. In the hosts only those species remained in the hosts outside the spoil banks occured with a higher extensity. A similar phenomenon was recorded by Kisielewska (1970 a) after transfer of individuals of *C. glareolus* on an island in the Mazurskie Lake System. After the introduction of the bank voles on the island the changes in the percentual representation of individual species of helminths took place. An analogous fact we noticed also in the region of Most in *M. arvalis* and *A. sylvaticus* after the migration of animals on a freshly heaped spoil bank (Tables 5, 6). During the development of the spoil bank a radical transformation of helminthofauna of the species under study took place. Some nematode species disappeared gradually, others appeared to a greater extent (*T. muris*). On the spoil banks we found a higher percentage of hosts infested with tapeworms belonging especially to fam. Anoplocephalidae, and finally we met here a heminthofauna which was quite different from that found in the hosts caught outside the spoil banks. For example, in *M. arvalis* we found in the localities outside the spoil banks a similar helminthofauna as it was found in the whole territory of Europe. (Tenora, Meszáros, Murai 1973), i. e. the nematode species with the majority of prevailing species *H. costellatum* and *S. nigeriana* are predominant. On the older spoil banks, on the contrary, the tapeworm species predominates and *H. costellatum* is totally missing. A typical phenomenon on the older spoil banks is the increased percentage of individuals of all hosts species infested with the tapeworms of the family Anoplacephalidae and with the nematode *T. muris*. In the introduction experiment made by Kisielewska an the lake island analogous facts were ascertained. In young individuals of *C. glareolus*, descendants of the parents introduced from the Bialowiezski virgin forest, an increase of the invasion extensity of the nematode *T. muris* and the tapeworm *C. pusila* also took place. The mentioned changes of the specific composition of helminthofauna depends on the biology of individual species of helminths. The occurrence of helminths may be influenced by a number of circumstances. e. g. by phenological characteristics of the host's habitat (Prokopič 1972 b), by the occurrence of contingent intermediate hosts (Prokopič 1972 a), or by the population pecularities of the host species (Kisielewska et all 1973, Kisielewska, Zubczewska 1973). A certain part play here doubtlessly the interspecific competition of individual nematode species in the hosts, too, (Baba 1974, Kisielewska 1970 a, Courtney, Forrester 1973).

The commonly used interpretation of Shannon's species diversity index and species evenness index (Rejmánek 1973, Odum 1977), by which the higher value of both indexes indicates the better balanced ecosystem, was applied in the evaluation of the intestinal helminthofauna. As both indexes have been used for the first time for the evalution of helminthofauna and their interpretation is not quite clear, the results in this respect are to be regarded for the present time as methodically-orientating ones only. In *C. glareolus* the highest values of both indexes were found for the spoil bank reclaimed by afforestation, i. e. they are higher than in the natural forest. The environment of this spoil bank is apparently so much variable and with a number of ecotones that it enables the development of a wider spectrum of helminth species than in the natural forest. Moreover, in the case of the spoil bank reclaimed by afforestation a succession stage is involved, where the species diversity often is higher than in the climax stage (Odum 1977). In *M. arvalis* the values of both indexes for the three localities under study (II, III, IV) are on a high level. A half value was found only for the spoil bank reclaimed by afforestation. This low values of species diversity and species evenness indexes may bear upon the successive reduction of optimum biotope of *M. arvalis* and upon the total rearrangement of the helminthofauna of this species in comparison with the other localities. In *A. sylvaticus* the highest values of both indexes are to be found in the localities which offer favourable life conditions for the host species (surroundings of the water course, natural forest, afforested spoil bank). On the other hand, the low values of diversity and evenness indexes were found for the spoil bank after 25 years of natural development (with the biotopes of grassy steppe type) and the freshly heaped spoil bank. *A. sylvaticus* is a species demanding the biotopes with a disconnected herb vegetation (Zejda 1965), while on the naturally developing spoil bank after 25 years a prevailingly continuous stand of perennial grasses is to be met. On the freshly heaped spoil bank in the time of migration of *A. sylvaticus* there exist extreme conditions characterized by sporadically occurring vegetation and by specefic microclimatic conditions different from any other biotopes. When the results obtained are taken into deliberation, one of the possible interpretations of the species diversity and species evenness indexes, as used in the evaluation of helminthofauna, offers itself. The higher value of both indexes might indicate a higher optimality degree of life conditions not only for the helminths themselves, but for their hosts, too.

It was found that on the older spoil banks a higher number of tapeworm species in the hosts occurred than in the localities outside the spoil banks. Also the quantitative characteristics of tapeworm invasions on the older spoil banks were higher than in the localities outside the spoil banks (Jirouš, in press). In all host species it was caused by the increased number of infestation of tapeworms of the family Anoplocephalidae, whose development passes through the intermediate hosts — springtails (Collembola) or soil mites (Smirnova, Kontrimavičus 1977, Ryžikov et al. 1978). With regard to these facts, the occurrence of intermediate hosts enabled by favourable life conditions may be considered one of the factors limiting the existence of infestations with these tapeworms. The existence of different life conditions on the spoil banks and in the areas outside them is suggested hereby (Jirouš, in press).

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The figures 1—4 will be found at the end of this issue.

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USE OF GROWTH PARAMETERS IN LABEO ROHITA (PISCES, CYPRINIDAE)

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Abstract. In *Labeo rohita* (Hamilton), one of the Indian major carps, some growth parameters, such as the growth characteristics, growth constant, specific rate of the linear growth and of the weight increase, index of species average size and of the population weigth, growth intensity and annual rate of the increment, was studied. It has been observed former conclusions based on the annual increment only often led in the past to the incomplete interpretation in growth studies.

INTRODUCTION

In India and abroad scales and other hard parts such as otoliths, vertebrae, cleithra and dorsal spines have been employed for age determination and back-calculated lengths. In India such studies are not very common. Indian workers (Natarajan and Jhingran, 1963; Kamal, 1969; Hanumantharao, 1974; Pathani, 1981) restricted their studies only upto the back-calculated lengths. It is felt that the complex phenomenon of growth in fishes in more understandable if other growth parameters such as growth characteristic, growth constant, specific rate of linear growth, specific rate of weight increase, index of species average size and index population weight growth intensity are also studied.

MATERIAL AND METHODS

For the purpose of present studies 1181 scale samples of *Labeo rohita* (Hamilton) were collected from Gobindsagar (Longitude 76°20′ E; latitude 31°10′ N), river Ghagger at Rang Mahal (longitude 73°54′ E; latitude 29°18′ N) and Harike (longitude 74°57′ E; latitude 31°10′ 15″ N) during the years 1979—1981. 3—4 scales were removed from the lateral side below the dorsal fin, above the lateral line from the second or third row of scales. Scales were kept in the ordinary envelops with the following covering data: total and standard lengths with the accuracy of ±1 mm and weight in gm. The scales were brought to the laboratory for detailed studies. Extraneous matter and mucus from the scales were removed by washing them in tap water and rubbing between the finger tips. Scales were studied in dry mounts using VEB microfilm reader with the magnification of 10.5X. The following formulae were used for back-calculations, growth characteristis (C_{th}), growth constant (C_{lt}), specific rate of linear growth (C_l), specific rate of weight increase (C_w), index of species average size (φh) and index of population weight growth intensity (φC_w).

For back-calculations:

$$l_n - a = \frac{S_n}{S} \cdot (l - a)$$

where

l_n = length of the fish when annulus 'n' was formed,
l = length of the fish at the time of capture.
S_n = radius of annulus 'n' (at fish length l_n).

S = total scale radius.
a = constant (correction factor).

$$C_{th} = \frac{\log l_n - \log l_{n-1}}{0.4343} \cdot l_{n-1}$$ (Chugunova, 1963)

$$C_{lt} = \frac{\log l_n - \log l_{n-1}}{0.4343} \cdot \frac{t_2 + t_1}{2}$$ (Chugunova, 1963)

$$C_l = \frac{l_n - l_{n-1}}{l_{n-1}} \cdot 100$$ (Chugunova, 1963)

$$C_w = \frac{W_n - W_{n-1}}{W_{n-1}} \cdot 100$$

$$\varphi h = \frac{\sum_{h=1}^{n_j+a} h}{n_j + a}$$ **(Balon, 1971)**

$$\varphi C_w = \frac{\sum_{C_w=1}^{n_j+a} C_w}{n_j + a}$$ **(Balon, 1971)**

where

l_n, l_{n-1} = total length of fish at ultimate and penultimate ages
W_n, W_{n-1} = weight at ultimate and penultimate ages
j = juvenile
a = adult
h = absolute increase in length, t_2 and t_1 are time interval between ultimate and penultimate age classes.

For the calculation of growth constant, the earlier published data have also been used.

OBSERVATIONS AND DISCUSSION

In *Labeo rohita* from three water bodies viz., Gobindsagar, Rang Mahal and Harike the relationship between total length (X) and lateral scale radius (Y) has been found to be linear. High degree of positive correlation coefficient exists between these two parameters. The regression equation from each locality is given below:

$Y = a + bX$

Gobindsagar
$Y = 0.09 + 0.1606X$
$r = 0.9965$
$CF = 10$ mm.
$N = 246$

Rang Mahal
$Y = -0.4 + 0.1834X$
$r = 0.9995$
$CF = 14$ mm.
$N = 691$

Harike
$Y = -0.35 + 0.1695X$
$r = 0.9981$
$CF = 16$ mm.
$N = 244$

(r = coefficient of correlation, CF = correction factor, N = total number of specimens examined from each locality)

In tables 1—3, the back-calculated lengths in cm (L), annual increment in cm (h), annual increase in weight in gm (w), index of species average size (φh), index of po-

Tab. 1. Summary of growth data on *Labeo rohita* collected during the years 1979—81 from Gobindsagar

Parameters	Years of life							
	1	2	3	4	5	6	7	
L (cm)	23.96	40.43	53.37	63.81	70.23	75.20	78.39	
h	23.96	16.57	12.94	10.44	6.42	4.97	3.19	
φh				11.19				
C_1		68.74	32.00	19.56	10.60	7.08	4.24	X = 23.53
C_{th}		12.54	11.21	9.54	6.11	4.80	3.13	
		11.87				5.89		
W (gm)	163	814	1906	3299	4425	5457	6201	
w	163	651	1092	1393	1126	1032	744	
C_w	—	399	134	73	34	23	13	
φC_w				112.66				

pulation weight growth intensity (φC_w), specific rate of linear growth (C_1), specific rate of weight increase (C_w) and growth characteristic (C_{th}) are presented from Gobindsagar, Rang Mahal and Harike respectively. In table 4, the growth constant (C_{lt}) and average growth constants are given. For age determination and back-calculations the annulus formed in the months of June—July/August has been considered valid.

The annual length increment, specific rate of linear growth and specific rate of weight increase decrease with the increase in age from the localities under report. The phenomenon of growth compensation has been observed between the age classes 4—5 from Rang Mahal, 5—6 and 7—8 from Harike. Tandon and Johal (1983a, b) described this phenomenon in *Tor putitora* from Gobindsagar and in *Cirrhina mrigala* from different localities of India. Growth compensation takes place because of lack of competation and inefficiency of fishing gear with the availability of more food and space in the higher age classes.

The values index of species average size are very close to each other from three localities. The value of index of population weight growth intensity is higher from Gobindsagar as compared to those of Rang Mahal and Harike. Since, much variation has not been recorded in the number of age classes from three localities, it can be concluded on the basis of these two parameters that *Labeo rohita* from Gobindsagar has better population composition in terms of weight, because of the presence of 7 age classes as compared to 8 age classes from Rang Mahal and Harike. According to Balon (1968) these two parameters are useful to compare the growth of various shoals of a certain species, populations in various waters, various species living in common biotype. Higher the value of these two parameters, better the population composition in terms of length increment and weight and vice versa, as the value of these parameters is influenced by the number of age classes in a population.

The average values of growth characteristic are useful in determining the growth periods where the first ends and second begins (Balon, 1968). From the tables 1—3, it is evident from the sudden decrease in the value that this species enters the second period after third year. This observation proves that there is a regular growth pattern between the first and second periods. Chugunova (1963) also found regularities of growth by using growth characteristic in Russian Cyprinidae. She stated that for comparison of growth of different fish species and genera, the growth characteristic

Table 2. **Summary of growth data on *Labeo rohita* collected during the years 1979—81 from Rang Mahal**

Parameters	Years of life 1	2	3	4	5	6	7	8	
L (cm)	28.00	43.13	54.96	64.90	75.46	79.80	83.01	85.38	
h	28.00	15.13	11.83	9.94	10.56	4 34	3.21	2 37	
φ_h					10.67				
C_1		54.03	27.43	18.08	16.27	5.75	4.02	2.85	$X = 18.35$
C_{th}		12.10	10.45	9.14	9.79	4.22	3.14	2 33	
		11.27				5.72			
W (gm)	226	950	2125	3692	6092	7337	8362	9179	
w	226	724	1175	1567	2400	1245	1025	817	
C_w	—	320	123	74	65	20	14	10	
φCw					89.42				

for the second period is used, because this value changes little within one species furing this period even in different basins. The present observations are in conformity with those of **Chugunova** (1963). **Vasnetsov** (1958) described that the first period of growth characteristic varies considerably under the influence of external conditions and depends on the changes in the length of fish of different species, whereas second period characterizes the hereditary growth rates.

The study of growth constants (Table 4) of *Labeo rohita* shows that there are two phases of life in majority of the populations, whereas the population of this species from the riverine sources of Aligarh (**Khan** 1972) has three phases of life. According to **Chugunova** (1963) 'the study of growth constants has led to the discovery that majority of the fish populations show two phases of growth and some even three. Compairing these three phases with the life span of the fish, it becomes clear that first coincided with the sexual immaturity. The second includes the sexual maturity and third is the period of old age. Thus using the average growth constants, it become possible to distinguish the phases of growth for any species of fish'. In *Labeo rohita*, the fish attains sexual maturity by the end of first year or second year of life (**Khan**

Tab. 3. Summary of growth data on *Labeo rohita* collected during the years 1979—81 from Harike

Parameters	Years of life 1	2	3	4	5	6	7	8	
L (cm)	31.76	49.56	64 08	70.66	74 58	79.91	83.40	87.45	
h	31.76	17.80	14 52	6.58	3.92	5 33	3.49	4 05	
φ_h					10.93				
C_1		56.15	29 30	10.27	5.55	7.12	4 36	4 86	X =
C_{th}		14.13	12.73	6.27	3.81	5.15	3 42	3 89	16.80
		13.43				4.51			
W (gm)	354	1549	3631	5023	6004	7550	8701	10159	
w	354	1195	2082	1392	981	1546	1151	1458	
C_w	—	337	134	38	19	25	15	16	
φC_w					83.43				
K									

Tab. 4. Growth constants (C_{1t}) and average growth constants ($Av.C_{1t}$) of *Labeo rohita* from different localities of India

Age class	Riverine fishes of Aligarh*+ L (cm)	S_{1t}	$Av.C_{1t}$	Gobindsagar L (cm)	C_{1t}	$Av\ C_{1t}$	Rang Mahal L (cm)	C_{1t}	$Av.C_{1t}$	Harike L (cm)	C_{1t}	$Av.C_{1t}$
1	31.00			23.96			28.00			31.76		
		0.7166			0.7850			0.6483			0.6673	
2	50.00		0.5551	40 43			43.13		0.5058	49.56		0.5263
		0.3937			0.4165	0.4898		0.3633			0.3854	
3	65.00			53.37			54.96			64.08		
		0 1944			0.2680			0.2494			0.1468	
4	74.00		0.1339	63.81			64.90			70.66		
		0.1171			0.1437			0.2262			0.0808	
5	80.00			70 23			75.46		0.1321	74 58		0.0931
		0.0901			0.1026	0.1029		0.0839			0.1036	
6	85.00			75.20			79.80			79.91		
		0.0691			0.0625			0.0591			0.0642	
7	89.00			78.39			83.01			83.40		
		0.0497	0.0461					0.0421			0.0701	
8	92.00						85.38			87.45		
		0.0321										
9	94.00											
		0.0335										
10	96.00											

* Khan, 1972
\+ Without using correction factor

and **Jhingran**, 1975), and rarely in the third year of life (**Khan**, 1972). In *Labeo rohita* the phase extends upto 3rd year of life and rarely upto 4th year of life (which evidently includes the size at first maturity).

The average values of growth constant (Table 4) in *Labeo rohita* from different localities of India in the first phase varies from 0.4898–0.5551, second phase 0 0931–0.1339 and in the third phase it falls down to 0.0461. When the fish enters from first phase to the second and second to third the values of growth constant showed sudden decrease. In those water bodies i e. Gobindsagar, Rang Mahal and Harike, where there occur only two phases of life history, there is optimum rate of exploitation. In riverine populations of Aligarh, where the fish enters the third phase 'old age' — indicates that in this water body, the rate of exploitation is not optimum or the population of this phase are not vulnerable to the fishing gear or some immigration takes place. From fishery management point of view, fish should not enter the the third phase i.e. 'old age'.

The perusal of the literature reveals that that the study of growth parameters has not been reported to in Indian species. Hence, if systematic attempt is made, an accurate picture of complex phenomenon of growth of fish can be drawn, which will be useful in rational exploitation.

SUMMARY

The various growth parameters such as growth characteristic, growth constant, specific rate of linear growth, specific rate of weight increase, index of species average size and index of population weight growth intensity of *Labeo rohita* (Hamilton) from Gobindsagar, Rang Mahal and Harike has been calculated. The annual rate of increment, specific rate of linear growth and specific rate of weight increase, decrease with the increase in age. The phenomenon of growth compensation has been observed between the age classes 4–5 from Rang Mahal, and 5–6, 7–8 from Harike. The values of index of species average size and index of population weight growth intensity are influenced by the total number of age classes in a population. The sudden decline in the value of growth characteristic indicated that *Labeo rohita* in the third year of life enters into the second period of growth from the first period of growth. This growth parameter proved that there occurs some regularities in the life history of the fish. The use of average growth constant has shown that majority of the fish populations of this species from most of the water bodies have two phases of life, and in the population from the riverine sources of Aligarh (Table 4) has three phases of life. The third phase of life is also termed as "old age". The occurrence of "old age" is related to the poor rate of exploitation.

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NOTE ON THE FEATHERBACK FISH OF THE GENUS NOTOPTERUS (PISCES, CLUPEIFORMES, NOTOPTERIDAE)

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Received May 14, 1984

Abstract. 12 specimens of the featherback or knife fish, *Notopterus chitala* (Hamilton) were examined with regard to 20 plastic and 3 meristic characters. All material was donated from aquarium hobbyists and originated from the import, the precise locality remained unknown.

MATERIAL AND METHODS

All measurements were made on formalin fish by means of dividers with the accuracy ±0.1 mm. Some characters, such as the number of spines (serrae) on the ventral margin of the belly and counts of rays and scales were made by the use of binocular microscope. All specimens were purchased to the Department by the courtesy of now anonymous aquarium hobbyists and were kept until their death in their tanks. Several persons helped in this way, especially Messrs. Chvojka, Habel, Petrovický, Polák and others. Thanks are due also to Dr. O. Oliva who offered me all the material being at disposal, showed me the keen interest during the course of this study and critically checked the typescript.

RESULTS AND DISCUSSION

Our results, compared with the data of Day (1878), Boulenger (1909), Weber and De Beaufort (1913), Smith (1945) and Johal and Tandon (1979), are summarized in the description. It is interesting, that specimens held in the aquaria of Czech hobbyists do not belong to the species *Notopterus afer* Günther, 1868, as it was presumed judging from the fact of simultaneous import of a small sample of African knife fish, *Xenomystus nigri* Günther, 1868, by Czech aquarists. Examined specimens belong to the South Asiatic species, *Notopterus chitala* (Hamilton, 1822).

From *Notopterus afer* they differ clearly by the possesing of 9–10 rays in the dorsal fin (the first one having only 6–7, Boulenger 1909), and by possesing of very short, rudimentary ventral fins, which are absent in *Notopterus afer*. According to Sterba (1959) *Notopterus afer* was imported into aquaria already in 1912, but it dissapeared apparently due to inpossibility to reproduce in tanks. The same fate had *Notopterus chitala*, imported later in 1934 and *Notopterus notopterus* (1933). The interesting spawning habits of these fishes were summarized by Smith (1945).

Description of examined specimens is as follows: 12 specimens of 53–109 (ave. 62.5) mm in total length and 48–105 (58.4) mm of body length were studied. In % of the total length: head 25–26 (25.4), depth (height) of body 19–24 (21), predorsal distance 45–55 (21.0), preanal distance 31–39 (35.0), body width 5–7 (5.7), P–A distance 10–17 (13.0), length of D 2–3 (2.4), depth of D 7–16 (12.0), length of A 62–70 (67), depth of A 5–8 (6.1). In % of the head length: preorbital distance 20–25 (22.0), eye diameter 15–24 (21), interorbital distance 16–23 (21), postorbital distance 56–65 (60), head depth 64–74 (68), head width 29–35 (32), maxilla's length 31–46 (40). Eye in interorbital distance 95–115 (102) % of the last, 76–110 (94.9) % of the legth of the snout, P length of the snout, P length 33–69 (55) % of the head length. Dorsal fin rays 9–10 (9.2), anal fin rays 105–137 (125). There is about 170–180 scales in the lateral line and 38–52 (49) spines (serrae) on the ridge along the median line of the belly.

There are some differences comparing our specimens with the description in literature. The maxillary is shorter, not extending in my small specimens very far beyond the orbit, as it is given in keys of Day (1878), Weber and De Beaufort (1913), Smith (1945), Johal and Tandon (1979). My specimens are slender than those described by Weber and De Beaufort (1913), but their head is larger, also the number of serrae is somewhat greater. Comparing my results with Day (1978) and Weber and De Beaufort (1913), my specimens show greater ranges in head length, body height, size of eye, rays in anal fin. Some plastic characters could be influenced by smaller size of my fish. The largest from my collection showed more typical appearance, especially with regard to the tendency to prolongation of the maxilla, than the smaller ones. Also the humplike dorsal profile in younger specimens is not so apparent as in the adult one (see Fig. 6 in Weber and De Beaufort, 1913). The origin of the dorsal fin is almost equidistant between posterior margin of caudal fin and the tip of snout (ave. 51, ranges 45–55 %), this is in agreement with description of Weber and De Beaufort (1913). Pectoral fins in our specimens have considerably larger ranges of their length than as it is given in description of Weber and De Beaufort (1913). Concerning coloration examined specimens show the same tendency to have cross bands as it was described and figured by Smith (1945), but on contrary, spots, typical for Siamese specimens, were not observed. Specimens from Indo-Australian archipelago are usually immaculated. Unspotted specimen is show in Fig. 52 in Sterba (1959), but a spotted specimen along the lower half of the body proclaimed as in the „juvenile coloration" is figured also in Sterba (1959). Thus specimens imported to Czechoslovakia originated from Indo-Australian region and not from Siam or Thailand.

The number of ventral spines (serrae) lies within ranges given in the literature but the diameter of the eye is of the same length as the snout, or the eye was found to be slightly smaller. Other meristic characters agree with literature data. Due to the small size the exact number of lateral line scales was not counted.

SUMMARY

12 specimens of the Indian knife fish, *Notopterus chitala* (Hamilton, 1822) were examined. The total length ranged from 53–109 (62.6) mm, the standard length 48–105 (48) mm. In the specimens examined maxilla is somewhat

shorter, greater ranges were found in the length of the head, body depth, size of the eye and in anal fin rays. They are also slender and their head is somewhat larger comparing literature data; the same concerns the number of serrae along the median line of the abdomen, which exceeds somewhat the number given in literature. Some differences in plastic characters may be due to their smaller size.

