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**GEOGRAPHICAL DISTRIBUTION OF THE COLOUR PHASES OF THE RED  
SQUIRREL IN BOHEMIA AND MORAVIA (MAMMALIA: SCIURIDAE)**

Miloš ANDĚRA

Received March 26, 1984

**Abstract:** The geographical distribution of the two main colour phases of the red squirrel (*Sciurus vulgaris*) was studied upon the territory of the Czech countries. The dark phase usually prevails in areas of an average annual air temperature of 6 – 7°C at the highest, while the red phase prefers warmer (i.e. the minimum of 7 – 8°C) and also drier areas (the annual precipitation average totalling up to 600 – 650 mm). The respective connection of a dominant dark phase occurrence with an original extension into the mountain beech- and spruce forests was ascertained.

INTRODUCTION

The red squirrel, *Sciurus vulgaris* Linnaeus, 1758, is known to be polymorphic as regards the fur coloration within most of its distribution area including the territory of our country. Two colour phases being predominant, fox-like reddish and dark brown black, intermediately coloured individuals are also found. The aim of the present study was to examine the geographical distribution of both colour phases of the red squirrel in the territory of Czech countries and to evaluate whether there is any dependence of the relative frequencies of the phases upon environmental conditions.

METHODS AND MATERIAL

The basic material for this study consisted of data obtained from respondents to our simple questionnaires. In 1972 – 1975 we distributed more than 5,000 questionnaires. Most of them were sent to the local organisations of the Czech Gamekeepers' Union and to the forest intendants of the Czechoslovak State Forests. From these organisations we got 2,379 replies of which 2,051 could be applied for the present study. The map survey of localities covered by the questionnaires is given Anděra (1979). The questionnaire was drawn up in a simple way and was therefore easy to complete. Each respondent was asked to check one of the following relative frequencies of the colour phases of the squirrel: dark phase occurs only (Fig. 1 ■), dark phase predominates (⊕), both colour phases are balanced (⊙), red phase predominates (○) and red phase occurs only (□). Where contradictory data were obtained we evaluated the locality by the prevailing information. For some regions the author's own findings and literature data were also applied (Brdička, 1980; Hanel, 1982).

RESULTS

The red squirrel is a typical forest form occurring on the whole territory of our country. Its occurrence is conditioned mainly by the presence of trees offering both cover and food. The red squirrel inhabits most of the forest types, especially the coniferous and mixed ones. It occurs also at the outskirts

of the city agglomerations from where it penetrates into parks in the centre of the towns. The squirrel is absent only in the unforested lowland landscapes and in the agrocenoses; it reached the upper limit of dwarf pine in the mountain (1700 m a.s.l. in Slovakia — Rosický and Kratochvíl, 1955). About 15 — 20 years ago there was a sharp fall in the population density in the whole territory of the Czech countries, reaching almost a critical level. Consequently, at present the squirrel is rare in many regions.

A summarized survey of the data achieved on the relative frequencies of both the colour red squirrel phases upon the territory of Bohemia and Moravia is given in Figure 2. From this map it is evident that the dark phase is not limited in its dominant occurrence to the higher located mountain areas but prevails, in some places, the red phase in the highlands and in the hilly country parts. Apart from that, the former occurs in a considerably large part of the territory in an approximate balance with the red form as well. The total absence of the same appears in lowland areas only, roughly speaking, in about an 300 m a.s.l. altitude, where exceptions in this respect are very rare. The centre of the red phase occurrence is mainly in the lowland areas, nevertheless, in some places it is more abundant than the black form even in the highlands, as well as in some mountain areas (e.g. in several parts of the Krušné hory Mts., in the Český les Mts., in the Šumava Mts. and in the Šumavské podhůří Piedmont, etc.). All in all, we may ascertain that in spite of the more frequent occurrence of the black phase in the mountain regions and of the red phase occurring in the lowland, one cannot consider the altitude to be the main factor which would determine the relative frequencies of both the colour squirrel phases in a unique way on the territory of the Czech countries.