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MORPHOLOGISCHE VARIABILITÄT VON DREI ARTEN DER UKELEIE (ALBURNUS ALBURNUS, A. ALBIDUS, A. CHARUSINI) (PISCES: CYPRINIDAE)

Luděk LIŠKA und Karel PIVNIČKA

Received March 7, 1984

Abstract. The morphological variability of the bleak *Alburnus alburnus* (Linneacus, 1758) was studied with respect to the populations of two related species namely *Alburnus albidus* Costa, 1838 and *Alburnus charusini* Herzenstein, 1889. Using samples from 23 localities covering nearly the whole area of distribution of these species there were possible to distinguish two different groups of populations. The first of them occurs inside the original area of distribution of *Alburnus alburnus* and may be designated as *Alburnus alburnus alburnus*, the second one is from south and south-east localities from where the species *Alburnus albidus* and *Alburnus charusini* were described and is designated as *Alburnus alburnus albidus*.

EINLEITUNG

Der Ukelei ist eine weitere Art, deren morphologische Variabilität innerhalb des ganzen Verbreitungsareals bewertet wurde. Ebenso bewertet wurde z. B. die morphologisch Variabilität der Quappe (Pivnička, 1970), der Äsche (Pivnička, Hensel, 1976), der Plötze (Holčík, Skořepa, 1971), der Elritze (Řepa, Pivnička, 1980). Es väre möglich auf Grund dieser Arbeiten das Niveau der morphologischen Variabilität von Fischen verschiedener systematischer Gruppen aus verschieden umfangreichen Verbreitungsarealen abzuschatzen. Gemeinsam mit den Populationen des Ukeleis, welche eindeutig zu den Arten *Alburnus alburnus* (Berg 1932, 1949; Banarescu, 1964) gerechnet werden, wurden in dieser Arbeit auch morphologische Merkmale des Ukeleis aus dem Fluss Po und dem Ochridasee bewertet, welche zu der Art *Alburnus albidus* Costa, 1838 als ihre Unterart *Alburnus albidus alborella* (De Filippii, 1844) gereiht werden. Ausserdem wurden auch Populationen aus dem Ostkaukasus bewertet (den Flüssen Kura, Sulak, Safíd Rúd), welche als *Alburnus charusini* Herzenstein, 1889 beschrieben wurden.

Berücksichtigt wurden auch der Geschlechtsdimorphismus und die Wachstumsvariabilität und zwar so, dass Merkmale mit extremen Abweichungen unter den Geschlechtern, sowie auch unter den einzelnen Längsgruppen aus der Bewertung ausgeschieden wurden.

MATERIAL UND METHODIK

Diese Arbeit bewertet Angaben morphologischer Merkmale von 930 Ukeleien aus 23 Lokalitaten (Tab. Nr. 1). Angaben von Fischen, die von uns gemessen wurden, enthalt die Tab. Nr. 2, im ganzen 14 Lokalitäten. Es wurden folgende plastische Merkmale gemessen: longitudo corporis (Lc), longitudo capitis (lc), distantia praedorsalis (dpD), distantia postdorsalis (dpstD), minimum altitudo corporis (minac), maximum corporis (mac)), longitudo pedunculi caudae (lpc), altitudo pedunculi caudae (apc), longitudo pinnae dorsalis (ld), altitudo pinnae dorsalis (aD), longitudo pinnae analis (lA), altitudo pinnae (aA), longitudo pinnae pectoralis (lP), longitudo pinnae ventralis (lV), longitudo pinnae caudalis (lC), distantia inter pinnae pectoralis et ventralis (P–V), distantia inter pinnae ventralis et analis (V–A), diameter oculi (do), distantia praeorbitalis (dpo), distantia postorbitalis (dpso), altitudo capitis (ac). Es wurden weiter noch zwei meristische Merkmale berchnet: squmae lineae lateralis (11), radii dichotomi pinnae analis (A).

Der sexuelle Dimorfismus wurde an Fischen aus der Elbe festgestellt. Es wurden 34 weeibliche und 40 männliche Exemplare benutzt, das Geschlecht wurde mit Hilfe von Sektionen ermittelt. Die gegenseitige geschlechtliche Verschiedenheit wurde bei jeder Messung der Merkmale mit Hlife des CD Koeffizienten ermittelt. (Mayr, Lindsley, Usinger 1953, Hubbs und Hubbs 1953).

Bei ausgewählten plastischen Mekmalen (siehe weiter) wurde ihre Wachtumsvariäbilität bewertet, was zu entscheiden ermöglichte, ob die Unterschiede zwischen den Langegruppen derselben Lokalität Unterschiede zwischen Populationen verschiedener Lokalitaten nicht übersteigen. Die Wachstumsvariabilität wurde an Ukeleien aus der Elbe bei Brandýs nad Labem bewertet, und zwar im Rahmen der Langegruppen von 80 mm und 160 mm (welche als extreme Längegruppen betrachtet werden). Diese beiden Gruppen wurden als selbständige Auswahl bewertet und miteinander mittels des CD Koeffizienten verglichen. In allen Fallen, bei denen der Koeffizient den Wert 1,3 überschritt, wurde eine hohe Wachstumsvariabilität konstatiert. Falls man diese Merkmale zur weiteren Bewertung benutzte, wurden Populationen mit auffalend geringer Körperlänge (Olza), sowie die mit übermässig grosser Körperlänge ausgeschaltet (Batak).

Die geograpische Variabilität wurde bei Ukeleien aus 18 Lokalitäten bewertet. Alle diese Lokalitäten wurden miteinander in allen Mekmalen mittels des CD Koeffizienten systematisch jede mit jeder verglichen. Dabei wurden drei Stufen des CD Koeffizienten bewertet: $CD \geqq 1,3$, wo die verglichenen Populationen sich im gegebenen Merkmal voneinander in 90 % oder noch mehr unterscheiden; $1,3 > CD \geqq 1$, beide Populationen unterscheiden sich im gegebenen Merkmal in 84–90 % und $1 > CD \geqq 0,7$, beide Populationen sind in 76–84 % aller Falle verschieden. Zur entgültigen Gesamtbewertung wurden Merkmale gewahlt, welche die grösste Anzahl von Paaren mit $CD \geqq 1,3$ aufweisen bei Einhaltung der früher angeführten Kriterien (der geschlechtliche Dimorfismus und die Wachstumsvariabilitat).

Wir danken hiermit Dr. V. V. Barsukov von dem Zoologischen Institut der Akademie der Wissenschaften in Leningrad fur die eingesandten Exemplare von Ukeleren, fur das Verleihen von Fischen aus dem Čagan, dem Dněpr, aus der Talsperre Tsciskoe, den Flussen Oka, Vyčegda und Volga; dem Dr. P. Whitehead vom Britischen Museum in London fur Fische aus dem Fluss Themse, Dr. R. Quillier von der Landwirtschaftlichen Hochschule in Toulouse fur Fische aus dem Fluss Garonne, Dr. E. Tibaldi von der Universität in Mailand für Fische aus dem Fluss Po, Dr. T. Živkov von der Akademie der Wissenschaften in Sofia für Fische aus den Flüssen Jantra, Rosica und aus der Talsperre Batak. Wir danken auch dem Dr. J. Holčík fur seine kritischen Bemerkungen.

ERGEBNISSE

Die Wachstumsvariabilität der plastischen Merkmale wurde bei 94 Ukeleien, welche bei Brandýs nad Labem in der Elbe gefangen wurden, bewertet. Es geht um die Längegruppen von 70 mm–160 mm, eingeteilt nach je 5 mm. Die Abhängigkeit des bewerteten Merkmals von der Körperlänge wurde mit der Regressionslinie abgeschatzt, deren Korrelationskoefficient und die beiden Regressionskoeffizienten in Tab. Nr. 3 angefuhrt sind. Der Minuswert des Korrelationskoeffizienten bedeutet eine negative, der Pluswert eine positive Alometrie. Gleichzeitig deuten hohe Werte des Korrelationskoeffizienten eine rasche Änderung des gegebenen Merkmals mit dem Körperwachstum. Bei diesen Merkmalen sind auch hohe Werte des CD Koeffizienten unter den äussersten Längegruppen zu erwarten. Aus Tab. Nr. 3 ist ersichtlich, dass bei manchen Merk-

Tab. 1. Übersicht der Lokalitaten und Anzahl der Exemplare

Lokalitat	Nr.		Autor	Zahl der Exemplare
Themse-Fluss	1	*Alburnus alburnus*	*eigene Ergebnisse*	13
Garonne-Fluss	2		eigene Ergebnisse	11
Elbe-Fluss	3		eigene Ergebnisse	74
Hostivař-Talsperre	4		eigene Ergebnisse	33
Olza-Fluss	5		Balon, 1952	10
Pskowsee	6		Petrov, 1930	72
West Dwina-Fluss	7		Žukov, 1965	49
Rosica-Fluss	8		eigene Ergebnisse	9
Jantra-Fluss	9		eigene Ergebnisse	11
Batak-Talsperre	10		eigene Ergebnisse	32
Dnepr-Fluss	11		eigene Ergebnisse	3
Dnepr-Fluss	12		Žukov, 1965	68
Oka-Fluss	13		eigene Ergebnisse	3
Vycegda-Fluss	14		eigene Ergebnisse	3
Volga-Fluss	15		eigene Ergebnisse	3
Ural-Fluss	16		eigene Ergebnisse	10
Tsciekoe-Talsperre	17		eigene Ergebnisse	5
Ural-Fluss	18	*Alburnus charusini*	Petrov, 1930	44
Sulak-Fluss	18		Petrov, 1930	140
Kura-Fluss	20		Petrov, 1930	251
Safíd Rúd-Fluss	21		Petrov, 1930	51
Po-Fluss	22	*Alburnus albidus*	eigene Ergebnisse	10
Ochridasee	23		Oliva, 1950; Oliva, Šafránek, 1962	16

malen (lc, aA, dio) die Werte dec CD Koeffizienten, berechnet für die Längegruppen 70 mm—80 mm und 150 mm—160 mm, grosser sind als 1,3. Diese Merkmale sollten also nicht zur Bewertung der morphologischen Variabilität der einzelnen Populationen im Rahmen ihres Verbreitungsareals verwendet werden. Anderseits ist aber zu erwägen, dass die morphologische Variabilität innerhalb einer Längegruppe wesentlich geringer ist, als wenn das Material aus mehreren Längegruppen zusammengesetzt ist, denn im Rahmen der einzelnen Langegruppen sinken die Werte des CD Koeffizienten. Dabei ist es auch möglich, bei solchen Merkmalen Lokalitäten mit zu kleinen oder zu grossen Fischen auszuschliessen (der Fluss Olza, die Talsperre Batak). Der sexuelle Dimorphismus wurde im Rahmen einer Lokalität (Fluss Elbe) bewertet. Es wurden dabei insgesamt 17 plastische Merkmale bewertet, wobei die Werte der CD Koeffizienten 0,0—0,4 betrungen. Die grössten Differenzen wurden bei der Höhe der Afterflosse und der Rückenflosse festgestellt. Die beiden Flossen sind höher bei den Männchen, auch die Bauchflosse ist bei ihnen etwas länger. Auf geschlechtliche Unterschiede dieser Merkmale machten schon Vladykov (1931) und Oliva (1952) aufmerksam. Daraus geht hervor, dass der sexuelle Dimorphismus die Mittelwerte der bewerteten Merkmale nicht beeinflusst.

Tab. 2. Durchschnittliche Werte ($\bar{x}$) und Standardabweichungen (s) der *morphologischen* Merkmale der Ukeleie

Lc von—bis	Themse 111,5 (76—135)		Garonne 101,7 (90—140)		Elbe 132,2 (108—163)		Hostivař 140,5 (123—168)		Rosica 112 (94—137)	
	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	s
l. l.	48,3	1,254	47,8	0,789	48,3	1,500	47,8	1,359	48,5	1,309
radii A	16,8	0,750	16,0	0,707	18,6	1,049	17,3	1,376	16,7	0,928
in % Lc										
lc	22,2	0,714	21,4	0,571	21,4	0,863	21,5	1,358	21,2	1,391
dpD	56,6	2,587	55,8	1,393	54,6	1,437	56,3	0,990	54,5	1,118
dpstD	34,7	1,044	35,4	1,067	35,4	1,752	35,0	1,205	36,4	2,467
minac	8,8	0,630	8,6	0,404	8,4	0,437	8,9	0,322	9,0	0,876
mac	25,2	1,764	23,4	1,435	25,3	1,389	24,7	1,293	23,9	1,345
lpc	18,6	1,027	19,3	1,079	19,5	1,270	18,8	1,249	18,6	0,472
apc	11,1	0,822	10,7	0,649	10,6	0,758	10,6	0,692	10,7	1,090
lD	9,7	0,659	9,9	0,789	10,3	0,799	10,0	0,866	10,0	0,633
aD	16,3	1,333	17,4	0,877	15,5	1,292	17,7	1,054	16,8	0,752
lA	17,8	0,730	18,5	0,429	18,2	1,321	18,8	1,179	20,0	1,062
aA	12,2	0,871	12,7	0,668	11,2	0,942	13,2	0,732	11,4	0,781
lP	18,6	0,652	18,5	0,924	18,2	0,990	19,9	1,937	19,1	0,766
lV	13,9	0,297	14,1	0,422	13,8	0,862	14,8	0,726	13,7	0,784
lC	22,0	0,851	21,5	0,066	21,7	1,094	23,8	1,441	22,2	1,177
P—V	22,7	1,704	22,7	1,061	—	—	22,2	1,269	22,6	1,376
V—A	20,1	2,048	19,6	1,010	20,2	1,403	20,0	1,793	19,6	1,197
do	6,2	0,373	5,9	0,532	5,6	0,306	5,5	0,250	5,5	0,321
dpo	6,2	0,405	5,6	0,573	6,0	0,384	6,4	0,335	5,8	0,389
dpso	9,9	0,390	9,4	0,355	—	—	9,6	0,479	9,7	0,652
ac	15,6	0,502	15,3	0,492	—	—	14,9	0,056	15,3	0,495
in % lpc										
apc	59,9	6,168	55,8	4,808	56,6	7,462	56,4	3,643	57,9	5,759
in % lc										
do	27,9	1,545	27,6	2,377	26,1	1,282	24,7	1,518	26,2	1,171
dpo	27,8	1,994	26,2	2,369	28,2	1,503	29,9	2,011	27,4	1,643
dpso	44,6	1,904	44,3	1,257	—	—	44,4	2,773	45,8	1,240
ac	70,2	1,908	72,2	3,225	—	—	69,1	3,835	72,1	4,824

Die geograpische Variabilität. Nach dem Ausscheiden von Lokalitäten mit weniger als 9 Exemplaren blieben im ganzen 15, welche systematisch jede mit jeder mit dem CD Koeffizienten bewertet wurden. Es ergab sich, dass die meisten Fälle von CD ≧ 1,3 zwei meristische Merkmale (die Anzahl der Schuppen in der Seitenlinie, die Anzahl der weichen Strahlen der Afterflosse) und ein plastisches Merkmal (die Kopfläge in % der Körperlänge) aufweisen. Weitere Merkmale siehe Tab. Nr. 4. Auf diese drei Merkmale konzentrierte sich unsere Aufmerksamkeit.

Die Anzahl der Schuppen in der Seitenlinie. Im ganzen wurden Ukeleie aus 15 Lokalitäten bewertet. (Abb. 1). Soweit es sich um Populationen der Art *Alburnus alburnus* handelt, bewegen sich die Mittelwerte der Schuppenzahl in der Seitenlinie zwischen 47,8 (Fluss Garonne) und 50,1 (Pskowsee). Eine Ausnahme bilden nur Ukeleie aus dem Fluss Ural (Petrov, 1930) mit durchschnittlich 49,5 Schuppen in der Seitenlinie. Ukeleie aus derselben Lokalität, die wir bewertet haben) es handelt sich aber nur um 5 Exemplare (hatten im Durchschnitt auch nur 44,6 Schuppen in der Seitenlinie. Ukeleie

Tab. 2. **Fortsetzung**

	Jantra		Batak		Dnepr		Po		Ural + Nebenflüsse	
Lc	107,4		139,9		101,3		77,3		93,9	
von—*bis*	(100—115)		(110—194)		(99—105)		(70—90)		(75—113)	
	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	s
l. l.	48,0	1,426	48,0	1,436	48,7	1,155	44,1	1,370	44,6	0,548
radii A	16,6	1,433	16,8	1,091	16,7	1,528	13,7	0,749	17,3	0,949
in % Lc										
lc	21,8	0,696	19,8	0,750	22,2	0,473	22,2	0,538	21,7	0,611
dpD	55,0	1,442	54,7	3,672	55,8	0,710	54,9	0,937	56,1	1,506
dpstD	36,0	3,585	35,6	1,458	34,7	0,454	34,4	1,275	34,1	1,211
minac	9,0	0,445	8,7	0,569	8,6	0,100	9,5	0,688	8,4	0,652
mac	24,9	1,194	24,4	1,786	22,7	0,988	23,8	0,892	23,8	2,359
lpc	18,7	0,892	19,2	1,104	20,1	0,700	19,9	1,088	18,7	1,264
apc	11,1	0,387	11,3	0,765	16,9	0,404	11,6	0,469	10,9	1,579
lD	10,5	0,782	10,4	0,961	10,5	0,651	11,0	0,669	9,8	0,634
aD	16,1	0,693	16,6	1,452	16,8	0,954	18,2	1,143	16,7	0,593
lA	19,5	1,551	18,2	1,310	19,5	0,884	17,0	1,289	18,5	1,921
aA	11,5	0,723	11,9	0,944	12,5	0,866	13,2	0,537	12,2	1,365
lP	18,7	0,921	17,8	1,585	19,8	0,208	19,8	0,887	20,4	0,809
lV	13,9	1,369	13,4	0,834	13,9	0,416	14,6	0,602	15,0	0,970
lC	21,3	1,431	21,5	1,208	23,8	1,697	22,6	1,148	23,3	2,331
P—V	22,8	0,567	23,9	1,472	21,5	1,124	23,7	1,431	23,7	1,172
V—A	20,2	1,276	20,7	1,393	19,1	0,666	18,9	1,018	20,8	2,144
do	5,5	0,164	4,9	0,360	6,5	0,200	6,0	0,250	6,2	0,450
dpo	6,0	0,359	5,6	0,401	5,9	0,153	5,5	0,183	5,4	0,608
dpso	10,2	0,604	9,3	0,462	9,6	0,306	10,2	0,706	9,9	0,430
ac	15,8	0,722	14,9	0,878	15,5	0,265	16,4	0,713	14,9	0,476
in % lpc										
apc	59,3	2,255	58,8	5,254	54,5	3,729	58,4	3,638	58,8	10,716
in % lc										
do	25,5	1,315	24,5	1,686	29,2	1,185	26,8	1,038	28,4	1,606
dpo	27,6	1,702	28,4	2,153	26,3	0,833	24,8	0,799	24,8	2,589
dpso	47,0	1,857	46,8	2,369	43,0	1,332	45,9	2,419	45,6	1,899
ac	72,8	3,230	75,0	5,826	69,7	1,562	73,5	3,060	68,9	1,998

aus dem Fluss Ural nähern sich mit der Schuppenzahl den Werten der Ukeleie aus dem Fluss Kura (41,8 Schuppen), dem Fluss Safíd Rúd 42,6) und dem Fluss Sulak (43,7), welche alle als die Art *Alburnus charusini* bezeichnet werden. Ukeleie aus dem Fluss Po (*Alburnus albidus*) haben im Durchschnitt eine etwas höhere Anzahl der Schuppen in der Seitenlinie (44,1), dagegen weisen Ukeleie aus dem Ochridasee eine sehr hohe Anzahl dieser Schuppen auf (50,5) und können so in den Komplex der Populationen *Alburnus alburnus* einbezogen werden. Im Rahmen des Verbreitungsareals des *Alburnus alburnus* gibt es keine zwei Lokalitäten (insgesamt sind es 10), wo der CD Koeffizient den Wert 1,3 übersteigt. Auch Populationen aus dem südlichen Randgebiet des Areals, aus den Flüssen Po, Sulak, Kura, Safíd Rúd gleichen sich in diesem Merkmal, unterscheiden sich aber von den nördlichen Populationen insgesamt in 39 Fällen (Fluss Sulak in 10, Fluss Kura in 11, Fluss Safíd Rúd in 10 und Fluss Po in 8 Fällen). Ausserdem unterscheidet sich jede von diesen Populationen von den Ukeleien aus dem Ochridasee in 5 Fällen. Mit der Bewertung

Tab. 2. Fortsetzung

Lc	Volga 96,7 (93—101)		Vycegda 95,3 (89—106)		Oka 90,3 (84—98)		Tsciskoo 89,2 (82—98)	
	x̄	s	x̄	s	x̄	s	x̄	s
l. l.	—		—		44,7	1,155	46,8	2,630
radn A	16,3	1,528	16,0	1,000	17,3	1,528	16,8	1,708
in % Lc								
lc	21,6	0,666	21,3	0,808	21,4	0,945	20,5	0,907
dpD	58,9	0,569	57,6	0,306	55,9	1,704	55,5	3,162
dpstD	33,3	1,343	35,0	2,052	35,0	1,253	35,7	1,539
minac	8,6	0,404	8,6	0,252	8,9	0,569	9,2	0,472
mac	26,5	1,044	22,1	1,457	21,8	1,153	25,8	1,064
lpc	18,0	0,551	20,3	1,955	18,4	2,194	19,0	0,819
apc	10,3	0,400	10,7	0,737	10,7	0,611	11,3	0,622
lD	9,8	0,100	9,3	0,322	10,0	0.702	9,9	0.718
aD	17,6	1,193	15,9	1,000	18,3	2.183	16,9	0,736
lA	18,4	1,082	17,7	0,611	19,3	1,677	19,3	0,956
aA	13,2	1,069	13,0	0,208	13,9	0,854	12,9	0,875
lP	20,5	0,608	18,4	0,643	20,5	0,794	20,1	0,623
lV	14,9	0,608	13,4	1,021	15,4	1,054	15,0	0,856
lC	—		—		—		23,5	1,668
P—V	24,3	0,608	24,3	0,404	23,6	1,504	23,3	1.702
V—A	20,5	0,945	18,6	2,060	19,7	0,781	21,0	1,172
do	6,7	0,332	6,4	0,520	6,5	0,208	6,1	0,230
dpo	5,1	0,160	5,6	0,322	5,0	0,306	4,9	0,239
dpso	9,4	0,917	9,5	0,451	9,7	0,208	9,3	0,820
ac	14,7	0,723	14,6	0,800	15,1	0,464	15,0	0,398
in % lpc								
apc	47,4	1,058	53,0	4,051	57,8	8,802	59,6	5,051
in % lc								
do	30,9	0,361	30,1	2,352	30,2	0,289	29,7	0,808
dpo	23,7	0,231	26,3	1,626	23,4	0,611	23,9	1,617
dpso	43,5	2,909	44,8	2,939	44,9	1,229	45,4	2,401
as	68,2	1,405	68,7	2,026	70,2	2,427	73,6	2,592

aller Lokalitäten wurde in 44 Fällen eine Differenz höher als CD≧1,3 festgestellt.

Die Zahl der weichen Strahlen in der Afterflosse. Es wurden Ukeleie aus 18 Lokalitäten bewertet und 13 von ihnen waren aus dem Areal der Art *Alburnus alburnus* (Abb. 1). Der Durchschnittswert bewegt sich bei diesen Populationen von 16 (Fluss Garonne) bis 18,6 (Fluss Elbe).

Populationen aus dem Südrand des Areals weisen wieder eine bedeutend niedrigere Zahl Strahlen in der Afterflosse auf. (Fluss Po 13,7; Fluss Safíd Rúd 13,7; Fluss Kura 12,8; Fluss Sulak 15,5; Ochridasee 14,7). Innerhalb des Verbreitungsareals von *Alburnus alburnus* gibt es keine zwei Lokalitäten mit Differenzen von CD≧1,3. In allen 38 Fällen unterscheiden sich Ukeleie aus den südlichen Lokalitäten von denen aus den nördlichen (Fluss Po in 12, Fluss Safíd Rúd in 12 Fällen, Fluss Sulak nur in einem Fall von den Ukeleien aus dem Fluss Kura). Ukeleie aus dem Ochridasee unterscheiden sich von den nördlichen Populationen in 4 Fällen.

Die Kopflänge. Von den Ukeleien aus 16 Lokalitäten, die bewertet wurden, waren 11 aus dem Verbreitungsareal des *Alburnus alburnus*. Der

Tab. 3. Wachstumsvariabilitat der plastischen Merkmale. Statistisch bedeutende Korelationskoeffizienten |r| ≧ 0,4.

Merkmal	a	b	r	CD
lc	—0,02	23,8	—0,776	1,8
dpd	—0,03	58,7	—0,850	1,2
dpstd	0,00	34,9	0,00	0,0
minac	—0,01	9,8	—0,326	0,3
ma	—0,01	23,8	—0,373	0,0
lpc	0,01	17,1	0,408	0,6
apc	0,00	11,1	0,010	0,1
lD	0,00	10,8	—0,020	0,0
aD	—0,03	18,9	—0,620	1,4
lA	—0,02	21,2	—0,543	1,1
aA	—0,03	15,7	—0,887	2,1
lP	—0,02	21,2	—0,713	1,2
lV	—0,02	15,7	—0,777	0,9
lC	—0,03	25,6	—0,828	1,7
V—A	0,02	17,8	0,530	0,6
dio	—0,01	7,2	—0,840	2,3
dpo	—0,01	6,6	—0,367	0,5

Mittelwert der Kopflänge bewegt sich bei den Populationen *Alburnus alburnus* zwischen 21 (Pskowsee), 22,2 (Fluss Themse), evtl. 22,6 (Fluss Ural) Petrov 1930). Hinsichtlich der hohen Wachstumsvariabilität dieses Merkmals, wurden Ukeleie aus dem Fluss Olza (durchschnittliche Körperlänge 78 mm), aus der Talsperre Batak (Durchschnittslänge 140 mm) nicht bewertet. Mittelwerte der Kopflänge erreichen in beiden Lokalitäten erwartungsgemäss äusserst hohe Werte. (Abb. 2) Ebenso sind die Werte der Kopflänge bei den Ukeleien aus dem Fluss Po (22,2) durch die Körperlänge beeinflust (durchschnittliche Köperlänge 77 mm). Einen auffallend langen Kopf haben Ukeleie aus dem

Tab. 4. Die wichtigsten Merkmale bei denen die geographische Variabilitat bewertet wurde. Zahl derFälle für CD ≧ 1,3; 1,0; 0,7; N — Zahl der bewerteten Lokalitäten.
A — alle Populationen, B — Populationen, welche nur zur Art *Alburnus alburnus* gehoren

Merkmal		CD > 1,3	1,3 ≧ CD > 1	1 ≧ CD > 0,7	N
l. l.	A	44	4	11	15
	B	0	0	11	10
A	A	39	3	16	18
	B	0	2	9	13
lc	A	22	7	16	16
	B	0	1	5	11
mac	A	3	6	27	18
	B	3	3	12	13
dpd	A	0	0	15	18
	B	0	0	6	13
lpc	A	1	4	13	16
	B	0	1	3	11
lA	A	5	7	12	12
	B	2	2	5	10

Ochridasee (24,3), welcher nicht mit deren Körperlänge zu erklären ist (101 mm). Die erwartete Kopflänge wäre 22 %. Gleichfalls können die hohen Mittelwerte der Kopflänge der Ukeleie aus dem hinteren Kaukasus, 23,2–24,6 nicht endgültig bewertet werden, Petrov (l. c.) gibt ihre Durchschnittslänge nicht an. Hinsichtlich der erheblichen Zahl der gemessenen Exemplare ist eine normale Verteilung der Längen zu erwarten. Die Durchschnittswerte der Kopflänge werden deshalb von der Körperlänge nur geringfügig beeinflusst. Alle 22 Fälle, wo CD≧1,3, kommen bei Paaren *Alburnus charusini*, *Alburnus albidus* einerseits und *Alburnus alburnus* anderseits vor (Fluss Safíd Rúd 9 Fälle, Ochridasee 10, Fluss Po 2, Fluss Kura 1).

Die maximale Körperhöhe. Dieses Merkmal ist nur geringfügig von der Körperlänge abhängig (Abb. 2), es ändert sich aber bei Populationen aus Flüssen und Talsperren (bei den letzteren erreicht es höhere Werte). Es wurden 18 Lokalitäten bewertet (13 davon aus dem Areal von *Alburnus alburnus*). Die Anzahl der Fälle, in welchen CD≧1,3, ist gering (nur in 3 Fällen), alle im Rahmen der Populationen *Alburnus alburnus*.

Die anderen Werte des CD Koeffizienten für die Merkmale: der predorsale Abstand, die Schwanzstiellänge, die Länge der Afterflosse in Prozenten der Körperlänge siehe Tab. 4. Bei diesen und allen weiteren Merkmalen wurden keine zwei Lokalitäten ermittelt, wo der CD Koeffizient den Wert 1,3 erreichte, oder waren diese Fälle vereinzelt. Meistens war es bei Merkmalen mit erheblicher Wachstumsvariabilität (Länge und Höhe der Afterflosse). Ausser durch die Kopflänge kann man auf Grund der angeführten plastischen Merkmale die Populationen *Alburnus alburnus* von denen aus dem südlichen Gebiet des Areals nicht unterscheiden.

Der antedorsale Abstand ist das Beispiel eines Merkmals, welches bei Populationen aus dem bewerteten Areal in keinem Fall den Wert CD≧1 aufweist, trotz seiner erheblichen Wachstumsvariabilität um dem Umstand, dass die Populationen aus dem Fluss Olza und der Talsperre Batak mit eingerechnet wurden. Unterschiede sind lediglich bei CD≧0,7 zu bemerken. Es geht um 15 Fälle, wovon 9 bei Lokalitäten aus dem Südrand des Areals (*Alburnus charusini, Alburnus albidus*) und 6 im Rahmen der Art *Alburnus alburnus* vorkommen.

DISKUSSION

Aus der vorliegenden Bewertung der geographischen Variabilität zweier plastischen Merkmale (die Anzahl der Schuppen in der Seitenlinie, die Anzahl der weichen Strahlen in der Afterflosse, die Kopflänge und die maximale Körperhöhe) kann mit Hinblick auf die übrigen plastischen Merkmale konstatiert werden, dass einzig bei den drei ersten Merkmalen eine gewisse Verschiedenheit unter den einzelnen Populationen der Ukeleie existiert. Ukeleie aus den Randgebieten des Areals, welche zu zwei veschiedenen Arten d. h. *Alburnus albidus* und *Alburnus charusini* gehören, unterscheiden sicht nicht einmal in diesen Merkmalen. Eine Vermehrung der Schuppen in der Seitenlinie und der Strahlen in den einzelnen Flossen bei den nördlichen Populationen gleicher Art oder bei verwandten Arten wurde schon öfter festgestellt. Die Abhängigkeit von der Wassertemperatur ist klar. Eine niedrige Wassertemperatur während der embryonälen Entwicklug beeinflust positiv die Werte der meristischen Merkmale. Diese Abhängigkeit wurde festgestellt und auch experimentell bewiesen (Hubbs, 1922; Taning, 1952; Tatarko, 1968). Ein entgegengesetzter Verlauf der Merkmalenwerte würde in den südlichen Gebieten eher die Anwesenheit einer unterschiedlichen Population andeuten. Es könnte sich auch um selbständige Populationen handeln. In dieser Studie haben eine unerwartet hohe Anzahl von Schuppen in der Seitenlinie nur Ukeleie aus dem Ochridasee. Bei den anderen Populationen verläuft alles erwartungsgemäss, d. h. dass bei ihnen eine zunehmende Schuppenzahl in Richtung Süd — Nord zu beachten ist. Die Schuppenzahl in der Seitenlinie sowie die Zahl der weichen Strahlen in der Afterflosse vermindert sich in südlicher Richtung, was schon Petrov (1930) und später auch Oliva und Šafránek (1962) feststellten. Anderseits haben Ukeleie aus dem Ural hinsichtlich der geographischen Lage der Lokalität, eine geringe Anzahl von Schuppen in der Seitenlinie. Eine ähnliche Situation besteht bei der Zahl Strahlen in der Afterflosse, wo wieder Ukeleie aus dem Ochridasee eine etwas grössere Anzahl Strahlen besitzen und sich dadurch den nördlichen Populationen *Alburnus alburnus* anreihen. Mit ihrer Kopflänge aber gleichen sie den südlichen Populationen, welche durchwegs längere Köpfe als die nördlichen haben. Nach diesen beiden meristischen Merkmalen können die beiden behandelten Ukeleiengruppen nicht differenziert werden, da ihre Werte dem vorausgesetzten Verlauf ansteigender Mittelwerte der nördlichen Populationen entsprechen. Die grössere Kopflänge der Ukeleie aus den südlichen Lokalitäten hängt mit der vorausgesetzten geringeren Anzahl der Wirbel und dem so relativ kürzeren Körper dieser Populationen zusammen. Von den weiteren plastischen Merkmalen kann keines zum Differenzieren der einzelnen Arten verwendet werden. Die beiden Arten dem südlichen Teil des Areals unterscheiden sich voneinander in den wichtigsten diagnostischen Merkmalen (die Schuppenzahl in der Seitenlinie, die Zahl der weichen Strahlen in der Afterflosse) überhaupt nicht (siehe auch Berg, 1932).

Vergleichen wir die geographische Variabilität bei den studierten Lokalitäten (im ganzen 18) mit Hilfe der Wahrscheilichkeit des Vorkommens des vorher festgesetzten Wertes des CD Koefficienten für die wichtigsten Merkmale (die Schuppenzahl in der Seitenlinie, die Zahl der weichen Strahlen in der Afterflosse, die Kopflänge, der antedorsale Abstand und die Maximalkörperhöhe), bekommen wir für den Rang CD≧0,7 den Wert 0,29. Das heisst, dass wir annähernd bei jedem dritten Lokalitätenpaar den Wert CD≧0,7 erhalten. Der Wert für CD≧1,3 beträgt 0,14. Für Elritzen (Řepa, Pivnička, 1980) aus 19 Lokalitäten und bei 6 Merkmalen sind die entsprechenden Werte 0,36 und 0,15, für Plötzen (Holčík, Skořepa, 1971) aus 17 Lokalitäten bei 9 Merkmalen sind diese Werte 0,26 und 0,11. Das Niveau der geographischen Variabilität ist ähnlich, bei den letzteren zwei Arten kann das Verbreitungsareal im Vergleich mit dem der Ukeleie beiläufig, als doppelt abgeschätzt werden.

Aus den Flüssen Kura und Safíd Rúd wurde die Art *Alburnus filippii* Kessler, 1877 beschrieben (in Berg 1949), welche eine auffalend niedrige Zahl der Strahlen in der Afterflosse (10—13), dagegen eine hohe Schuppenzahl in der Seitenlinie (48—63) aufweist. Petrov (1. c.) gibt die Schuppenzahl in der Seitenlinie und die Zahl der weichen Strahlen in der Afterflosse der Population *Alburnus charusini* mit 41,8; 12,8; (Kura), 42,6; 13,7; (Safíd Rúd) an. Durch die Schuppenzahl in der Seitenlinie unterscheidet sich also *Alburnus filippii* deutlich von *Alburnus charusini*. Weitere Angaben über *Alburnus filippii* fehlen aber.

Zur Erhaltung der Kontinuität mit der früheren Gliederung der Populationen der Ukeleie ist die Gliederung, die Banarescu (1964) angibt, am meisten realistisch Dieser Autor anerkennt in dem studierten Areal einzig die Art *Alburnus alburnus* (ahnlich auch Petrov, 1930) mit den Unterarten *Alburnus alburnus alburnus*, *Alburnus alburnus albidus* and *Alburnus alburnus charusini* Er halt aber an Karamans Gliederung der Unterarten der Art *Alburnus alburnus* (Karaman 1924, 1928, 1955) fest *Alburnus alburnus scoranza*, *Alburnus alburnus belvica*, *Alburnus alburnus macedonicus*, *Alburnus alburnus strumicae*, welche ausser den Unterarten *Alburnus alburnus alburnus* und *Alburnus alburnus alborella* nicht als valid angesehen werden konnen Dasselbe gilt fur die Unterart der Art *Alburnus charusini*, welche Berg (1949) als *Alburnus charusini hohenackeri* anfuhrt Es wurde schon erwahnt, das zwischen den Populationen aus dem hinteren Kaukasus keine Unterschiede festgestellt werden konnten Diese Populationen sollten eigentlich in eine gemeinsame taxonomische Kategorie eingereiht werden Soweit wir uns an die Einteilung Banarescus (Banarescu 1964) halten, ist es unvermeidlich die nordlichen Populationen zu der Art *Alburnus alburnus* (als Unterart *Alburnus alburnus alburnus*) und alle sudlichen Populationen, fruher selbstandige Arten *Alburnus albidus* und *Alburnus charusini* zu derselben Art als Unterart *Alburnus alburnus albidus* zu reihen *Alburnus albidus* und *Alburnus charusini* werden so Synonyme der Art *Alburnus alburnus*

Beide Unterarten d i *Alburnus alburnus alburnus* und *Alburnus alburnus albidus* sind geograpisch getrennt wie folgt *Alburnus alburnus alburnus* kommt in Europa vor, aber ausser in Irland, Skotland und den westlichen Teilen Norwegens (welche dem Gebiet des Atlantischen Ozeans angehoren), Spanien, Portugal, Italien, Albanien und Teile Jugosloviens, welche zum Gebiet des Adriatischen Meeres gehoren und Griechenland *Alburnus alburnus albidus* bewohnt Italien, Dalmatien, Albanien, nordlich aber auch sudliche Hange des Kaukasus und sudliche Nebenflusse des Kapischen Meeres bis zum Fluss Safíd Rúd Populationen in den Flussen des sudlichen Bulgariens, welche in das Agaische Meer munden, wahrscheinlich auch im Delta des Flusses Ural und im Flussgebiet des Flusses Kuban, bilden einen morphologischen Übergang zwischen beiden Unterarten

Morphologisch konnen die Populationen der beiden Unterarten folgendermassen unterschieden werden:

1(2) Die Anzahl der Schuppen in der Seitenlinie 44–54, (haufigsten 47–50), die Anzahl der weichen Strahlen in der Afterflosse 14–21, (haufigstens 16–19), die Kopflange in % der Korperlange 19–25 (haufigsten 21–23) . *Alburnus alburnus alburnus*

2(1) Die Zahl der Schuppen in der Seitenlinie 39–47 (haufigstens 42–44), die Zahl der weichen Strahlen in der Afterflosse 10–17 (haufigstens 13–15), die Kopflange in % der Korperlange 22–27 (haufigstens 23–25) *Alburnus alburnus albidus*

Morphologische Charakteristik der Art *Alburnus alburnus*

D III-IV, 7–9, A III, 10–21, Schuppenzahl in der Seitenlinie 38–54, die Kopflange in % der Korperlange 20–27, die maximale Korperhohe 18,7 – 28, die Lange des Schwanzstiels 16 23, die Lange der Afterflosse 14–22,5.

ZUSAMMENFASSUNG

In der vorliegenden Arbeit wurde der sexuelle Dimorphismus sowie die Wachstumsvariabilitat der Ukeleipopulationen (*Alburnus alburnus*) aus dem Fluss Elbe und auch die geographischen Variabilitat der Ukeleie aus 23 Lokalitaten, die sich im Verbreitungsareal der Arten *Alburnus alburnus*, *Alburnus albidus* und *Alburnus charusini* ausbreiten, bewertet

Es wurde festgestellt, dass der sexuelle Dimorphismus nicht statistisch nachzuweisen ist Unbedeutende Unteschiede zwischen mannlichen und weiblichen Exemplaren wurden bei der Hohe der Ruckenflosse und der Afterflosse, sowie bei der Lange der Bauchflose wiederholt bestatigt

Die Wachstumsvariabilitat ist am meisten ausdrucksvoll bei der Kopflange, der Lange der Afterflosse und der Korperhohe Bei diesen Merkmalen ist es bei der Bewertung der geograpischen Variabilitat notig, die Langenzusammensetzung der studierten Populationen zu beachten

Beim Studium der geographischen Variabilitat der diagnostischen Hauptmerkmale (die Schuppenzahl in der Seitenlinie, die Zahl der weichen Strahlen in der Afterfolsse und die Kopflange) konnen in dem gegebenen Bereich zwei Gruppen von Populationen definiert werden

1 Nordliche Populationen aus dem Verbreitungsareal von *Alburnus alburnus* mit hoheren Mittelwerten der meristischen Merkmale und einem kurzeren Kopf

2 Sudliche und sudostliche Populationen aus dem Verbreitungsareal des *Alburnus albidus* und *Alburnus charusini*, mit niedrigeren Werten meristischer Merkmale und einem langeren Kopf Die beiden letzteren Arten unterscheiden sich in keinem Merkmal voneinander

Wie schon Petrov (1930) und Banarescu (1964) angeben, kònnen auch die Unterschiede der morphologischen Merkmale zwischen den nordlichen und sudostlichen Populationen nicht als artenunterscheidend bewertet werden Aus diesem Grunde werden beide Arten, namlich *Alburnus albidus* und *Alburnus charusini* zu Synonymen der Art *Alburnus alburnus*

3 Die morphologische Charakteristik der Art *Alburnus alburnus* D III—IV, 7—9, A III, 10—21, Zahl der Schuppen in der Seitenlinie 38—54, die Kopflange in $^{0}{}_{0}$ der Korperlange 20—27, die maximale Korperhohe 18, 7—28, die Lange des Schwanzstiels 16—23, die Lange der Afterflosse 14—22,5

4 Die nordlichen Populationen sollten laut angefuhrter Fakten als *Alburnus alburnus alburnus*, die sudlichen und sudostlichen im Rahmen der studierten Bereiche, als *Alburnus alburnus albidus* bezeichnet werden

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Die Abbildungen 1 und 2 sind am Ende des Heftes zu finden.

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AGE STRUCTURES IN A WILD POPULATION OF MICROTUS ARVALIS DURING ITS POPULATION CYCLE (MAMMALIA: RODENTIA)

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Abstract. I examined age structures in a wild population of *Microtus arvalis* (Pall.) during its three-year-population cycle (1979 to 1981), using the dry matter weight of the eye lens for determining the age of the individual animals. The relative proportions of the individual age groups (cohortes C1–C5) were studied during the phases of the population cycle (phase of population increase, peak phase). These differences were found to be caused mainly by changes both in the duration of the reproduction period and in the number of animals becoming sexually mature. Considerable fluctuation of value of both parameters are typical of the population cycle of Microtinae. Differences in the proportions of the given cohortes recorded during the peak phase in the study area occurred even within an identical span of time in the three different types of grassland habitats.

INTRODUCTION

An exact determination of the age of the individuals of *Microtus arvalis* in field samples meets always with considerable difficulties. Criteria such as body weight or body length have proved unreliable for this purpose (Bašenina 1953, 1962; Frank and Zimmermann 1957; Šebek 1959; Reichstein 1964), and so have methods using osteological changes (Bašenina 1953; Hagen 1955; Frank and Zimmermann 1957; Stein 1958).

The most accurate method of determining age in unmarked individuals of *M. arvalis* appears to be that suggested by Lord (1959) which is based on an increment in the weight of the eye lens. Its usefulness and reliability has been confirmed by a number of authors both for *M. arvalis* (Martinet 1966; Adamczewska-Andrzejewska 1973 a; Hlaváč 1979; Pykal 1981) and for many other species of small mammals (Adamczewska-Andrzejewska 1971, 1973 b; Askaner and Hansson 1967; Pokrovskij 1971; Kozakiewicz 1976; Nabaglo and Pachinger 1979).

However, if the population under consideration is spread widely over a large area, this criterion should be treated with a certain circumspection, because a comparison of results obtained from laboratory-bred and wild animals indicates possible differences in an increase in lens weight depending on the quality, quantity and availability of food (Martinet 1966; Adamczewska-Andrzejewska 1973 a; Hansson 1983). Therefore, similar differences may be expected also among the individual feral populations.

The main restriction on Lord's (1959) method is his disregard of a different rate of increase in lens weight in animals born in spring and early summer months and in individuals born during the remaining months of the reproduction period. These differences have been confirmed by Schwartz et al. (1964) for *Microtus oeconomus* and *M. gregalis*, by Pokrovskij (1971) for *M. oeconomus*, by Adamczewska-Andrzejewska (1973 a) for *M. arvalis*, but the results by the latter author lack statistical significance.

In order to avoid further confusion, Hlaváč (1979) tried to design a model illustrating an increase in eye lens weight, considering thereby differences in the rate of its increase both within the course of the year and during the population cycle.

Therefore, on the basis of Hlaváč's method, a detailed analysis has been made of the age structure in a population of *M. arvalis* with the intension to contribute to a better understanding of changes in the age structure in the population during the population cycle. In addition, the results may provide information of the convenience of this model in other similar studies.

MATERIALS AND METHODS

Our material consisted of 2,697 specimens of *Microtus arvalis* obtained from February 1979 to October 1981, of which 906 specimens (396 ♂♂, 510 ♀♀) were used for determining the age structure in the population.

Small snap-traps commonly used for trapping small mammals were distributed throughout the area of the Zbudovská blata situated at about 15 km NW of České Budějovice (the northwestern part of the basin of České Budějovice in S-Bohemia). The setting of traps in squares was performed twice a year (June, October) in three types of homogenous grassland habitats formed after the melioration of the originally uniform substrate which differ now both in hydrological conditions and the plant cover.

1) Habitat A — undrained, ariginal grassland, belonging phytocoenologically to the alliance Caricion gracilis Neuhäusel 1959, community Caricetum gracilis Almquist 1929.
2) Habitat B — partly drained grassland with plant communities of the alliance Calthion Tüxen 1937.
3) Habitat C — dry, drained, cultured grassland.

The distance between the individual localities was from 500—1500 m. Two squares (100 × 100 m) were marked off in each habitat, one for spring—, the other for autumn trapping. The distance between the nearest corners of the squares was from 30—60 m. Sampling from each plot was repeated after one year.

In order to complement our material, snap-traps were placed in lines in similar habitats in about monthly intervals. Also here, the interval between sampling was one year. Detailed description of both the habitats and the sampling methods are available from an earlier paper (Moravec 1982).

The material was treated with common mammalogical methods. The density of *M. arvalis* per hectare was calculated from the number of specimens trapped in the individual squares, and these data were used for assaying the course of the population cycle. (For calculation methods see, e. g., Bejček 1977, 1981; Pelikán 1975, 1976; Moravec 1982).

The age of the individuals was determined with Lord's (1959) method using always freshly trapped animals with undamaged eye bulbs. For analyzing the age structure, we combined the yield from trapping squares in the individual habitats under consideration with that from the trapping lines. Our sample from October 1981 was large enough to enable a comparison of the situation in the individual localities.