Contrary to that the comparison with some climate factors, namely, in particular, with the air temperature and the precipitation quantity, proves to be much more of an advantage (Syrův, 1957). Dark squirrels prevail, as a rule, upon territories with an average January air temperature of  $-3$  to  $-4^{\circ}\text{C}$  and those with lower temperatures, whereas the April isotherm equals to  $5$  to  $6^{\circ}\text{C}$  and, the July one from  $15$  to  $16^{\circ}\text{C}$ . Regarding the red phase type, one may consider an approximately limiting January isotherm to reach up to  $-2$  to  $-3^{\circ}\text{C}$ , the April one being  $7$  to  $8^{\circ}\text{C}$  and, the July one equalling to  $17$  to  $18^{\circ}\text{C}$ . Within the annual average period the dark phase prefers areas with a maximum air temperature of  $6$  to  $7^{\circ}\text{C}$ , whereas the red phase prefers areas with values higher by  $1$  to  $2^{\circ}\text{C}$  at least ( $7$  —  $8^{\circ}\text{C}$ ). It is not without interest that the dominant occurrence of the dark phase correspond more to the winter isotherm, while for the red phase the spring and summer isotherms are of a much more greater significance. After all, this appears also in the comparison with some of the further temperature factors. For instance, the area of the dominant occurrence of the dark form equals altogether well enough to the areas with an annual average of at least 130 frost days and 40 to 50 ice days. Contradictionally, the regions where the red form occurrence prevails may better be characterized by a minimum number of 40 — 50 summer days.

Also the precipitation conditions display a certain effect on the proportion of both the red and dark phases in our territory. The areas with the most frequent occurrence of the red form are drier, i.e. with an annual precipitation of usually 600 to 650 mm. During the vegetation period the amount of rainfall

reaches some 350 to 400 mm. In the winter season there is a snow cover lasting 60 days at the highest, even when it often takes a much shorter time. The connection of the mean annual total precipitation and the black form dominance is already not so expressive, the isohyets of 650 mm and higher mostly include also the areas of a balanced representation of both the colour phases. Equally, the amount of precipitation during individual months of a year does not seem to be decisive.

From the aspect of the vegetational conditions the comparison with the map of the reconstructed natural vegetation (Moravec and Neuhäsl, 1976) are most interesting. This proves that in spite of the changed ecological potential of the existing landscape the dominant occurrence of the squirrel dark phase correspond generally to the original extension of the vegetation-geographical zones of mountain beech forests and the mountain spruce forests. This is, therefore, a further indirect proof of a certain connection of the squirrel regional differentiations with the climatic conditions of our territory. The vegetation zones mentioned include the following reconstructed phytocoenological units: herb-rich beech forests, woodrush beech forests and fir forests, acidophilous mountain beech forests, waterlogged spruce forests and mountain climax spruce forests. As for the red phase the binding with some of the vegetation tiers is not so expressive. Also, the present composition of tree species with predominance of timber plantations of spruce stands does not affect the relative frequencies of both the colour phases to a substantial extent (See the Atlas ČSSR, 1966, Map. No. 23 — 1).

With regard to the reliability grade of the applied method of a questionnaire form one may take it for granted in the end that, within the scope of the Bohemian and Moravian territories there shows a certain dependence of the squirrel colour phase relative frequencies upon the environmental conditions, especially upon the average air temperature and the precipitation. Even when the stated occurrence areas of the dark or red phases do not correspond fully with the single isotherms and isohyets, this dependence is, in the global measure, fully obvious. At the same time, it is necessary to stress to the fact that within the questionnaire action there were some cyclic changes in the frequency rates of the phases recorded in several cases, which were equally observed in other parts of the area where the red squirrel occurrence took place (Voipio, 1969). Their detailed analysis would, however, require a much more accurate access to the problem sphere than it is possible in a questionnaire action.