Since Hlaváč's (1979) model considered differences in the rate of weight increment of the eye lens (higher in spring, March-June, lower in the remaining months of the year) we used it for reading off the age of the animals. We also accepted his hypothesis that the rate of increase in the weight of the eye lens does not increase in spring of the year of the peak phase (we used it from March 1981) because this fitted best our data on the assessed rate of increase in eye lens weight during this period. This state was in agreement with the finding that the rate of increase in the body weight of the animals was higher in the phase of a population increase than in the peak phase(see,e.g., Krebs et al. 1973).

However, we used this method merely for determining the approximate age of the animals because our data differed slightly from the actual situation in the population. In our opinion, this disagreement may have arisen either from an inaccurate graphical method used for reading off the age, or from the relatively small material of Moravian origin upon which Hlaváč (1979) designed his model.

RESULTS

The course of the population cycle of *Microtus arvalis* in plots A, B and C is shown in Fig. 1. We divided it approximately into these phases: low numbers – 1979 + spring 1980; increase – remaining part of 1980; peak – 1981.

The animals were divided into five age groups (cohortes) on the basis of their approximate dates of birth:

Spring cohorte – C1 (born in March and April)
Early summer cohorte – C2 (May and June)
Summer cohorte – C3 (July and August)
Autumn cohorte – C4 (September, October and first half of November)
Winter cohorte – C5 (from second half of November to end of February).

Dry matter weight of eye lenses of all animals for which their age was determined is shown in Fig.2. The individual cohortes are separated by lines drawn between points illustrating the weight of lenses (at each sampling date) of hypothetical animals born on March 1 (C1), May 1 (C2), July 1 (C3), September 1 (C4), November 15 (C5). Individuals of the cohorte under consideration are found between these borderline values. In 1980, cohortes C3, C4, C5 overwintering from 1979, could clearly be distinguished from C1 of the current year (1980) to about the end of June. From then onwards, differences in dry matter weight of eye lenses disappeared as the rate of weight increment of eye lenses of C1 (1980) increased. However, the proportion of individuals overwintering from the previous year, was already minimal in the population at that time. Using Hlaváč's (1979 method which considers a slow rate of increase in eye lens weight during the peak phase (in this case the year 1981), it was relatively easy to distinguish, up to October 1981, all cohortes of the foregoing year from those of the current year.

Having determined the cohortes in this way, and considered also certain inaccuracies, an estimate was made of the proportions of the individual cohortes in the population (Table 1).

In 1979 (phase of low numbers), all age groups of the current year (C1–C5) were present in the population. In spite of our small material, we were able to assume that C1 and C2 (spring and early summer 1979) were sparsely represented in the population. This was in agreement with the small number of parental animals overwintering from 1978. Relatively higher proportions of C3 and C4 in the population may be ascribed to a participation of C1 and C2 (1979) in the reproductive process. The presence of C5 in the population confirmed in the winter (1979/1980). Animals born in 1979 (C1 and C2) were last found in the October sample of 1980.

Similarly in 1980 (increase phase), the proportion of C1 (1980) was very small in the population. An exception were samples from April and May in which C1 specimens (81.8 to 61.5 %) dominated. However, this was followed by a quick reduction of C1 to 6.7 % due to the appearance of the more abundant C2 and C3

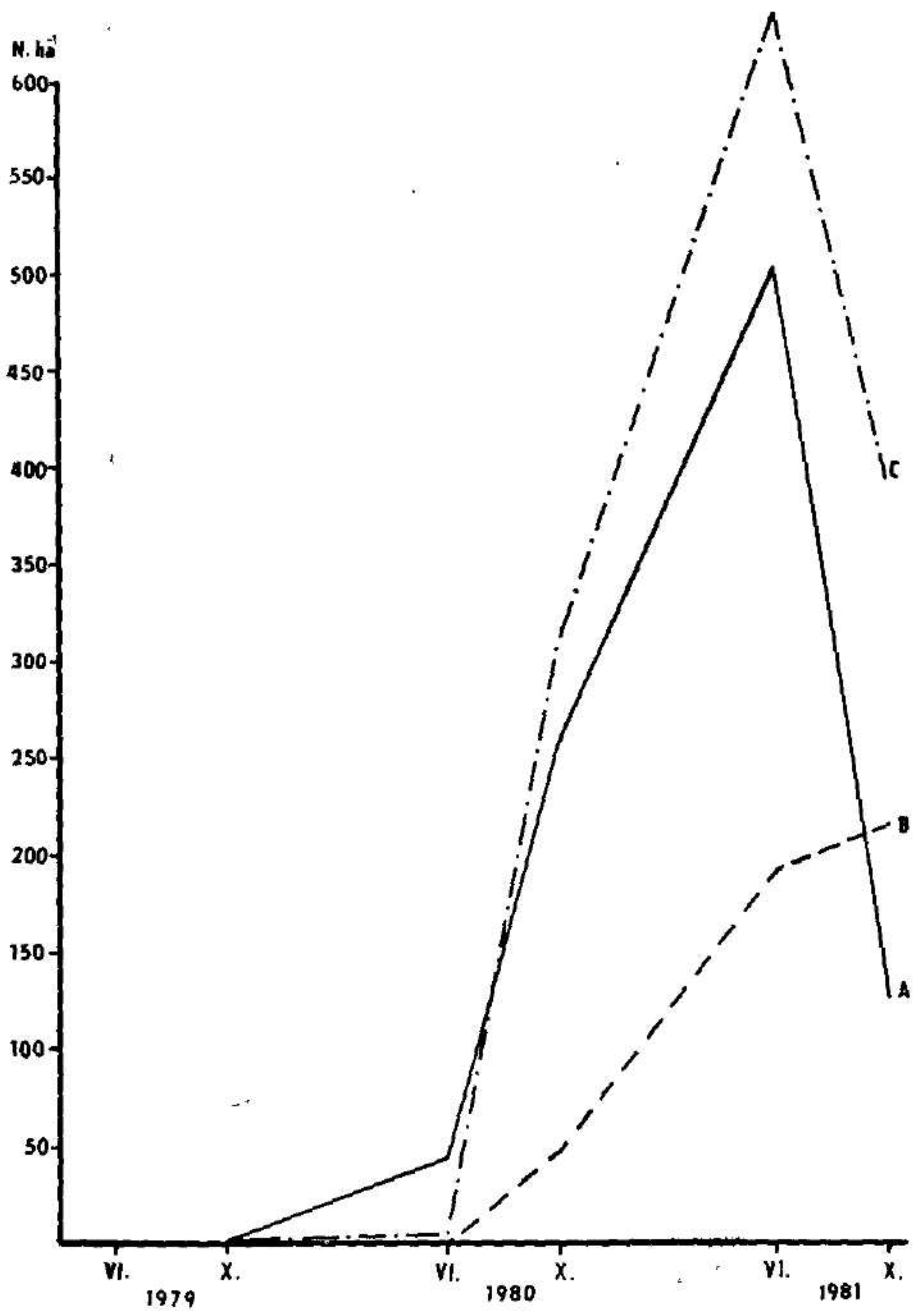

Fig. 1 Changes in the density of *Microtus arvalis* in the individual habitats A, B, C in the years 1979–1981

Tab. 1. Relative proportions of the individual cohortes (C1—C5) in a population of *Microtus arvalis*, relating to the years 1979—1981

Month		Cohorts 1978	Cohorts 1979—80					Cohorts 1980—81					Cohorts 1981				N
		C3—C4	C1	C2	C3	C4	C5	C1	C2	C3	C4	C5	C1	C2	C3	C4	
1979	III.	(1)															1
	IV.	(2)															2
	V.	(1)															1
	VIII.		(1)														1
	X.				(2)	(1)											3
	XI.				(1)	(2)											3
	XII.				(2)	(6)	(1)										9
1980	II.			(1)		(2)	(1)										4
	IV.			(1)			(1)										2
	V.				9.1	9.1		81.8									11
	VI.			7.7			7.7	61.5	23.1								13
	VII.							6.7	33.3	60.0							15
	VIII.							4.5	15.9	79.6							44
	IX.							1.7	23.3	65.0	10.0						60
	X.		0.7	0.7				3.7	16.9	52.2	25.8						136
	XI.							3.3	10.0	36.7	50.0						30
	XII.								22.9	25.0	52.1						48
1981	II.								31.4	37.2	31.4						35
	III.							3.1	31.3	31.3	34.3						32
	IV.								14.8	7.4	11.1		66.7				27
	V.								7.6	15.4	15.4		30.8	30.8			13
	VI.							1.7	11.7	1.7	4.2	3.3	41.6	35.8			120
	X.							1.0	2.7	1.0	3.7	7.8	22.6	30.1	25.0	6.1	296

Numerals in brackets = absolute number of individuals of the cohorte under consideration; remaining values = percent

(1980). A few individuals of C1 survived till October 1981 in the population Animals of C2 (1980) attained their highest number in the sample collected in July 1980 (33.3 %), but this started to change greatly in the following months owing mainly to the rate of natality and mortality in the other cohortes. Age group C3 (1980) attained its maximum abundance in August 1980 (79.6 %) This was followed by a steady decrease in numbers up to December 1980. By contrast, age group C4 (1980) started to increase in numbers in September, and continued up to November (from 10.0 %—50.0 %). The proportion of C2 in the population was decreasing until November 1980 mainly in connection with an increase in C4. In December, the proportion of C4 in the population stabilized more or less at 52.1 %, that of C2 increased to 22.9 % in which it came close to values of C3 (25.0 %). Animals of the current year (1981) were still absent in samples from February and March 1981, the proportions of C2, C3, C4 were about equal (31.3 %—37.2 %). Starting from April 1981, i. e., after the appearance and predominance of C1 (1981) in the population, a considerable reduction occurred in the number of earlier cohortes which lasted until October 1981. At that time, their proportions in the population were minimal. The presence of C5 (1980) was first recorded in June 1981 (3.3 %), and again in October 1981 (7.8 %) (material from the squares).

In contrast to the foregoing year, cohortes C1 and C2 (1981) (peak phase) dominated in the population. They decreased in number at a slower rate than in 1980, and were still relatively numerous in autumn as indicated by a comparison of October values of the two years: 1980 — C1=3.7 %, C2=16.9 %; 1981 — C1=22.6 %, C2=30.1 %. The proportions of summer and autumn cohortes were less high in the population (October 1981 — C3=25.0 %, C4=6.1 %) (Fig. 2). A comparison of the situation in plots A, B, C (Fig. 2) indicated that differences occurred in the individual habitats depending on a differently long reproduction period (plot A — C3=14.3 %, n=63; plot B — C3=31.5 %, n=124, plot C — C3=21.7 %, n=106).

DISCUSSION

In 1979, (phase of low numbers), all cohortes (C1—C5) were present in the population. Unfortunately, our material was not large enough to examine in detail their proportions in the population. Cohortes C3 and C4 were slightly more numerous evidently as the result of the participation of cohortes C1 and C2 in the reproduction. The presence of individuals of C5 in the population confirmed reproduction in winter. This was suggested also by the general physical condition of several individuals trapped in winter, and by the state of their gonads (Moravec 1982). In our case, winter reproduction seems to indicate the start of the phase of increase in the population (Chernyavsky 1975, Pykal 1981). Individuals born in 1979 persisted until October 1980 in the population (members of cohortes C1 and C2), which is about four months longer than reported by Pykal (1981) for *M. arvalis* from a similar habitat and the same period.

In 1980, the proportions of the individual cohortes (C1—C4 1980) changed depending on their rate of natality, mortality, and on their dispersion. The presence of these cohortes to as late as October 1981, and the almost equal proportions of C2—C4 during the postreproductive period suggested the prolonged survival of cohortes C1 and C2. Pykal (1981) using a method identical to ours in his examination of the age structure in a population of *M. arvalis* from S-Bohemia, but not the method considering a varying rate of increase in the weight of eye lenses, reported a speedy disappearance of the generation (conform to our cohortes C1 and C2) from the population. In March 1981, he found three cohortes (marked with our symbols): C2=15 %, C3+C4=85 %. According to our results, C1=3.1 %, C2 was approximately twice as high (31.3 %), C3 less high (31.3 %), C4=34.3 %. However, the general trend, i. e., a marked predominance of C3+C4 (65.6 %), was evident from both Pykal's (1981) and my own results. A successful survival of individuals of the older cohortes may well be in support of the statement that adult specimens survived well both in the increase – and the peak phase (Krebs et al. 1973, Krebs and Myers 1974), and also that the young born at the beginning of the season survived bettern than those born later (Fuller 1977).

Specimens of the winter cohorte C5 (1980) were present in two large samples collected in June and October. This confirmed breeding in winter. Reproduction in the winter preceding the start of the peak phase is a feature common to cyclically changing populations of Microtinae (Newson 1963, Krebs et al. 1969, Keller and Krebs 1970, Krebs and Myers 1974), and marks the onset of a heavy increase in their abundance.

As our population attained its maximum density in 1981, the proportions of age groups in it differed from those in 1980. The numbers of the current-year cohortes (C1, C2) remained fairly high until October 1981. A prolonged persistence of these high values was due to a premature termination of the reproductive process, a feature frequent with Microtinae during their peak phase (Krebs and Myers 1974). In our material, the majority of the population terminated reproduction in July which was about three months earlier than in the increase phase (Moravec 1982). Also a reterdation of the sexual development of Microtinae during the peak phase may have been the reason for a limited number of newborn individuals of C3 and C4 (Zejda 1967, Chernyavsky 1975, Hansson 1978) in addition to the fact that apart from animals of the previous year, a few individuals only of C1 and several females of C2 participated in the reproduction. The proportions of C3 and C4 in the population were lower than in the increase phase, because in 1980, individuals of C1 and C2 of the current year, a majority of females and exceptionally males of C3 participated in the reproduction (Moravec 1982).

Differences in the proportions of C3 observed in plots A, B and C in 1981, may have easily been caused by differences in the time at which reproduction terminated in the individual plots as indicated by the different number of gravid females in these plots in June 1981. Reproduction ceased, apparently first, in plot A judging from the small number of gravid females in the sample (7.0 %, n=228). More gravid females were present in plots B (47.2 %, n=106) and C (43.8 %, n=281) where reproduction appeared to continue for a longer period. However, adverse to the described situation was the presence of C4 in the population, and their incidence may be explained either by an intensive reproduction after the termination of the main reproductive period or that these animals were immigrants from habitats in which reproduction was still continuing.

SUMMARY

Different proportions of the individual cohortes of *Microtus arvalis* were observed in the increase and peak phases. During the increase phase (1980),

individuals of C1 (1980) dominated in the population in May and June 1980 only. A few individuals survived until October 1981. The proportions of cohortes C2 — 1980 (May, June), C3 — 1980 (July, August), C4 — 1980 (September to first half of November) were fairly well balanced in the postreproductive period. This state persisted until the onset of reproduction in 1981.

Reproduction in the population was heavy in the winters of 1979/1980 and 1980/1981, apparently in connection with the start and further progress of the increase phase.

The proportions of cohortes C1 — 1981 and C2 — 1981 remained high until October 1981 (peak phase) as the result of a shorter reproduction period during this phase. On the other hand, the numbers of cohortes C3 — 1981 and C4 — 1981 were limited and differed in the individual grassland habitats owing to an ununiform termination of the reproduction period.

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The figures 2 and 3 will be found at the end of this issue.

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NEW PALEARCTIC LEPIDOCYRTUS AND PSEUDOSINELLA SPECIES (COLLEMBOLA: ENTOMOBRYIDAE)

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Abstract. Three new *Lepidocyrtus* species and three new *Pseudosinella* species from the Palearctic region are described: *Lepidocyrtus uzeli* sp. n. (Czechoslovakia), *Lepidocyrtus szeptyckii* sp. n. (Siberia), *Lepidocyrtus sibiricus* sp. n. (Siberia), *Pseudosinella noseki* sp. n. (Czechoslovakia), *Pseudosinella horaki* sp. n. (Czechoslovakia) and *Pseudosinella marcuzzii* sp. n. (Italy).

The taxonomy of Lepidocyrtinae began to develop rapidly after discovering a set of new characters in the genus *Lepidocyrtus* Bourlet, 1839 and *Pseudosinella* Schäffer, 1897 by Gisin (1964 a, b, 1965, 1967). The taxonomy of these two genera was further advanced especially by Snider (1967), Hüther (1971) and Szeptycki (1967) describing such important characters as chaetotaxy of abdominal tergites III and IV and the labral chaetae and papillae. Barra (1975) contributed to the postembryonic development and variability of these characters. Gama and Gama et Gisin (many contributions) have described most of the European *Lepidocyrtus* and *Pseudosinella* species. The described *Pseudosinella* species of the world were catalogued by Christiansen, Gama et Bellinger (1983) using a code system. The formulae of chaetotaxy given in the descriptions of the new *Lepidocyrtus* and *Pseudosinella* species below are the same as in the catalogue by Christiansen, Gama et Bellinger (1983).

The European *Lepidocyrtus* species are well known, but in some less studied habitats it is still possible to find new species as in the case of *Lepidocyrtus uzeli* sp. n. The species of the genus *Pseudosinella* are in Europe more numerous than those of *Lepidocyrtus* because of the highly developed endemism and elcological specialisation. The *Lepidocyrtus* and *Pseudosinella* representatives from Asia, North America and especially from the tropics are almost unknown. The species described below were found during synecological studies of soil Collembola in different parts of Europe and Asia. They belong mostly to the common components of the soil collembolan communities in the habitats under study.

DESCRIPTIONS OF THE NEW SPECIES

Lepidocyrtus uzeli sp. n. (Figs. 1 A–I)

Diagnosis: 1600 μm long. Dark blue. Mesonotum not protruding over head. Labial chaetotaxy $M_1M_2RL_1L_2$, R shorter than M_1. Dorsal macrochaetae R001/00/0101+3. Chaetotaxy of abdominal tergite II $paBq_1q_2$. Abdominal tergite

IV without microchaeta s. Claw with two short proximal, one dorsal and two lateral teeth, distal tooth missing (Fig. 1E). Empodial appendage truncate apically. Dorsal tibiotarsal tenent hair spatulated, ventral one acuminate. Trochanteral organ consists of 18 smooth chaetae.

Description: Body 1600 µm long. Mesonotum not protruding over head. Colour dark violet, legs (including coxa), antennae and furca pale. 8+8 ommatidia present on head.

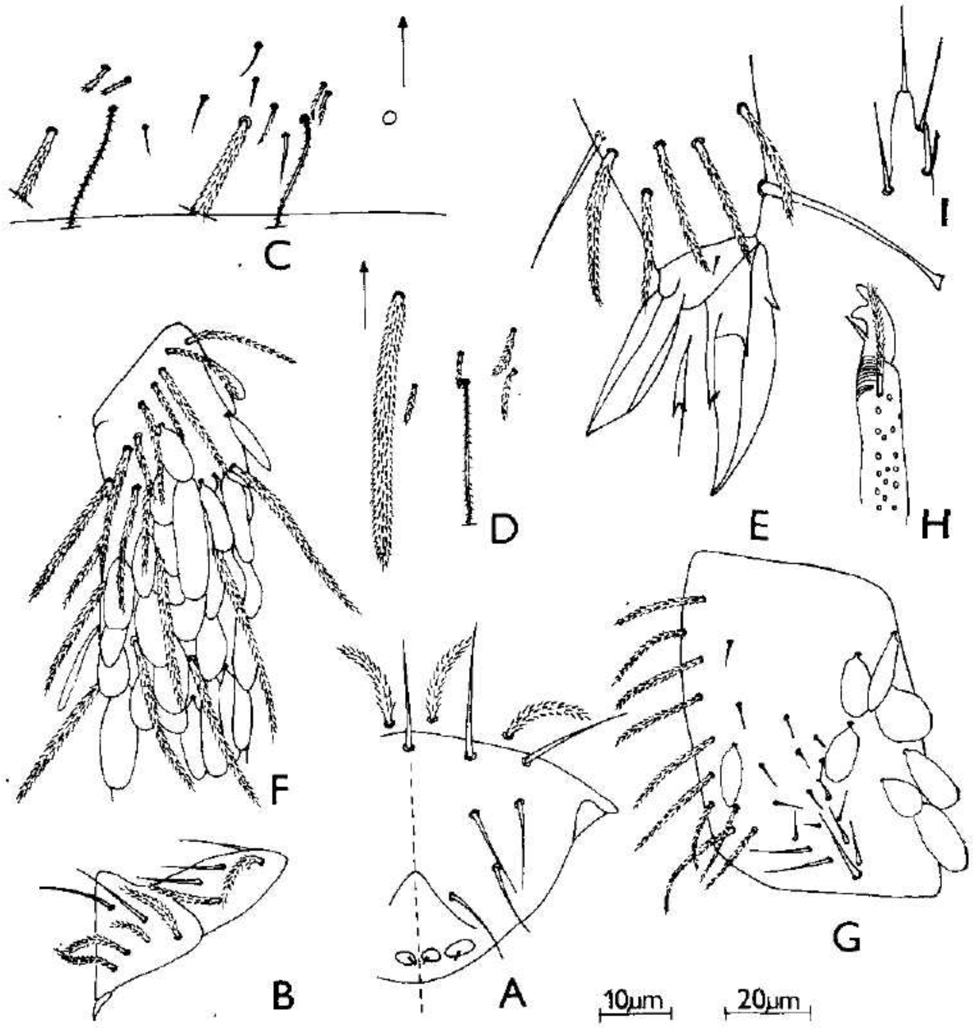

Fig. 1. *Lepidocyrtus uzeli* sp. n.: A — left half of labrum and praelabral chaetae; B — left half of labium; C — dorsal chaetotaxy of left half of abdominal tergite II; D — chaetotaxy around anterior trichobotrium on abdominal tergite IV; E — end of tibiotarsus and claw III; F — basal part of tibiotarsus III; G — trochanteral organ; H — apical part of dens and mucro; I — outer labial papilla. Scale: Figs. A, B, E, I: 10 µm; C, D, F, G, H: 20 µm.

Antennae longer than head, as 350 : 290 µm. Antennal segments I : II : III : IV as 45 : 100 : 55 : 150 µm. Antennal segments I and II covered with scales. Antennal organ II consists of one thickened and one thin sensory pegs, 3 and 2 µm long. Many smooth, thin, slightly curved and 7 µm long and many smooth, slightly thickened, 5 µm long sensory hairs present among the ciliated chaetae on antennal segment II. Antennal organ III consists of two 4 µm long, ovoid sensory pegs and two thin sensory hairs. Many smooth sensory hairs, 5–8 µm long present among the ciliated chaetae on antennal segment III. Antennal segment IV with many thin, 5–12 µm long sensory hairs among the ciliated chaetae, without apical papilla.

Praelabral chaetae ciliated, labral chaetae smooth, not branched (Fig. 1A). Formula of labral chaetotaxy 4/554 (Fig. 1A) (in holotype 4/544). Labral margin with 2+2 papillae, each with one minute spinula (Fig. 1A).

Labium with chaetal arrangement $M_1M_2RL_1L_2$ (Fig. 1B), R distinctly shorter than M_1. Anterior row of labial chaetae smooth. Outer labial papilla with slightly thickened, 6 µm long sensilla slightly overreaching basis of anteapical chaeta (Fig. 1I).

Formula of dorsal macrochaetae R001/00/0101+3. Chaetotaxy of abdominal tergite II $paBq_1q_2$ (Fig. 1C). Microchaeta s absent on abdominal tergite IV (Fig. 1D).

Claw of third pair of legs (Fig. 1E) 35 µm long, with two proximal, one dorsal and two lateral teeth, distal tooth missing. Both proximal teeth of the same size, minute (Fig. 1E), in 50 % length of ventral lamella. Empodial appendage 20 µm long, lanceolate, with typically truncate apex (Fig. 1E), without teeth. Outer tibiotarsal tenent hair 30 µm long with spatulated apex, inner one smooth, acuminate, 22 µm long (Fig. 1E). All legs densely covered with scales down to the tibiotarsi (Fig. 1F). Trochanteral organ consists of 18 smooth chaetae (Fig. 1G).

Manubrium : dens : mucro as 320 : 330 : 22 µm. Mucro with apical and anteapical teeth and one chaeta (Fig. 1H). Apical part of dens (45 µm) not crenulated, with fine striated structures dorsally (Fig. 1H).

Differential diagnosis: *Lepidocyrtus uzeli* sp. n. is related to *L. ruber* Schött, 1902. Both have the same chaetotaxy of abdomen and nota and the same truncate shape of empodial appendage. *L. uzeli* differs clearly from *L. ruber* by the macrochaeta behind the area ocularis (chaetotaxy of head R001 in sp. n. and R000 in *L. ruber*) and by the missing distal tooth on the inner lamella of claws (distal tooth present in *L. ruber*).

Holotype No. 16. V. 1978/A-552 and 16 paratypes in author's collection in the Laboratory of Soil Biology, Czechoslovak Academy of Sciences, Č. Budějovice.

Locus typicus: Czechoslovakia, Moravia meridionalis, inundated lowland forest complex around „Lanžhotský prales" Natural Reserve east of the village Lanžhot, south from the highway Brno-Bratislava, in soil samples from the forest community *Betuleto-Alnetum* with *Molinia arundinacea*, *Deschampsia caespitosa*, *Poa trivialis*, *Equisetum palustre*, etc. in understory, 16. V. 1978 six specimens, leg. J. Rusek.

Further localities: – as Locus typicus but in „Lanžhotský prales" Natural Reserve east of village Lanžhot, in soil samples from the forest community *Ulmeto-Fraxineto carpineum*, 16. V. 1978 four specimens, leg. J. Rusek; – as Locus typicus but in soil samples from the forest community *Saliceto-Alnetum*, 16. V. 1978 seven specimens, leg. J. Rusek.

Derivatio nominis: The name of the new species is dedicated to the late Prof. Dr. J. Uzel, well known Czech entomologist and phytopathologist, contributing extensively to the taxonomy of Collembola in the end of the last century.

Lepidocyrtus szeptyckii sp. n. (Figs. 2 A—E)

Diagnosis: *1150 µm long. Dark violet. Mesonotum not protruding over* head. Labial chaetotaxy $M_1M_2REL_1L_2$, R shorter than M_2, Dorsal macrochaetae R001/00/0101+2. Chaetotaxy of abdominal tergite II paBq_1q_2. Abdominal tergite IV without microchaeta s. Claw with two minute proximal, one distal, one dorsal and two lateral teeth (Fig. 2 E). Empodial appendage lanceolate. Dorsal tibiotarsal tenent hair spatulated, ventral one acuminate. Trochanteral organ consists of 10 chaetae.

Description: Body 1150 µm long. Mesonotum not protruding over head. Colour dark violet. 8+8 ommatidia present on head (Fig. 2A).

Antennae longer than head, as 320 : 230 µm. Antennal segments I : II : III : IV as 50 : 80 : 70 : 120 µm. Antennal segments I and II with scales. Antennal organ II consists of two 4 µm long, thick sensory pegs. Some smooth, thin, 5 µm long sensory hairs present among the ciliated chaetae on ventral side of antennal segment II. Antennal organ III consists of two ovoid, 4 µm long, thick sensory

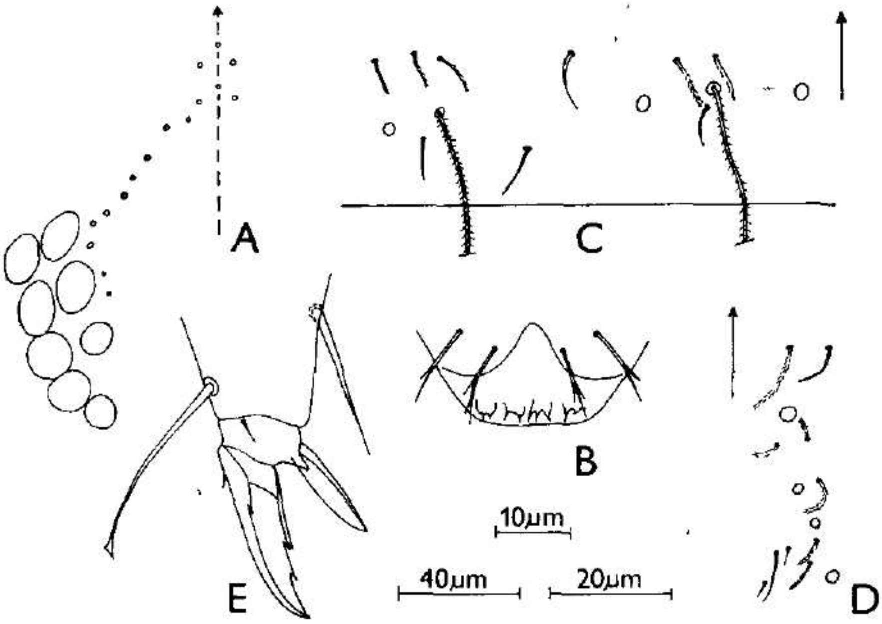

Fig 2. ***Lepidocyrtus szeptyckii*** sp. n.: A — ommatidia and frontoocular chaetotaxy on left side; B — end of labrum; C — dorsal chaetotaxy of left side of abdominal tergite II; D — lateral chaetotaxy of abdominal tergite III; E — tibiotarsal hairs, claw and empoidal appendage III; *Scale: Fig. A: 40 µm, Figs. C, D: 20 µm; Figs. B, E: 10 µm.*

pegs and two thin sensory hairs. Some smooth sensory hairs, 4–6 μm long present among the ciliated chaetae on ventral side of antennal segment III. Antennal segment III with many smooth, 5–9 μm long, slightly curved sensory hairs among the ciliated chaetae.

Formula of labral chaetotaxy 4/554. Praelabral chaetae ciliated, labral chaetae smooth, the four distal chaetae with 2–3 short branches (Fig. 2B). Labral margin with four papillae with 2–3 short spinulae (Fig. 2B).

Labium with chaetal arrangement $M_1M_2REL_1L_2$, chaeta R shorter than M_2. Anterior chaetae smooth.

Formula of dorsal macrochaetae R001/00/0101+2 (Fig. 2A). Chaetotaxy of abdominal tergite II $paBq_1q_2$ (Fig. 2C). Microchaeta s absent on abdominal tergite IV.

Claw of third pair of legs 20 μm long, with two minute proximal, one distal, two lateral and one dorsal teeth (Fig. 2E). Empodial appendage lanceolate, 10 μm long, without teeth (Fig. 2E). Outer tibiotarsal tenent hair 17 μm long, with spatulated apex (Fig. 2E), inner one acuminate, 14 μm long. Trochanteral organ consists of 10 chaetae.

Manubrium : dens : mucro as 250 : 240 : 13 μm. Mucro with apical and anteapical teeth and one mucronal chaeta. Apical part of dens (50 μm) not crenulated.

Differential diagnosis: The new species is related to *Lepidocyrtus weidneri* Hüther, 1971. The new species differs from it by the chaetotaxy of head (–011 in *L. weidneri*), by the labral papillae with 2–3 spinulae (labral papillae weakly developed in *L. weidneri*), by the E_1 macrochaeta on abdominal tergite IV [terminology after Hüther (1971) – in *L. weidneri* e_1 is microchaeta] and some further characters.

Holotype No. 24. V. 1973/A–223 and 15 paratypes in author's collection in the Laboratory of Soil Biology, Czechoslovak Academy of Sciences, Č. Budějovice.

Locus typicus: USSR, Siberia, at the 64th km of the road from Irkutsk to Kultuk, in moist mosses from a rock surrounded by taiga with dominant *Pinus cembra*, 24. V. 1973 four specimens leg. J. Rusek.

Further localities: USSR, Siberia, about 20 km north of Bol'šaja Rečka, about 30 m left from the road Irkutsk – Listvjanka (lake Baikal), in moist sample of rotten wood from a stump covered by mosses in taiga dominated by *Betula* sp. and *Pinus cembra* and with *Rhododendron dahuricum* in understory, 23. V. 1973 one specimen leg. J. Rusek; – USSR, Siberia, Listvjanka on the NW shore of Baikal Lake, in moist, dark brown humus sample from birch taiga with *Ledum palustre, Rhododendron dahuricum, Vaccinium* sp., *Rosa* sp., mosses and lichens in understory, W slope, 23. V. 1973 three specimens leg. J. Rusek; – as the previous locality but sample of mosses and lichens from tree trunks and from a rock in birch taiga, dry, 23. V. 1973 five specimens leg. J. Rusek; – USSR, Siberia, at the 64th km of the road from Irkutsk to Kultuk, 24. V. 1973 three specimens collected below large stones on a meadow with grasses, *Alchemila* sp., *Plantago* sp. and mosses, moist. leg. J. Rusek.

Derivatio nominis: The new species is dedicated to my friend Prof. Dr. A. Szeptycki, Krakow, contributing extensively to the taxonomy and morphology of Collembola and Protura.

Lepidocyrtus sibiricus sp. n. (Figs. 3 A–G)

Diagnosis: 1050 μm long. Colour pale yellow, only eyes dark blue pigmented. Mesonotum slightly protruding over head. Labial chaetotaxy $M_1M_2REL_1L_2$, R shorter than M_1. Dorsal machrocaetae R001/00/0101+2, R-group without R_2 chaetae. Chaetotaxy of abdominal tergite II $paBq_1q_2$. Abdominal tergite IV without microchaeta s. Claw with two minute proximal, one distal, two lateral and one dorsal teeth (Fig. 3E). Empodial appendage lanceolate, without teeth. Dorsal tibiotarsal tenent hair spatulated, ventral one acuminate. Trochanteral organ consists of 10 smooth chaetae.

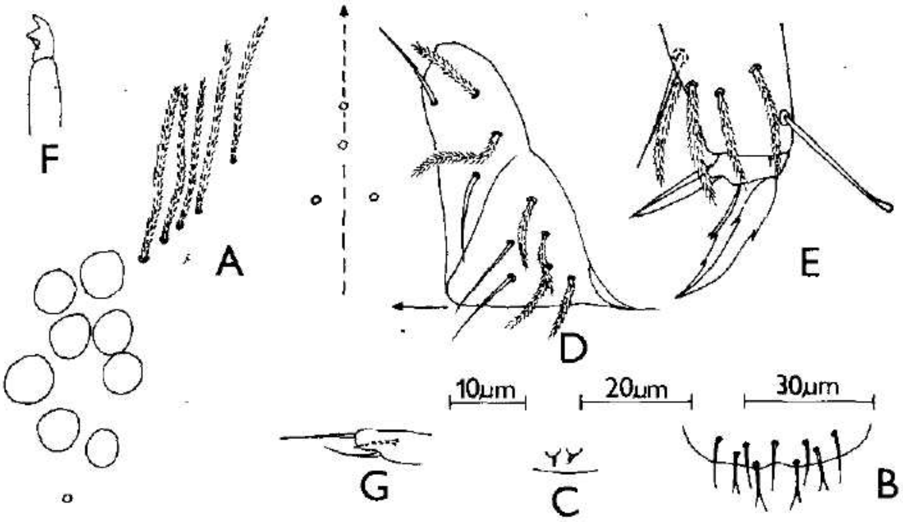

Fig. 3. ***Lepidocyrtus sibiricus*** sp. n.: A — ommatidia and frotoocular chaetotaxy on left side of head; B — two apical rows of labral chaetae; C — two medial labral papillae; D — chaetotaxy of left half of labium; E — apex of tibiotarsus and claw III; F — apex of dens and mucro; G — outer labial papilla. Scale: Figs. B, C, E, G: 10 µm; Fig. D: 20 µm; Figs. A, F: 30 µm.

Description: Body 1050 µm long. Mesonotum slightly protruding over head. Colour pale yellow, only eyes dark blue pigmented. Antennae and legs also without pigment. 8+8 ommatidia present on head (Fig. 3A).

Antennae longer than head, as 310 : 210 µm. Antennal segments I : II : III : IV as 30 : 70 : 70 : 140 µm. Antennal segments I and II with scales. Antennal organ III consists of two 3 µm long sensory pegs. Some smooth, 5 µm long sensory hairs present among the ciliated chaetae.

Formula of labral chaetotaxy 4/554. Praelabral chaetae ciliated, labral chaetae smooth, the four distal chaetae with 2—3 branches (Fig. 3B). Labral margin with four papilae with 1—2 short spinulae (Fig. 3C).

Labium with chaetal arrangement $M_1M_2REL_1L_2$ (Fig. 3D), R shorter than M_1. Anterior row of labial chaetae smooth (Fig. 3D).

Formula of dorsal macrochaetae R001/00/0101+2, R-group without R_2 chaeta (Fig. 3A). Chaetotaxy of abdominal tergite II $paBq_1q_2$. Microchaeta s absent on abdominal tergite IV.

Claw of the third pair of legs 20 µm long, with two minute proximal, one distal, two lateral and one dorsal teeth (Fig. 3E). Empodial appendage 10 µm long, lanceolate, without teeth (Fig. 3E). Dorsal tibiotarsal tenent hair 18 µm long, with spatulated apex, ventral one acuminate (Fig. 3E). Trochanteral organ consists of 10 smooth chaetae.

Manubrium : dens : mucro as 220 : 220 : 10 μm. Mucro with apical and anteapical teeth and one mucronal chaeta (Fig. 3F). Apical part of dens (45 μm) not crenulated.

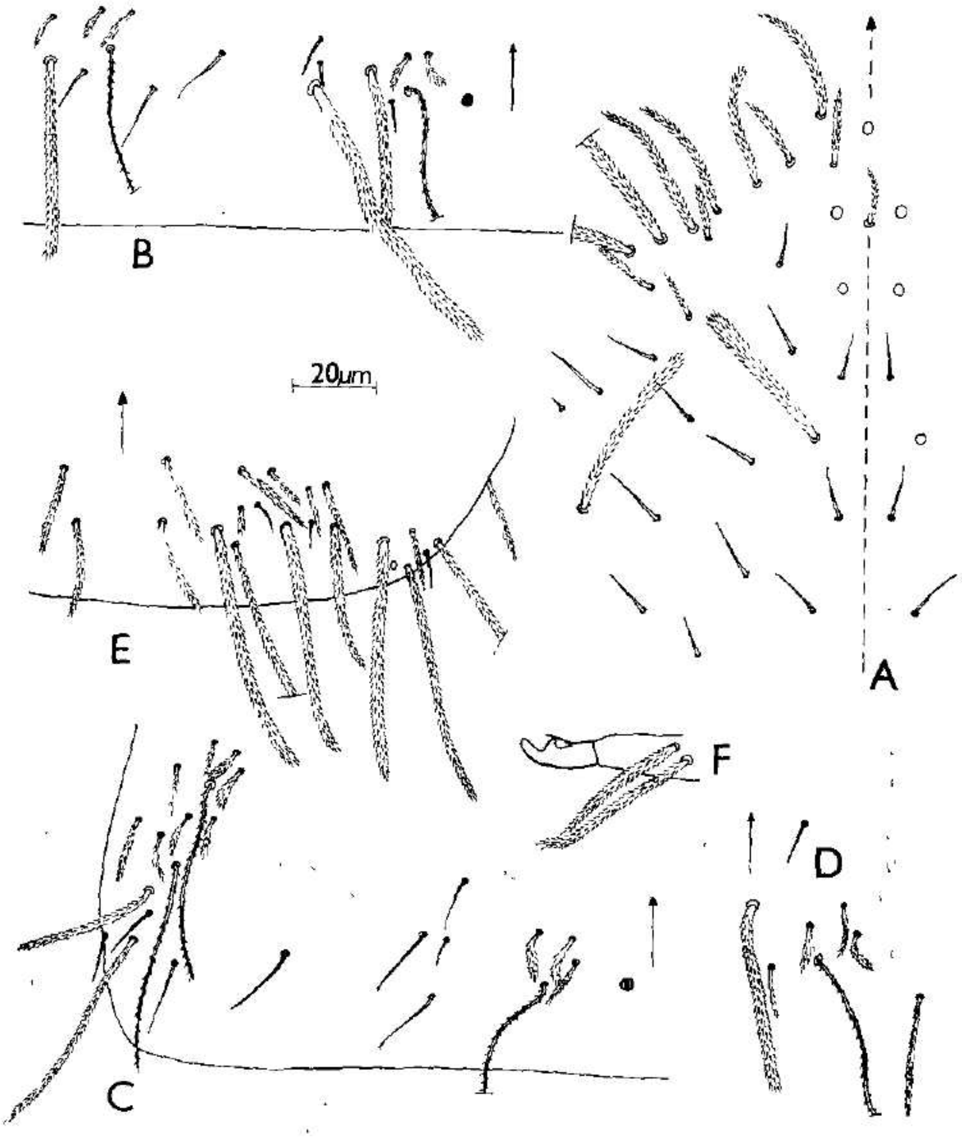

Fig. 4. *Pseudosinella noseki* sp. n.: A — anterior chaetotaxy of left dorsal side of head; B — dorsal chaetotaxy of left side of abdominal tergite II; C — dorsal and lateral chaetotaxy of left side of abdominal tergite III; D — chaetotaxy around anterior trichobotrium on abdominal tergite IV; E — dorsal chaetotaxy of left side of abdominal tergite V; F — apical part of dens and mucro. Scale: Figs. A—F: 20 μm.

Differential diagnosis: The new species is related to *L. weidneri* Hüther, 1971 and *L. szeptyckii* sp. n. It differs clearly from *L. weidneri* by the dorsal chaetotaxy of head (see in *L. szeptyckii* sp. n.) having only one macrochaeta behind the R-group. The new species differs from *L. szeptyckii* by the pale colour and by the missing R_2 chaeta on the head (R_2 chaeta present in the dark violet coloured *L. szeptyckii*).

Holotype No. 24. V. 1973/A-217 and 18 paratypes in author's collection in the Laboratory of Soil Biology, Czechoslovak Academy of Sciences, Č. Budějovice.

Locus typicus: USSR, Siberia, at the 64th km of the road from Irkutsk to Kultuk, in sample of moist mosses from a birch log from taiga dominated by *Abies sibirica*, *Pinus cembra* and *Betula* sp. with *Ledum palustre* and *Vaccinum myrtillus* in understory, 24. V. 1973 three specimens leg. J. Rusek.

Further localities: USSR, Siberia, Listvjanka on the NW shore of Baikal Lake, sample of mosses and lichens from birch trunks in a birch taiga with *Ledum palustre, Rhododendron dahuricum, Vaccinium myrtillus, Rosa* sp. and mosses in understory, 23. V. 1973 four specimens leg. J. Rusek; USSR, Siberia, at the 64th km of the road from Irkutsk to Kultuk, in protoranker soil sample from the top of a rocky hill with open plant community dominated by mosses, lichens, *Vaccinium vitis-idaea* and single *Rhododendron dahuricum*, 24. V. 1973 three specimens leg. J. Rusek; — close to the previous locality, in litter and humus sample below *Pinus cembra*, soil surface covered by lichens, 24. V. 1973 two specimens leg. J. Rusek; — USSR, Siberia, at the 64th km of the road from Irkutsk to Kultuk, in moist mosses from

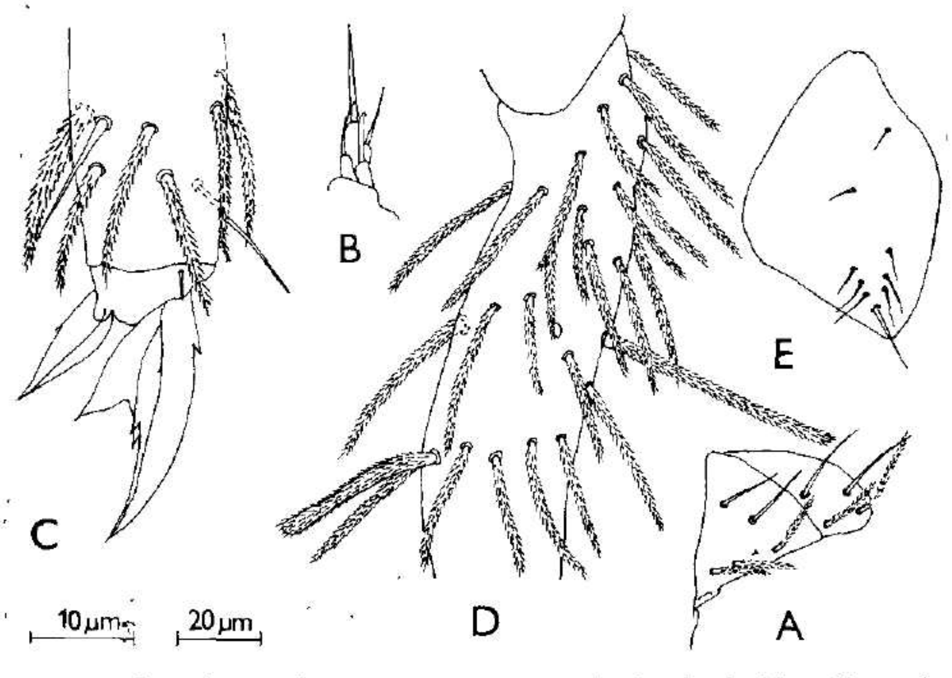

Fig. P. ***Pseudosinella noskei*** sp. n.: **A** — chaetotaxy of left side of labium; B — oute labial papilla; C — apical part of tibiotarsus and claw III; D — basal part of tibic tarsus III; E — trochanteral organ. Scale: Fig. C: 10 µm; **Figs. A, B, D, E: 20** µm. **20** µm.

a rock surrounded by taiga with dominant *Pinus cembra*, 24. V. 1973 **seven specimens** leg: J. Rusek.

Pseudosinella noseki sp. n. (Figs. 4A—F, 5A—E)

Diagnosis: 1200 μm long. White. Ommatidia missing. Chaetotaxy of labium $M_1M_2rEL_1L_2$, r reduced to short spine. Dorsal macrochaetae R011/32/ /0201+2. Chaetotaxy of abdominal tergite II $pABq_1q_2$. Abdominal tergite IV without microchaeta s. Claw with one large, wing-like and one minute proximal, one distal, one dorsal and two lateral teeth (Fig. 5C). Empodial appendage lanceolate, with one minute outer teeth. Dorsal tibiotarsal tenent hair acuminate. Trochanteral organ consists of 9 smooth chaetae.

Description: Body 1200 μm long. White, without traces of pigmentation. Ommatidia missing (Fig. 4A).

Antennae longer than head, as 390 : 270 μm. Antennal segments I : II : III : IV as 55 : 100 : 85 : 150 μm. All antennal segments without scales. Antennal organ III consists of two 6 and 4 μm long sensory pegs and some additional sensory hairs dispersed on the dorsal and lateral surfaces of the segment. Antennal organ II consists of one 6 μm long, thickened sensory peg dorsoanteriorly and some thin, smooth, slightly bent sensory hairs on the dorsal and lateral surfaces of the segment. Antennal segment IV without apical bulb and with numerous smooth sensory hairs among ciliated chaetae.

Praelabral chaetae ciliated, labral chaetae smooth. Formula of labral chaetotaxy 4/554. Labium with chaetal arrangement $M_1M_2rEL_1L_2$ (Fig. 5A), chaeta r reduced to very short spine. Frontal row of labial chaetae smooth (Fig. 5A). Outer labial papilla with long, thick sensilla (Fig. 5B).

Formula of dorsal macrochaetae R011/32/0201+2 (Fig. 4A). Chaetotaxy of abdominal tergite II $pABq_1q_2$ (Fig. 4B). Lateral chaetotaxy of abdominal tergite III as in Fig. 4C. Anterior macrochaeta present, microchaeta s absent on abdominal tergite IV (Fig. 4D).

Claw of third pair of legs (Fig. 5C) 25 μm long, with two proximal, one distal, one dorsal and two lateral teeth. Inner proximal tooth wing-like, in 55 % of length of ventral lamella and distal toth in 60 % of length of ventral lamella. Empodial appendage lanceolate, 15 μm long, with minute outer tooth (Fig. 5C). Dorsal tibiotarsal tenent hair acuminate, 12 μm long, inner one smooth, acuminate (Fig. 5C). Near base of tibiotarsus III long outer outstanding chaeta (Fig. 5D). Trochanteral organ consists of 9 smooth chaetae (Fig. 5C).

Manubrium : dens : mucro as 230 : 230 : 15 μm. Mucro with apical and anteapical teeth and one mucronal chaeta (Fig. 4F). Apical part of dens (55 μm) not crenulated.

Differential diagnosis: The new species is related to *Pseudosinella aelleni* Gama, 1973 known from one cave in Schwäbische Alb (West Germany). *P. noseki* sp. n. differs from *P. aelleni* in the much more slender claws and in the shape and size of proximal and distal teeth. In *P. aelleni* the distal tooth is in about 55 % of the inner lamella and the smaller proximal tooth is far from it, whereas in the new species the distal tooth is in 60 % of the inner lamella and the smaller proximal tooth is just below it. Empodial appendage bears in sp. n. a small outer tooth which is missing in *P. aelleni*. Also the lateral teeth on claws are missing in *P. aeleni*.

Holotype No. 16. V. 1978/A-549 and 4 paratypes in author's collection in the Laboratory of Soil Biology, Czechoslovak Academy of Sciences, Č. Budějovice.

Locus typicus: Czechoslovakia, Moravia meridionalis, in lowland forest

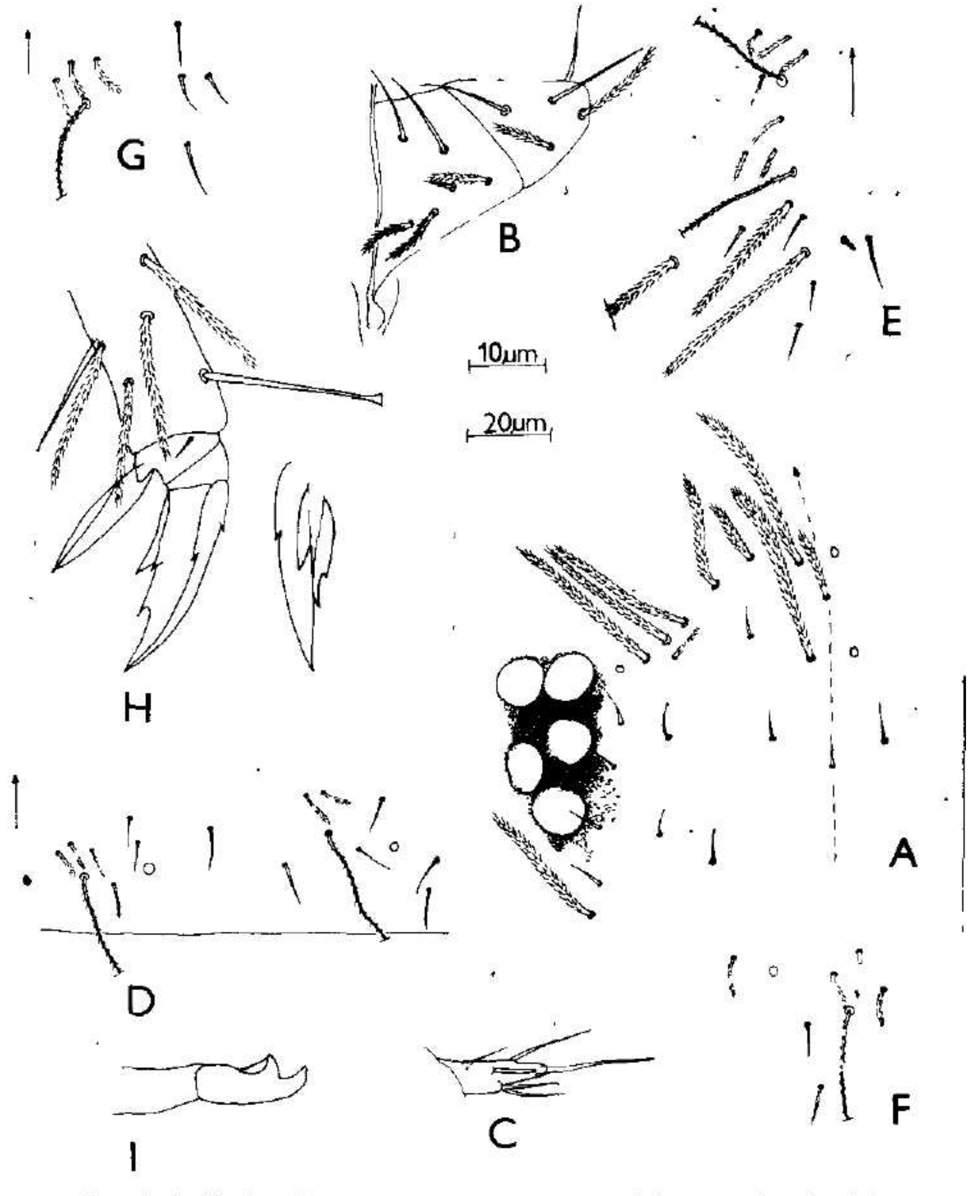

Fig. 6. *Pseudosinella horaki* sp. n. A — ommatidia and frontoocular chaetotaxy on left side; B — chaetotaxy of left side of labium; C — outer labial papilla; D — dorsal chaetotaxy of right side of abdominal tergite II; E — lateral chaetotaxy of abdominal tergite III; F — chaetotaxy arround anterior trichobotrium on abdominal tergite IV; G — dorsal chaetotaxy of abdominal tergite IV; H — apex of tibiotarsus and claw III; I — end of mucro and dens; Scale: Figs. C, H, I: 10 µm; Figs. A, B, D — G: 20 µm.

„Lanžhotský prales" Natural Reserve east of village Lanžhot, in soil samples from the forest community *Ulmeto-Fraxineto carpineum* with *Alium ursinum*, *Asperula odorata*, etc. in understory, 16. V. 1978 three specimens leg. J. Rusek.

Further locality: Czechoslovakia, Bohemia meridionalis, Bavorov near Vodňany, old apple orchard on the left from the road Bavorov – Vodňany, about 500 m from last buildings in Bavorov, in soil samples (brown grassland soil), 8. X. 1981 two specimens leg. J. Rusek.

Derivatio nominis: The new species is dedicated to my friend Ing. J. Nosek, Dr. Sc., Bratislava, well known soil zoologist and virologist contributing extensively to the taxonomy and ecology of Collembola, Protura and some other groups of animals, on the occasion of his 60th birthday.

•

Pseudosinella horaki sp. n. (Figs. 6 A–I)

Diagnosis: 1100 μm long. Pale grayish-blue. 5+5 ommatidia in dark pigmented eyespots. Chaetotaxy of labium $M_1M_2REL_1L_2$, chaeta R short, ciliated. Dorsal macrochaetae R001/00/0201+2. Chaetotaxy of abdominal tergite II $paBq_1q_2$. Abdominal tergite IV without microchaeta s. Claw with two proximal, one distal, one dorsal and two lateral teeth (Fig. 6H). Empodial appendage lanceolate, without teeth. Trochanteral organ consists of 13 smooth chaetae.

Description: Body 1100 μm long. Colour pale grayish-blue, area ocularis dark blue. 5+5 ommatidia, 12–15 μm in diameter (Fig. 6A).

Antennae longer than head, as 340 : 210 μm. Antennal segments I : II : III : IV as 50 : 95 : 60 : 135 μm. Antennal segments without scales. Antennal organ III consists of two 5 and 8 μm long sensory pegs and some additional sensory hairs dispersed on dorsal and dorsolateral surface of the segment. Antennal organ II consists of one 4 μm long sensory peg dorsoanteriorly and some thin, smooth, slightly bent sensory hairs on dorsal and dorsolateral face of the segment. Antennal segment IV without apical bulb.

Praelabral chaetae ciliated, labral chaetae smooth. Labral chaetotaxy 4/554. Labial chaetotaxy $M_1M_2REL_1L_2$, chaeta R short, but ciliated (Fig. 6B). Frontal row of labial chaetae smooth (Fig. 6B). Outer labial papilla with thin, 5 μm long sensilla not reaching to base of apical chaeta (Fig. 6C).

Formula of dorsal macrochaetae: R001/00/0201+2. Chaetotaxy of frontal and frontoocular areas on head as in Fig. 6A. Chaetotaxy of abdominal tergite II (Fig. 6D) $paBq_1q_2$. Lateral chaetotaxy of abdominal tergite III as in Fig. 6E. Anterior macrochaeta present and microchaeta s absent on abdominal tergite IV (Fig. 6F).

Claw of third pair of legs (Fig. 6H) 25 μm long, with two proximal, one distal, one dorsal and two lateral teeth. Inner proximal tooth wing-like, reaching to 50 % of length of ventral lamella. Distal tooth large, in 75 % of length of ventral lamella. Empodial appendage lanceolate, 15 μm long, without teeth (Fig. 6H). Outer tibiotarsal tenent hair with spatulated apex, 20 μm long, inner one acuminate, smooth, 16 μm long (Fig. 6H). Trochanteral organ consists of 13 smooth chaetae.

Manubrium : dens : mucro as 220 : 215 : 15 μm. Mucro with apical and anteapical teeth and one mucronal chaeta (Fig 6I). Apical part of dens (50 μm) not crenulated.

Differential diagnosis: *Pseudosinella horaki* sp. n. belongs to the

Pseudosinella wahlgreni – group having 5+5 ommatidia. It is related to *P. mauli* Stomp, 1972 and *P. sandelsorum* Gruia, 1977. The new species differs from *P. mauli* clearly by the ciliated R chaeta on labium (labial chaetotaxy in *P. mauli* is $M_1M_2rEL_1L_2$ – r reduced to short, smooth spinula) and by the different proportions between the teeth on claws (in *P. mauli* the distal tooth is in 65 % of the length of ventral lamella and the large wing-like inner proximal tooth reaches to 20 % of the inner lamella). The differences from *P. sandelsorum* are also in the labial chaetotaxy and in the shape of claw and empodial appendage. In *P. sandelsorum* are M_1 and R ciliated chaetae of the same length and are distinctly shorter than M_2 (in *P. horaki* M_1 and M_2 are of the same length and R is distinctly shorter). The ventral lamella of claws bears two distal teeth and on empodial appendage are three outer teethlets in *P. sandelsorum*, whereas the claws of *P. horaki* bear only one distal tooth and empodial appendage is without teeth.

Holotype No. 16. V. 1978/A-553 and 21 paratypes in author's collection in Laboratory of Soil Biology, Czechoslovak Academy of Sciences, Č. Budějovice.

Locus typicus: Czechoslovakia, Moravia meridionalis, in the lowland forest complex arround „Lanžhotský prales" Natural Reserve east of the village Lanžhot, in soil samples from the forest community *Ulmeto-Fraxineto carpineum* with *Quercus robur* and with *Brachypodium sylvaticum*, *Convalaria majalis*, etc. in understory, 16. V. 1978 22 specimens leg. J. Rusek.

Derivatio nominis: The new species is dedicated to Doz. Ing. J. Horák, CSc., Brno, geobotanist contributing extensively to the knowledge of synecology of different plant communities and studying also the inundated lowland forest complexes near Lanžhot and in other parts of South Moravia.

Pseudosinella marcuzzii sp. n. (Figs. 7 A–H)

Syn.: *Pseudosinella fallax:* Rusek, 1973, nec Börner, 1903

Diagnosis: 810 μm long. White. 3+3 ommatidia in 2+2 distinctly separated, dark pigmented eyespots. Chaetotaxy of labium $M_1M_2rEL_1L_2$, r reduced to small spinula. Dorsal macrochaetae R011/30/0101+2. Chaetotaxy of abdominal tergite II–aBq_1q_2. Abdominal tergite IV without microchaeta s. Claw with two proximal, one distal, two lateral and one dorsal teeth (Fig. 7G). Empodial appendage lanceolate, without teeth. Dorsal tibiotarsal tenent hair spatulated. Trochanteral organ consists of 11 smooth chaetae.

Description: Body 810 μm long. White, only 2+2 eyespots dark pigmented (Fig. 7A). 3+3 ommatidia in 2+2 distinctly separated eyespots; in frontal eyespot two, in posterior one 1 ommatidia present (Fig. 7A).

Antennae longer than head, as 310 : 200 μm. Antennal segments I : II : III : IV as 40 : 80 : 65 : 125 μm. All antennal segments without scales. Antennal organ III consists of two slightly bent, 5 μm long sensory pegs and some further sensory hairs dispersed on the dorsal and lateral surfaces of the segment. Antennal organ II consists of one 5 μm long, thickened sensory peg dorsoanteriorly and some thin, smooth, slightly bent sensory hairs on the dorsal and lateral surfaces of the segment. Antennal segment IV without apical bulb and with numerous smooth sensory hairs among the ciliated chaetae.

Praelabral and labral chaetae smooth. Formula of labral chaetotaxy 4/554.

Labium with chaetal arrangement $M_1M_2rEL_1L_2$ (Fig. 7B), chaeta **r** reduced to small spinula. Frontal row of labial chaetae smooth. Sensilla on outer labial papilla thickened, not reaching to base of apical chaeta (Fig. 7C).

Formula of dorsal macrochaetae R011/30/0101+2. Chaetotaxy of abdominal tergite II — aBq_1q_2 (Fig. 7D). Lateral chaetotaxy of abdominal tergite III as in Fig. 7E. Microchaeta s absent on abdominal tergite IV (Fig. 7F).

Claw of third pair of legs (Fig. 7G) 20 μm long, with two proximal, one distal one dorsal and two lateral teeth. Inner proximal tooth wing-like, in 45 % of the length of ventral lamella and the distal tooth in 64 % of the length of ventral lamella. Empodial appendage lanceolate, 14 μm long, without teeth

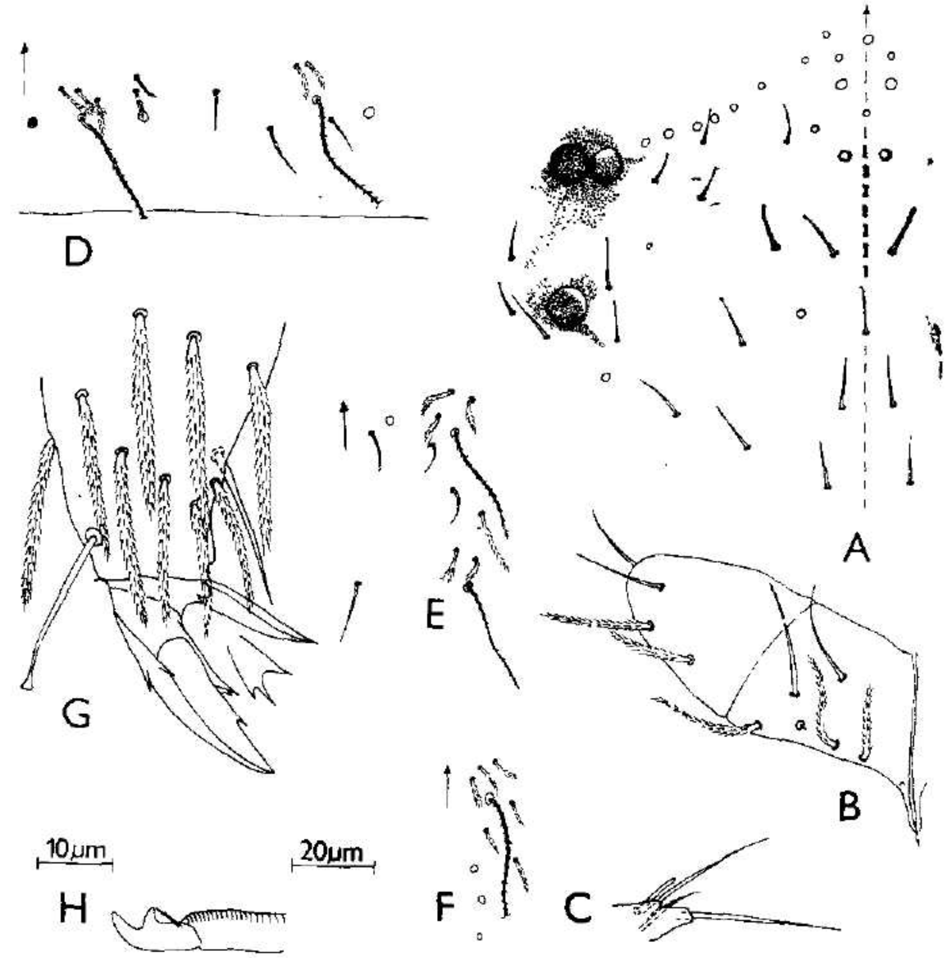

Fig. 7. *Pseudosinella marcuzzii* sp. n. A — eyespots, ommatidia and chaetotaxy of frontoocular area; B — chaetotaxy of labium; C — outer labial papilla; D — chaetotaxy of abdominal tergite II; E — lateral chaetotaxy of right lateral part of abdominal tergite III; F — chaetotaxy around anterior trichobotrium on obdominal tergite IV; G — apex of tibotarsus and claw III; H — end of dens and mucro. Scale: Figs. B,C,H,G: 10 μm; Figs. A, D, E, F: 20 μm.

(Fig. 7G). Dorsal tibiotarsal tenent hair 15 μm long, spatulated, inner one 13 μm long, acuminate (Fig. 7G). Outer long outstanding ciliated chaeta missing (?) on bases of tibiotarsi III. Trochanteral organ consists of 11 smooth chaetae.

Manubrium : dens : mucro as 150 : 160 : 10 μm. Mucro with apical and anteapical teeth and one mucronal chaeta (Fig. 7H). Apical part of dens (40 μm) not crenulated.

Differential diagnosis: The new species belongs to the *Pseudosinella sexoculata-group* having the three ommatidia on each side of head distinctly separated in two dark pigmented eye spots. *P. marcuzzii* sp. n. is related to *P. annemariae* Stomp, 1972 described from Greece. It differs from it in the labial chaetotaxy (in *P. annemariae* is only M_1 ciliated: $M_1m_2rel_1l_2$) and in the missing accessoric microchaeta s on abdominal tergite IV (microchaeta s is present on the abdominal tergite IV in *P. annemariae*).

Holotype No. 5. VI. 1970/A-98 and four paratypes in author's collection in the Laboratory of Soil Biology, Czechoslovak Academy of Sciences, Č. Budějovice.

Locus typicus: Italia borealis, Praealpe Venete, Cansiglio, in samples of brown rendzina soil from spruce forest stand with *Oxalis acetosella*, *Anemone ranunculoides*, *Cardamine* sp., *Dryopteris filix-mas*, *Fragaria* sp.. *Mnium* sp., *Polytrichum* sp., etc. in understory, 5. VI. 1970 three specimens leg. J. Rusek.

Further localities: — as Locus typicus, but in sample of rotting wood coveered with mosses, 5. VI. 1970 one specimen leg. J. Rusek; — near Locus typicus, under stones in beech wood with *Luzula* sp., *Oxalis acetosella*, *Dryopteris filix-mas*, *Polygonatum odoratum*, mosses and lichens in understory, E-slope, black mull rendzina, 5. VI. 1970 one specimen leg. J. Rusek.

Derivatio nominis: The new species is dedicated to Prof. Dr. G. Marcuzzi, Padova, ecologist and well known soil biologist contributing also to the soil fauna of Praealpe Venete.

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PROSTIGMATIC MITES (ACARINA : PROSTIGMATA) FROM THE UPPER CRETACEOUS AND PALEOGENE AMBER OF THE USSR

Miloslav ZACHARDA and D. A. KRIVOLUCKIJ

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Abstract· Fossil anystoid mites *Mesoanystis taymirensis* Zacharda, gen. n., sp. n., from the Upper Cretaceous period, and *Palaeoerythracarus sachalinensis* Zacharda, gen. n., sp. n., from the Paleogene era, are described as new taxa from the USSR Morphological data on an unidentified larva of an erythraeoid mite are presented.

INTRODUCTION

Prostigmatic mites are a large and extremely morphologically and ecologically diverse group of arachnids inhabiting perhaps all known biotopes of the world (Krantz, 1978, Lindquist et al., 1979). Mostly they are very small and delicate. Therefore it is very surprising to find the Prostigmata to be the oldest known fossil mites from the Lower Devonian (Hirst, 1923). Furthermore fossil Prostigmata are known from Cretaceous amber from Canada (Carpenter, 1937, Ewing, 1937, Vercammen-Grandjean, 1973) and have been frequently described from the Oligocene (Paleogene) Baltic amber (Koch and Berendt, 1854, Dubinin, 1962). Nevertheless the number of fossil prostigmatic mites known to date, as well as the fossils of the other Acarina groups, is minute and, in comparison with the modern known fauna, fragmentary (Krantz, 1978, Krivoluckij and Krasilov, 1977, Woolley, 1961).

These rare fossils have proved to be almost worthless for erecting a natural phyletic classification of mites (Woolley, 1961), because no phylogenetically important ancestors of modern groups have been discovered in this material. Acarologists have presumed that the principal period of extensive developmental radiation of Acarina occured during the late Mesozoic and early Cenozoic eras (Lindquist, 1975, Krantz and Lindquist, 1979). However, even the oldest known Devonian fossil Prostigmata can be classified as representatives of the modern families Nanorchestidae, Pachygnathidae, Alicorhagiidae and Tydeidae (Dubinin, 1962). Also, the fossil Prostigmata from Canadian Cretaceous amber (Ewing 1937, Vercammen-Grandjean, 1973) can be recognized as belonging to the families Bdellidae and Erythraeidae (Proterythraeidae), and oribatid mites found in amber of Jura origin (Mesozoic) are also representatives of modern families (Krivoluckij and Krasilov, 1977). All fossil mites from the Tertiary period that have been discovered particularly in amber may be placed in the principal modern families

(Woolley, 1961). Therefore currently known fossils of the Acari do not enable us to draw any conclusions about the early steps of evolution of these arachnids.

Nevertheless, the discovery of new fossil mites, even younger than Devonian, does lend precision to our knowledge of the evolutionary rate of the modern Acarina groups. These fossils also enable speculation concerning the palaeoecology of the extinct mites.

In 1971—1972 collectors from the Paleontological Institute of the Soviet Academy of Sciences discovered fossil prostigmatic mites embedded in amber originating from the Upper Cretaceous period and from the Paleogene in the Taymir peninsula and in the Sachalin Island, respectively. This material was treated in the framework of the cooperative programme between the Laboratory of Soil Biology, Institute of Landscape Ecology, Czechoslovak Academy of Sciences and the Laboratory of Radioecology, A. N. Severtzov Institute of Evolutionary Animal Morphology and Ecology, Academy of Sciences of the USSR. Representatives of the modern family Anystidae and the superfamily Erythraeoidea were distinguished. This fossil material is described in greater detail in the systematic part of this paper.

All specimens of the type material have been deposited at the National Museum in Prague, Section of Paleontology, Prague, Vítězného února 74, Czechoslovakia.

METHOD AND MATERIALS

Small, thin slices of amber containing fossil mites were cut off with a shaving-blade and polished with suède. The slices were dipped in lactic acid and examined under a standard light microscope.

SYSTEMATIC PART

Family Anystidae Oudemans, 1902

Diagnosis: Eleutherengonic predatory prostigmatic mites with short body and radiating legs. *Stethosoma and opisthosoma fused, no transverse disjugal* furrow. Mostly with distinct epivertex in frontal part of stethosoma. Chelicerae long and slender with terminal hook-like movable digit not opposed to remnants of digitus fixus. Palpal tibia with conspicuous distal thorn-like seta (setae) opposing to the terminal palpal tarsus in so called „thumb — claw complex". Dorsal integument often with smooth, non-striated, plates bearing setae. Tarsi of legs with 2 claws and 1 empodium.

To date 12 genera have been well defined within the Anystidae and divided into 2 subfamilies, Anystinae s. str. and Erythracarinae Oudemans, 1936. At present the representatives of the genus *Adamystis* Cunliffe, 1957 are classified within the separate family Adamystidae.

Fossil Anystidae are known from Baltic amber (Paleogene): ***Anystis venustula*** (Koch and Berendt, 1854). The family needs a complete taxonomical revision including further study of modern representatives.

1. Subfamily Anystinae Oudemans, 1902

Diagnosis: Body short and broad, anal aperture subterminal on ventral side of opisthosoma, coxae of legs gathered into one group, small unpaired medioventral shield between coxae III—IV. One to two pairs of small shields with long setae outside the genital aperture, hypostome long with 8—12 pairs of setae, palpal tarsus and tibia densely barbed, palpal basis with 1 small supracoxal seta, chelicera with 2 setae. Tarsus of leg shorter than tibia and always unsegmented, claws smooth or wrinkled, but never feather-like. Legs with 2 types of setae: short, spinulate, dense and smooth setae and long, scarce, pubescent setae.

Five well distinguished modern genera (Oudemans, 1936).

2. Subfamily Erythracarinae Oudemans, 1936

Diagnosis: Body slender and long, anal aperture terminal on opisthosoma, coxae of legs frequently divided into 2 groups. Unpaired shield between coxae III—IV, and shields aside genital opening, absent. Hypostome short with only 3—4 pairs of setae. Palpal tarsus and tibia scarcely barbed or nude, palpal supracoxal seta absent. Chelicera with 1—2 setae. In species with 4 eyes tarsus longer than tibia and often secondarily subdivided, claws feather-like. Legs mostly with only 1 type of setae: long and finely pubescent.

Seven well distinguished genera (Oudemans, 1936, Willmann, 1940).

Mesoanystis Zacharda gen. n.

Diagnosis: Body short and broadly oval, only 1 type of setae on legs: strong, thick, nude thorn-like setae arranged in wreaths, undivided tarsus a little *longer than tibia, claws smooth. Palpal tibia with 1 strong terminal thorn on* thick conic tibial projection (Fig. 1 — B).
Monotypic genus. Masculine gender.
Type of the genus: ***Mesoanystis taymirensis*** Zacharda, sp. n.

Mesoanystis taymirensis Zacharda sp. n. (Fig. 1 — A, B)
For the characteristics see the diagnosis of the genus.
Upper Cretaceous era.
Differential diagnosis: To date the only representative of the Anystidae known from the Cretaceous period. The shape of the body, undivided tarsus and smoth claws suggest the affinity to the subfamily Anystinae. The chaetotaxy of the legs and its arrangement partly resemble ones in the representatives of the modern genera *Tarsotomus* Berlese and *Tarsolarkus* Sig Thor (cf. Oudemans, 1936), but the tarsi of the latter two genera are always divided. The idiosomal morphological characters are not visible in the examined material.

Material examined: *Holotype, the USSR, Taymir* peninsula, Jantardach. 1971. embedded in amber from the Upper Cretaceous period (the data furnished by D. A. Krivoluckij), leg. A. Rašnicyn, coll. National Museum in Prague, Czechoslovakia, Section of Paleontology, 1 slice of polished amber, coll. no. T 701, 1 specimen badly visible in air-bubble enclosure; 1 paratype, otherwise the same data as in the holotype, destroyed and lost during manipulation.

Discussion: To date the only known fossil anystid mite, *Anystis venustula* (Koch and Berendt, 1854), originates from Paleogene Baltic amber (cf. Dubinin, 1962). *We have not seen this specimen and cannot give any detailed* taxonomic information on it. The original and only habitual drawing of this species (Koch and Berendt, 1854, Plate XIII, Fig. 106) enables us to distinguish only the representative of the Anystinae.

The newly described species *Mesoanystis taymirensis* from the Upper Cretaceous period is the oldest fossil anystid mite known. Unfortunately the very meager knowledge of the modern Anystidae does not allow us to discuss the taxonomic position of this fossil species in greater detail.

Palaeoerythracarus Zacharda gen. n.

Diagnosis: Body elongated and oval, anal aperture terminal, chaetotaxy of body and appendages very long and finely pubescent. Distinct epivertex with 1 pair of long setae. Prodorsal setae inserted in paraxial rows. On opisthosoma only 2 pairs of humeral setae, 1 pair of dorsal setae 1 and 2 arranged in transverse rows (cf. Oudemans, 1936). Tarsi apparently not secondarily subdivided, longer than tibiae and bear feather-like pubescent setae. Claws smooth. Palpi long and slender, palpal tibia with 1 very long and slender sickle-shaped thorn on distinct conic tibial projection. Chelicera with 1 seta. Monotypic genus. Masculine gender.
Type of the genus: *Palaeoerythracarus sachalinensis* Zacharda sp. n.

Palaeoerythracarus sachalinensis Zacharda sp. n. (Fig. 1 – C–H)

Length of body 395 and 500 μm, breadth of body 220 and 176 μm, ratio length of tarsus IV to tibia IV: 1.28, 1.40, 1.60. For further description see the diagnosis of the genus.
Paleogene period.
Differential diagnosis: The very long and sickle-shaped thorn on the palpal tibia and the smooth claws differ *P. sachalinensis* from the only known modern species *Erythracarus parietinum* (Herm., 1804).

Material examined: Holotype, the USSR, South Sachalin Isl., Starodubskoe, 1972, Paleogene amber, coll. National Museum in Prague, Czechoslovakia, Section of Paleontology, coll. no. T 703, the well preserved specimen in the slice of amber, paratype no. 1, coll. no. T 704, otherwise the same data as in the holotype. Paratypes no. 2–5, coll. no. T 705–T 708, respectively, are embedded in air-bubble enclosures and only their appendages can be well observed. Otherwise the same data as in the holotype.

Superfamily Erythraeoidea Oudemans, 1902

For the general characteristic of the superfamily see Southcott, 1961.
One larva was found embedded in amber from the Upper Cretaceous period.

The modern larvae of Erythraeoidea lack urstigmae, genital and anal apertures. Three families can be distinguished within the Erythraeoidea:

1. Proterythraeidae Vercammen-Grandjean, 1973, fossil monotypic family.
2. Erythraeidae Robineau-Desvoidy, 1828, modern, larvae without bothridial setae on legs I.
3. Smarididae Kramer, 1878, modern, larvae with bothridial setae on legs I

The fossil Erythraeoidea are known from the Cretaceous amber (Ewing, 1937, Wercammen-Grandjean, 1973) and Baltic Paleogene amber (Dubinin, 1962). The material of the Paleogene Baltic amber, as far as it exists at all, should be re-examined from the modern systematic viewpoint.

Description of the new fossil material (Fig. 2)

One well preserved specimen of the larva of Erythraeoidea. Terminal parts of legs missing or not visible. Urstigma absent,scutal shield with 5 pairs of setae or their insertion pits. Two pairs of eyes. Integument of idiosoma, except for smooth prodorsal scutal shield, strikingly striated in rough transverse rows. Hysterosoma with 8 dorsal rows of strong, long and probably pubescent setae. Length of body 400 μm, breadth 175 μm, length of gnathosoma 120 μm. The standard biometric data for Erythraeoidea (cf. Southcott, 1961) are as follows: AW — 44 μm, MW — 34 μm, PW — 53 μm, SBa — 12 μm, SBp — 17 μm, ISD — 53 μm, L — 70 μm, W — 70 μm, A—P 35 μm, AL — 35 μm, ML — broken off, PL — 34 μm, A Sens — broken off, P Sens — broken off, ASBa/ISD — 0.25, DS — 35—40 μm.

Discussion: According to the shape and chaetotaxy of the scutal shield the larva may be tentatively placed in the family Erythraeidae although the diagnostically important chaetotaxy of the legs I is not visible.

Material examined: 1 specimen embedded in a slice of amber, the USSR, Taymir peninsula, Jantardach, 1971, leg. A. Rasnicyn, coll. National Museum in Prague, Czechoslovakia, Section of Paleontology, coll. no. T 702.

CONCLUSION

On the basis of comparison of the fossil specimens of the Anystidae with the original descriptions of the modern taxa (Oudemans, 1936, Meyer and Ryke, 1960) we have erected two new monotypic genera *Mesoanystis* gen. n. and *Palaeoerythracarus* gen. n., There is no doubt that the new fossil species *Mesoanystis taymirensis* and *Palaeoerythracarus sachalinensis* belong to the modern family Anystidae, but they differ from modern species in many morphological features which have been stressed by erecting the new genera. However, the present meager knowledge of taxonomy of the modern Anystidae does not allow any more detailed conclusions about the taxonomic position of these fossils. In any case, *M. taymirensis* and *P. sachalinensis* cannot be considered ancestral to the modern Anystidae, and probably they are also worthless for phyletic classification of this group of mites.

The larva of Erythraeoidea should be evaluated from the viewpoint of modern knowledge of the larval morphology of this superfamily or allied groups (Vercammen-Grandjean, 1973). Therefore we have studied only diagnostic characters of the larval Erythraeoidea stressed in the literature (Southcott, 1961), but no classificatory conclusions have been made.

The modern larvae and adults of the Anystidae and Erythraeoidea are frequently found on vegetation (Meyer and Ryke, 1960, Southcott, 1961). Therefore it is not surprising to find the fossils of these mites embedded in amber, and the paleoecology of the fossil species can be assumed similar to that of the modern representatives.

Acknowledgement

We wish to thank Dr. Evert E. Lindquist, Biosystematics Research Institute, Agriculture Canada, Ottawa, for kindly furnishing us with basic information on fossil Prostigmata and Dr. Thomas Schiess, Natural History Museum Basel, Switzerland, for providing us with some arduously accessible acarological literature.

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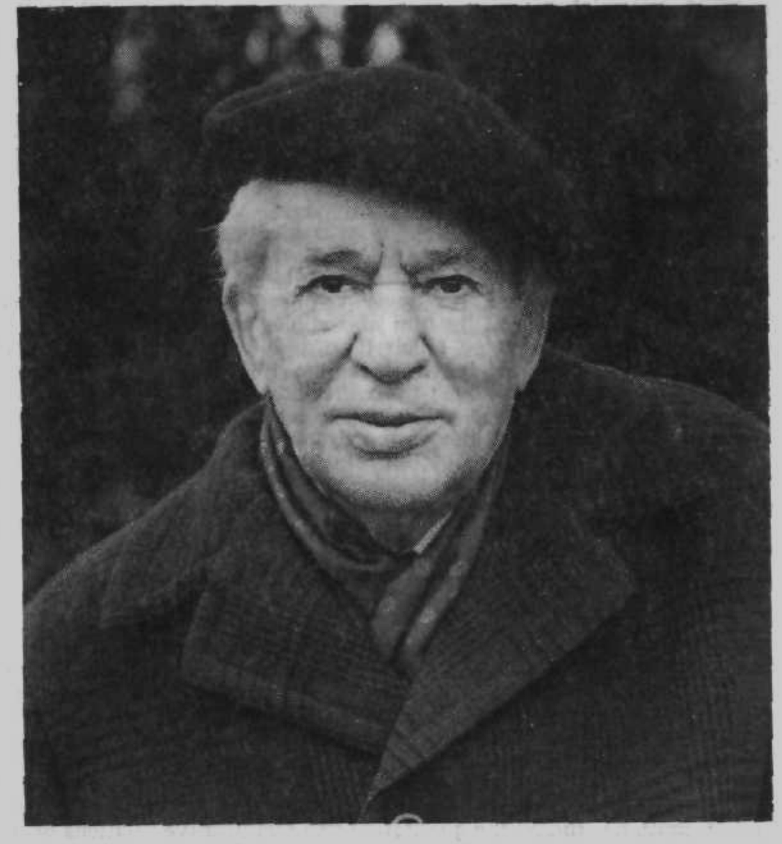
IN MEMORY OF PROF. RNDr. SERGĚJ HRABĚ, DrSc.

Dr. S. Hrabě, full professor of general and systematic zoology at the Faculty of Science, J. E. Purkyně University in Brno, holder of the Gold Medal of J. E. Purkyně University, holder of the Order of Labour of the ČSSR, one of the distinquished representatives of Czechoslovak zoology, died on 29 March 1984 at the age of almost 85 years. We parted with him on 5 April, 1984.



Prof. Hrabě did not have an easy life; to overcome the difficulties and obstacles, particularly in his youth and in his old age, he could only rely on himself. Despite this, he succeeded in achieving, through his great personal modesty, perseverance and industry, exceptional results in the scientific, pedagogical and social fields, which is documented by fully deserved recognitions including the Order of Labour which Prof. Hrabě highly valuved.

S. Hrabě was born on 16 July 1899 in Moscow; there he began his university studies which he continued — after *his family's return to their country* — at the Zoological Institute of the Faculty of Science, Charles University in Prague, headed by Prof. Dr. A. Mrázek. The studies of water fauna and particularly of the group Oligochaeta had had a long tradition at that institute and they had been of a high standard since the times of Prof. Dr. F. Vejdovský. It was therefore logical that S. Hrabě became concerned with the animal class Oligochaeta in his doctoral thesis and he remained faithful to it throughout his life.

After finishing his university studies and earning a degree Doctor of Natural History he left for Brno in 1927; there he became assistant lecturer at the Zoological Institute of the Faculty of Science of the University, headed by Prof. Dr. J. Zavřel. Despite an attractive offer of full professorship at Charles University in Prague after World War II he remained faithful to Brno and Moravia. In Brno he applied himself to intensive scientific, pedagogical and culture work. At the Zoological Institute he introduced an important methodological branch – zoological microscopy. After being appointed Associate Professor in 1933 he started lectures in hydrobiology, thus laying its foundations at the University of Brno. Gradually, hydrobiology achieved an international standard there, particularly the study of running waters and practically important prognoses of water quality in water reservoirs built at the time, as well as the study of determining water saprobity according to biological indicators. In 1938 he was proposed to become Professor Extraordinary, but the closing of Czech Universities and war events prevented his appointment. During World War II he did agricultural research. Immediately after the war he took over the much damaged Zoological Institute, had it renovated and organized zoology courses at the Faculty of Science of the University of Brno on behalf of the seriously ill director of the Institute. After Prof. Zavřel's death he was appointed Full Professor of general and systematic zoology at the Faculty of Science of the University of Brno, and became director of the Zoological Institute, later Department of Zoology and Anthropology.

As a university teacher he was popular with students not only for his personality but also for the form and clarity of his lectures which were characterized by perfect preparation and inclusion of the latest results of scientific research together with critical comments on them. He never required bookish formulations of his students. The excursion organized by him and zoological investigations in the field were also very popular. He devoted much time and energy to his students if they showed a genuine interest in zoology. His active interest in students' needs was reflected in the fact that he took over from the late Prof. Dr. E. Bayer, the edition of the first Czech university textbook "Zoologie všeobecná a přehled živočišné soustavy" (General Zoology and an Outline of the System of Animals), published in 1948 as the 116th volume of Publications of the Ministry of Agriculture in Prague. Later he translated into Czech 2 university textbooks of zoology, S. P. Naumov's "Zoology of Vertebrates" published in 1955 by the State Pedagogical Publishing House in Prague, and V. A. Dogel's "Zoology of Invertebrates" published by the same publishers in 1961. Of great importance to the general zoological public was the publishing of volume I of the series "Klíč zvířeny ČSR" (Key to the Fauna of the CSR) in 1954 by the Publishing House of the Czechoslovak Academy of Sciences in Prague, edited by him.

As documented by the list of his major scientific publications, Prof. Hrabě – in accordance with his function of university professor – showed a broad active interest in the fauna living in water and in humid environment (Coelenterata, Turbellaria, Annelida, Bryozoa, some groups of Crustacea, and others). Together with Prof. Dr. K. Absolon he described a new interesting taxon from the caves of the Balkans, Polychaeta Marifugia cavatica adapted to subterranean life. Important are his general hydrobiological works: at least his studies on the fauna of the tarns of the High Tatra (1939, 1942) should be mentioned, in which, using extensive material from 43 tarns and 23 pools, he studied the qualitative and quantitative relations of organisms in the given environment and on the basis of the obtained results he established his own typology of the Tatra tarns. His publication also show his interest in general zoological and experimental problems. His permanent active interest in the Czechoslovakian fauna of fishes is documented, among others, by his co-authorship of a practical handbook "Klíč našich ryb" (A Key to Our Fishes), published in 1953 by the Publishing House of the Czechoslovak Academy of Sciences Prague in collaboration with Asst. Prof. O. Oliva, which was soon out of print. Later it appeared in an extended edition in 1968 in the book "Stavovce Slovenska I" under the heading "Fishes, Amphibians and Reptiles", published by the Slovak Academy of Sciences in Bratislava in co-authorship with Asst. Prof. O. Oliva and Dr. J. Lác. In 1973, "Klíč našich ryb, obojživelníků a plazů" (A Key to Our Fishes, Amphibians and Reptiles) appeared again in the State Pedagogical Publishing House in Prague in coauthorship with Asst. Prof. O. Oliva and Dr. Opatrný.

In Moravia, Prof. Hrabě found much opportunity for field research of the animal groups studied by him and little known there. This particularly concerns research at important south Moravian localities to which he paid a systematic attention. Besides Bohemia and Moravia Prof. Hrabě investigated the fauna of Slovakia, the then Ruthenia and also some interesting regions outside of Czechoslovakia, especially in the Balkan.

Oligochaeta were Prof. Hrabě's main interest throughout his life. Owing to his profound morphological and systematical studies as well as ecological and phylogenetical ones published at home and abroad he soon became an internationally renowhed specialist in this group, receiving material from individual zoologists, institutions and even scientific expeditions. This is documented by the fact that, besides his own large collections, Prof. Hrabě worked out material of Oligochaeta from 13 countries of Europe, Asia and Africa. But his closest scientific contact was with the USSR: he studied the material of Oligochaeta from important localities in that country, such as lakes near the Volga River, Issyk-Kul, the lakes Aral, Onega, Teleckoe, the Caspian Sea, Baikal, Estonian lakes, and others.

Prof. Hrabě's extraordinary activity is also reflected in the unusual extent of the material worked out by him the described 15 new genera and 88 new species of the Oligochaeta which, except for his last papers (1980, 1982 and 1984) are listed in the catalogue "Nomenclatura Oligochaetologica" published in Canada in 1976. Its authors, J. W. Reynolds and D. G. Cook rank Prof. Hrabě among the most important research workers in limicole Oligochaeta and highly value his share in determining the occurrence of Tubificida in seas, which had formely been almost unknown. Among the newly described species of Oligochaeta, 17 come from Czechoslovakia which is one of the countries most throughly investigated in this respect. In recognition of the scientific merits of Prof. Hrabě, one new genus and 5 new species of Oligochaeta and 6 species of other animal groups have been described in his honour.

Prof. Hrabě retired at the beginning of March 1970, leaving the Faculty of Sciences of J. E. Purkyně University after 42 years of work at the department which he had helped to build and develop. Nevertheless, he remained as active as ever even after his retirement. He kept working systematically, doing field research in this country and abroad, studying the almost unknown fauna of Oligochaeta of the Black Sea and of the Mediterranean. The results of the study of his own material as well as that obtained from abroad were published in 12 papers after 1970. In them he further described new genera and species of Oligochaeta, revised, complemented and keyed a number of species and higher taxa of Oligochaeta.

His paper "Vodní máloštětinatci (Oligochaeta) Československa" (The Freshwater Oligochaeta (Annelida) of Czechoslovakia), published in the series Acta Universitatis Carolinae, Prague, 1981 is of national importance and practically usefulness. This work includes keys to and descriptions of all species of the class Oligochaeta found in this country, supplemented by new illustrations by the author in 20 tables, summarizing the knowledge and life-long experience of Prof. Hrabě. His last papers are studies on Oligochaeta from the tundra along the river Ob near the polar circle (1 new species), from the Lake Baikal (4 new genera and 5 new species) and from brakish waters of India, with descriptions of 2 new species.

On the whole Prof. Hrabě published more than 80 scientific papers, besides a number of technical articles, reports, reviews and obituaries, mostly concerning investigations of the Oligochaeta, particularly the families Lumbriculidae, Tubificidae, Haplotaxidae and Naididae.

Finally, the 42 years of Prof. Hrabě's activities at the Zoological Institute, later the Deparment of Zoology and Anthropology of the Faculty of Science, I. E. Purkyně University should be at least briefly mentioned. For a long time he was head of the Institute, participating in the education of specialists in zoology and hydrobiology and of a whole generation of grammar school teachers. Prof. Hrabě served in various important functions ensuing from his position and from his professional interest. In 1966 he was appointed head of a Hydrobiological Laboratory for the Research of Running Waters. It was characteristic of him to prefer functions requirin much if his time and energy to purely social ones. Throughout his life he was active in scientific societies (among others he was chairman of the Czechoslovak

Zoological Society in Brno), on editorial boards (also of the Journal of the Czechoslovak Zoological Society in Prague), in publications committees, in the publication exchange service of the Brno university, and in other societes of natural history. He participated in improving, instruments, especially for hydrobiological purposes, such as an improved sampling device for taking samples of pelagic and benthic faunas, also used in applied hydrobiology. In recognition of his merits he was twice awarded the title Examplary Worker of J. E. Purkyně University and appointed honorary member of the Czechoslovak Limnological Society of the Czechoslovak Academy of Sciences. However, what should particularly be pointed out is his uncommon interest and devoted activity in the Club of Natural History, one of the oldest Czech societies in Brno, which he joined immediately on his arrival in the city and whose member he remained til the end of his life. He became a member of the board, and besides participating in the programme of the Club he acted as its theasurer for many years. After the death of Academician Podpěra in 1954 he was elected its chairman, and thanks to his constant efforts the Club of Natural History has produced many valuable results in the field of natural history and culture.

Prof. Hrabě will be remembered as a modest but exacting scientist who saw and made his contribution to society in systematic and honest work. He really was one of the leading and most respected zoologists in this country. The community of naturalists, his friends, students and all who knew Prof. Hrabě and have been influenced by him esteem his work, his scientific legacy and personality and will never forget him.

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Stanislav Obr

Bykov B. A.: *Ekologičeskij slovar* (Ecological dictionary). Publ. House Nauka, *Alma-Ata, 1983, 215 pp., 47 Figs. Price 1.20 Rb. (15,50 Kčs).*

During a rapid development of a certain scientific discipline — and ecology undoubtedly belongs to such disciplines — a number of new concepts appear which enrich the existing generally known terminology. In such cases the professional public will surely appreciate a publication which provides the appropriate definitions. The ecological dictionary reviewed belongs to such helpful publications. It includes over 1000 terms from the fields of plant and animal ecology, often accompanied by explanations of their etymology. The text also includes examples to the terms explained and is suitably complemented by numerous figures and tables.

The wide and topical importance of ecology makes this publication very useful to everyone who concerns himself with this discipline and its related branches. Therefore, the appearance of this dictionary, the first of this kind in the USSR, is to be welcomed.

V. Černý

Vouk V. B. and Sheenan P. J. (eds.) (1983): *Methods for assessing the effects of chemicals on reproductive functions.* John Wiley and Sons, Chichester, New York, Brisbane, Toronto, Singapore. ISBN 0 471 105364. 541 pp.

The book reviews methods for evaluating toxicologic influences on reproductive functions of living organisms. It is issued by Scientific Group on Methodologies for the Safety Evaluation of Chemicals (SGOMSEC). SGOMSEC operates under the general sponsorship of the Scientific Committee on Problems of the Environment (SCOPE) and the International Program on Chemical Safety (IPCS), which are collective programs of three United Nations Organisations: the World Health Organisation (WHO), United Nations Environment Programme (UNEP), and the International Labour Organisation.

The book contains two main parts presented in different ways. The first Joint Report contains the conclusions and recommendations of a workshop in Ispra in Italy, 1981. The methods for testing the influence of chemicals on reproducitve functions of mammals are discussed separately; a special chapter is given to females and another one to males. Following are methods for assessing the above stated effects on other vertebrates, divided into subchapters for birds, fish, reptiles and amphibia. The invertebrates involved in the Joint Report are as follows: Plathelminthes, Cnidaria, Aschelminthes, Annelida, Arthropoda, Mollusca and Echinodermata, for which the results of laboratory tests are described. In addition, the results of field observations and analyses of material collected in the field are described in this part. The last section involves methodics suitable for higher plants, algae and microorganisms.

The second part of the book is composed of 24 contributions from 41 experts in various fields of interests. More than a half of these contributions are devoted to influences on reproductive functions of man and of some other mammals. The following group of papers describes the effects of chemicals on reproductive functions of birds, fish, reptiles, and amphibia. Among the invertebrates, special chapters are given to insects, sea molluscs and marine worms. Other groups of invertebrates which are reviewed include Cnidaria, Plathelminthes, Aschelminthes, Annelida, Crustacea, Echinodermata. The conclusion as well as the Joint Report are devoted to higher plants, algae and microorganisms.

Assessing effects of penetration of chemicals into natural and modified ecosystems is a very topical and still growing problem. Therefore it is necessary to protect human health and the environment from unfavourable influences of a growing number of chemicals in the market and in the environment. SGOMSEC deals this problem and supports scientists in their effort to develop and choose methods for assessing harmful chemical effects on various forms of life. This publication not only reviews methods known but also points out situations when suitable methods are not available and suggests ways to fill the gaps. The methods described are not detailed as the publication serves for specialists who are supposed to have general knowledge necessary for adopting these methods. The book should find readers mostly in governmental control and regulatory agencies, industries and research organisations. As a source of basic information on harmful effects of chemicals on reproduction of various living organisms, it will surely interest a large number of specialists.

The editors did a good job: each chapter icludes a list of basic literature, and a subject index enables easy orientation within the book.

This is the twentieth publication of SCOPE, and is also the first in the planned series of SGOMSEC.

M. Tonner

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ig. 3: Albrechtický spoil bank (85 [illegible]

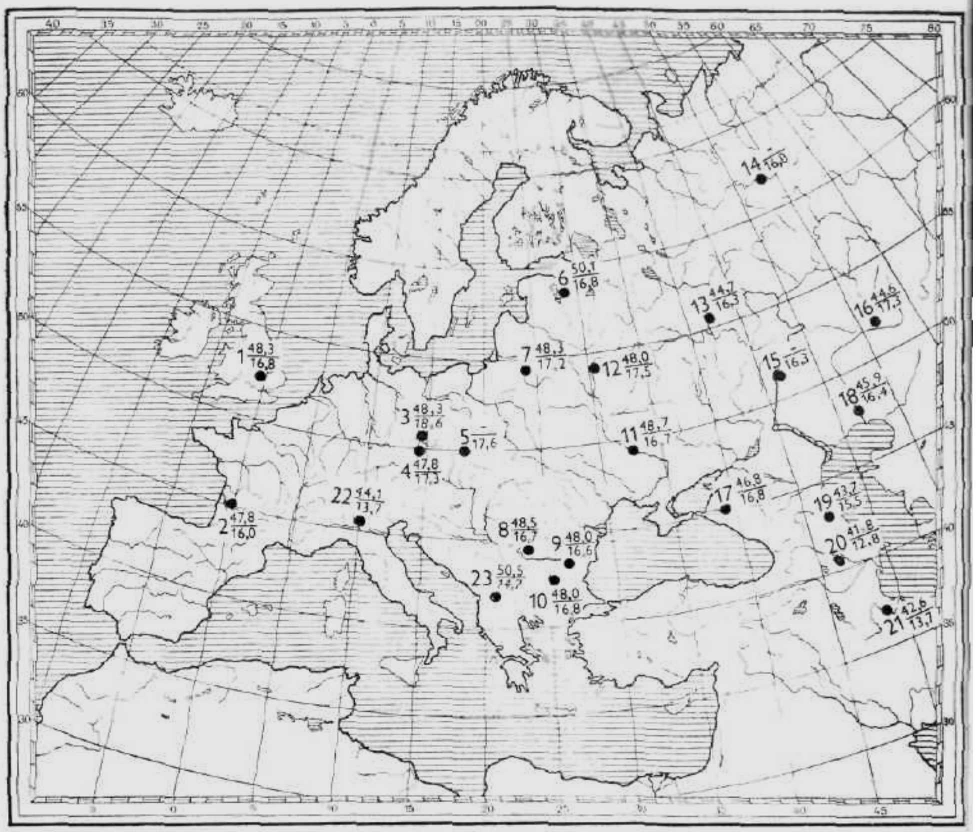

Abb. 1. Die geograpische Lage der Lokalitäten. Der Bruch bei jeder Lokalität gibt *im Zähler* die Schuppenzahl in der Seitenlinie, im Nenner die Zahl der weichen Strahlen in der Afterflosse an. Die „Übersicht und die Nummern der Lokalitäten siehe Tafel 1.

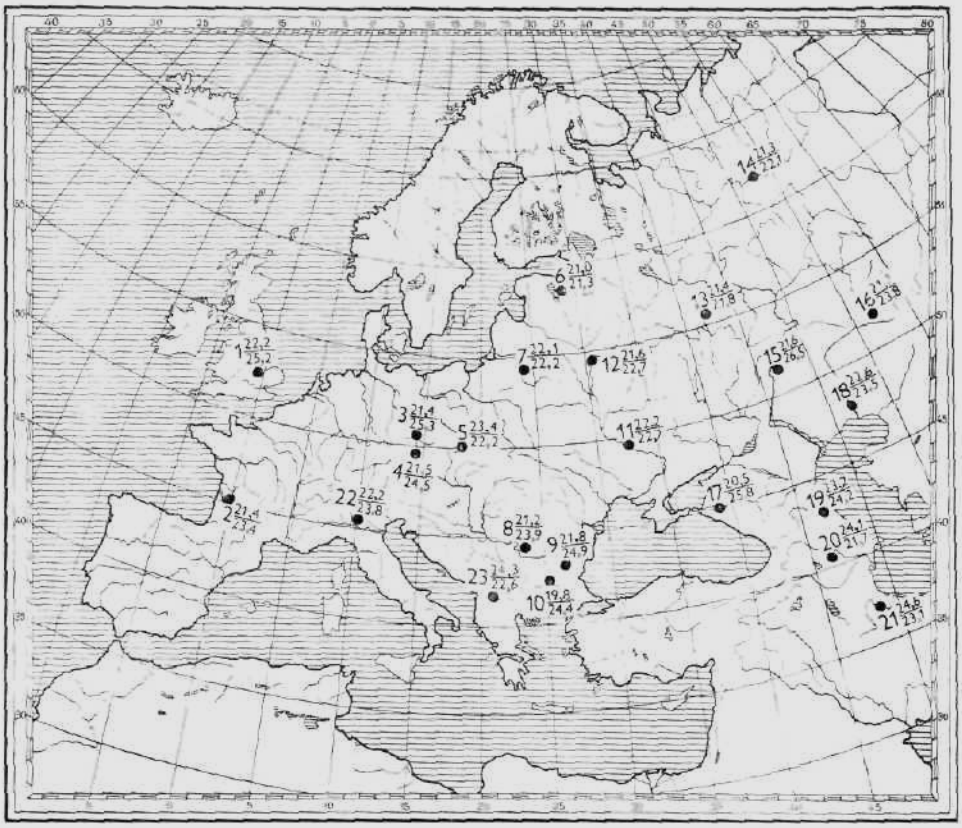

Abb. 2. Dasselbe wie in Abb. 1. Der Bruch gibt im Zähler die Werte der Kopflänge in % der Körperlänge, im Nenner die Werte der maximalen Körperhöhe in % der Korperlänge an.

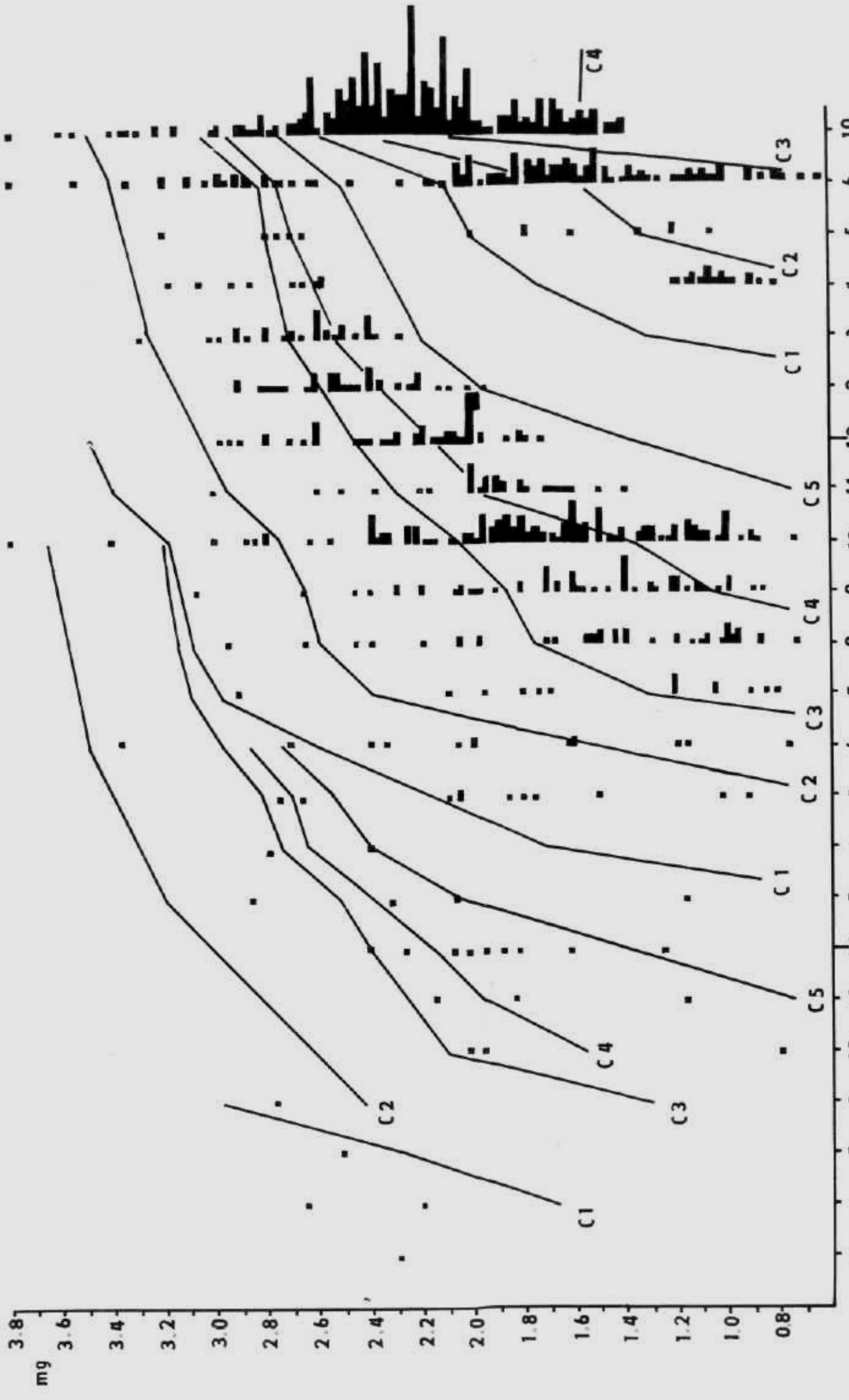

Fig. 2. Dry matter weight of eye lenses of *Microtus arvalis* in the years 1979–1981.

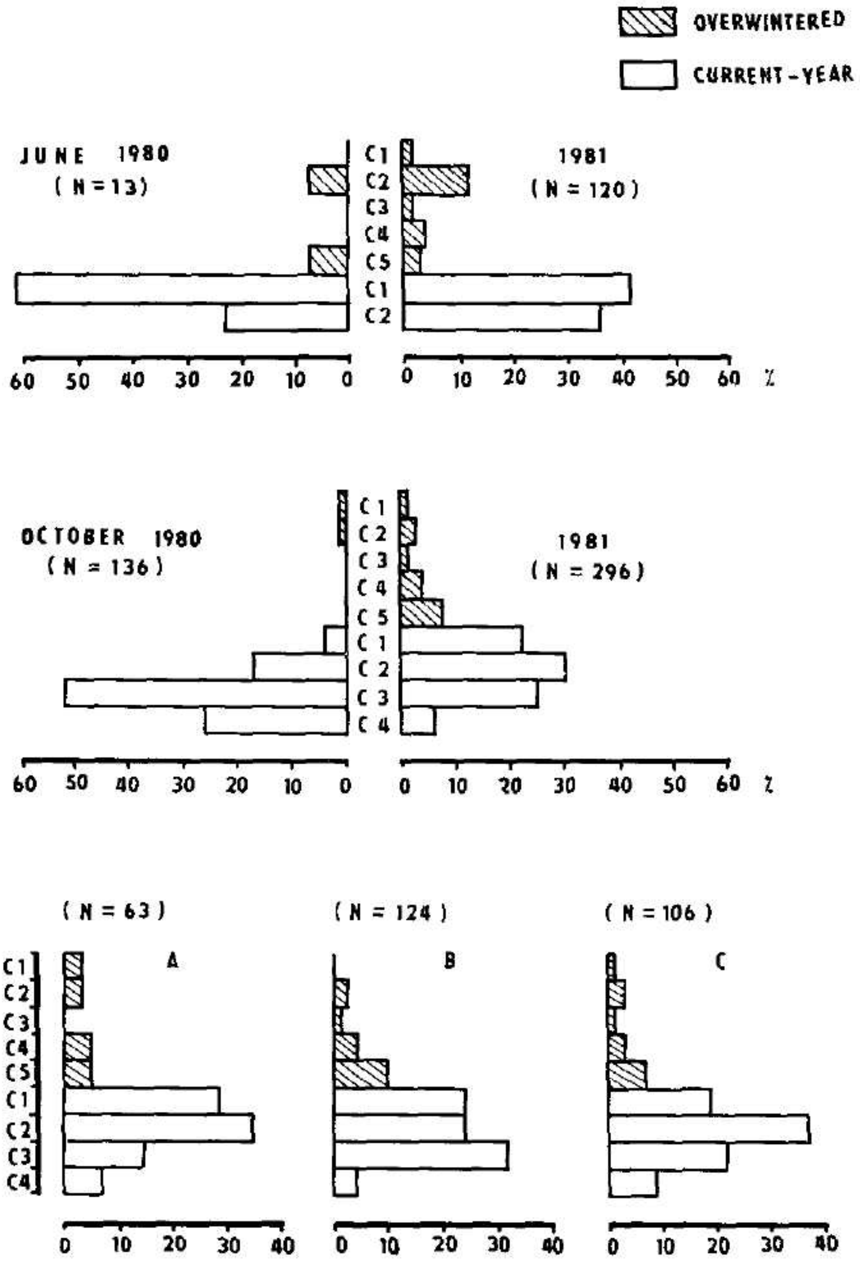

Fig. 3. Proportions of the individual cohortes (C1—C5) of *Microtus arvalis* in the years 1980—1981 in samples from July and October, and comparison of the proportions of cohortes in plots A, B, C in October 1981

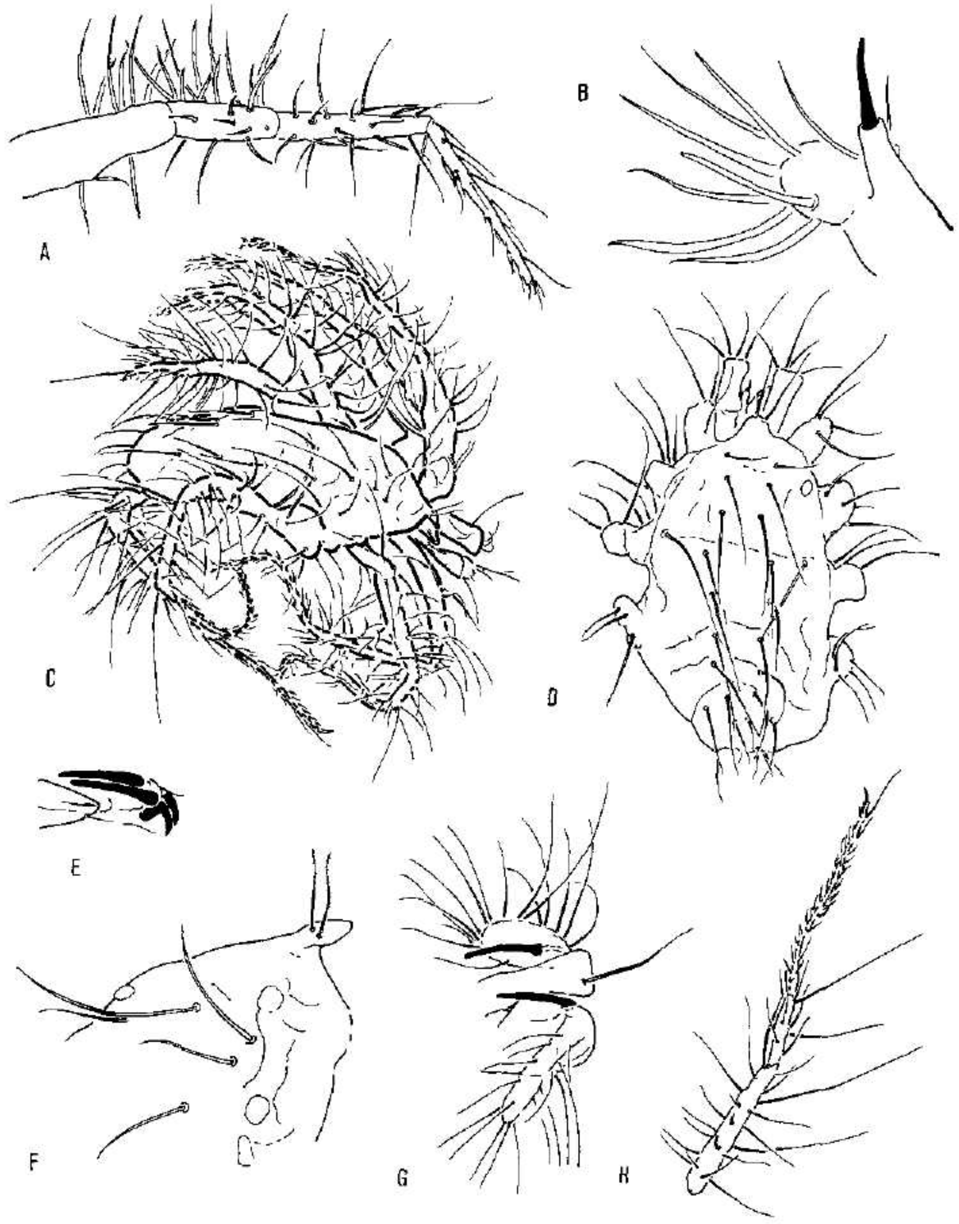

Fig. 1: *Mesoanystis taymirensis:* A — chaetotaxy and terminal articulation of leg IV, B — terminal part of palpus (holotype); ***Palaeoerythracarus sachalinensis:*** C — general view (paratype no. 1), D — arrangement of dorsal chaetotaxy (holotype), E — sickle-shaped thorns on pedipalpal tibiae and hook-like cheliceral movable digits (paratype no. 1), F — epivertex and prodorsal chaetotaxy in detail (paratype no. 1), G — terminal part of palpi in frontal view (paratype no. 2), H — arrangement of chaetotaxy on leg IV (paratype no. 1).

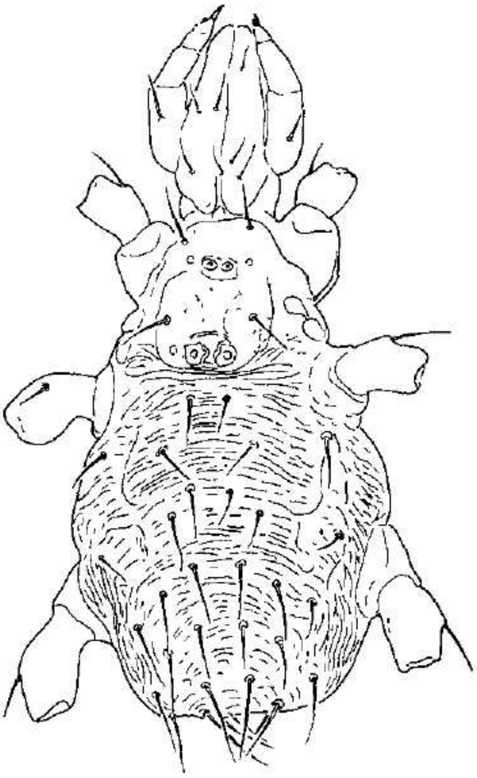

Fig. 2: The larva of Erythraeoidea of uncertain systematic position.

POKYNY PRO AUTORY

Věstník Československé společnosti zoologické uveřejňuje původní vědecké práce členů společnosti v rozsahu nejvýše 30 stran rukopisu, napsané v některé z kongresových řečí, a dále články, hodnotící životní dílo našich zoologů, vyžádané redakcí. Práce autorů, kteří nejsou členy společnosti, budou přijímány jen výjimečně.

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Hlavička práce. 1. Název pracoviště. 2. Název práce (u prací taxonomických v závorce za názvem systematické zařazení druhu nebo skupiny — např. Ostracoda: Cypridae), obojí v řeči, v níž je práce psána. 3. Jméno a příjmení autora.

Vlastní práce: 1. Velmi stručný abstrakt, v rozsahu nejvýše 15 řádek, v angličtině. 2. Úvod do problematiky (stručně). 3. Materiál a metodika (u známých metod pouze odkaz). 4. Vlastní část experimentální nebo popisná. 5 Diskuse. 6. Závěr. 7. Seznam citované literatury (nikoliv bibliografie!). 8. Adresa autora. 9. Tabulky, texty k obrázkům a grafům. Celý rukopis je průběžně stránkován.

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Přepis cyrilice proveďte podle mezinárodních pravidel transliterace (nikoliv fonetické transkripce — viz ISO Recommendation R 9. International system for the transliteration of cyrilic characters 1. Ed. October 1955 nebo Zekalle R., 1964:*Pedobiologia*, 4: 88—91, Jena.

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V taxonomických pracích dodržujte zásady, ustanovení a doporučení mezinárodních pravidel zoologické nomenklatury.

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