#### DISCUSSION

The question of polymorphism and regional differentiation in the red squirrel (*Sciurus vulgaris*) was already subject to studies by several authors, however, the result obtained were no fully uniform. In the Middle- and South East Europe it showed that the proportion of the dark phase generally tends to increase in the mountain regions (Lührling, 1928; Turček, 1950; Zawidska, 1958; Markov, 1961). In this connection Zawidska (l.c.) draws attention especially to the effect of the altitude and the type of forest stand. As for the territory of Poland she found that the black squirrel does not occur in forest stand composed only of pine or deciduous trees, but that this is probably connected with the occurrence of beech and spruce. Lührling (1928) and Markov (1961) stress the connection with climate conditions,

particularly with the average air temperature. Also in Finland the temperature gradient appears to be a dominant factor affecting the geographical distribution of the relative frequencies of the red squirrel colour phases (Voipio 1957). In this case the squirrel polymorphism represents a typically balanced polymorphism, i.e., the frequencies of the phases vary in accordance with the varying environmental conditions, the results of which lead to geographically variable polymorphism (Voipio, 1969). However, in Southern Sweden the polymorphic balance is determined in quite a different way than it is in Finland, most probably it also has a different genetic background, too (Voipio 1970).

Contrary to that, Wiltafsky (1977) while measuring the colour of the tail (seasonally unaffected) by means of an electric remission photometer emphasizes that in the European area the dependence of colour brightness and saturation on the annual air temperature and precipitation seems to be small. Mapping of means shows a clinal variation of the brightness values. The lowest means were found in the Alps, in South Italy and Yugoslavia, the highest in Eastern Europe and in Northern Scandinavia. Accordingly, when considering all the colour types, there appears an obvious gradient running from SW to NE.

Our own findings indicated that the territory of Bohemia and Moravia considerably diversified as regards its relief and climate, undoubtedly shows the effect of the environmental conditions upon the relative abundance of the polymorphic phases of the squirrel. This concerns especially the average air temperature and the amount of precipitation. The macroclimate is evidently connected with a more frequent occurrence of dark-coloured squirrels within the areas of the original extension of natural mountain forest tiers which, roughly speaking, corresponds to the respective results (Zawidska, 1958). Furthermore, the latter author found, on the basis of the same questionnaire inquiry that in Poland black squirrels occur in areas where the annual snow- and rainfall is relatively high, i.e. over 600 mm. Our results are in accordance with these statements. Moreover, the effect of the climate factor upon the occurrence frequency of the individual squirrel colour phases is also proved by the fact that the colour polymorphism of the squirrel is correlated with the fur density, i.e. that the average length and density of the under fur proves to be significantly larger in the dark phase than in the red one (Voipio and Hissá, 1970).

Due to this knowledge one may rightly presume that the different ecological conditions are reflected in the population genetic structure and thus also in its polymorphic frequencies. Nevertheless, the environmental conditions represent only one item of the whole factor complex, by which both the colour polymorphism and the regional differentiation are affected in the red squirrel. A detailed evaluation of same could be carried out only on basis of a long-termed and accurately collected material, since with the data gained from the questionnaires one must always take into consideration a certain mistake, presentation of the respective results, caused by a subjective evaluation or other kinds of inaccuracies.

#### SUMMARY

By means of the questionnaire action the geographical distribution was studied of the two main colour phases of the red squirrel, i.e. the red and

dark one, upon the territory of the Czech countries. It was found that the dark phase predominates not only in the mountain regions but also, in some areas in the hilly parts and highlands. Although the centre of the red form occurrence lies mainly in the lowlands, it is sometimes more abundant than the dark phase in higher altitudes as well (Fig. 2). Thus, one cannot consider the altitude to be a generally limiting factor as regards the geographic distribution of colour phases as our squirrel population is concerned. Much more expressive is the appearance of the climate conditions effect, especially as regards the average air temperature and the average precipitation level. The dark phase usually predominates in areas of an average annual air temperature of 6 — 7°C at the highest, while red phase prefers warmer (i.e. the minimum of 7 — 8°C) and also drier areas (the annual precipitation average totalling up to 600 — 650 mm). Furthermore, a connection of a dominant dark phase occurrence with the original extension of the mountain beech- and spruce forests has been ascertained. The present composition of the forests does not affect substantially the relative abundance of the both colour phases of the red squirrel.

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The figures 1 and 2 will be found at the end of this issue.

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**TO THE KNOWLEDGE OF SMALL MAMMALS (INSECTIVORA, RODENTIA) IN  
THE RODNEI MTS. (RUMANIA)**

Jiří FLOUSEK, Zdeňka FLOUSKOVÁ, Kristína TOMASOVÁ

Received May 4, 1984

**Abstract.** The paper presents the results of the catches of small mammals in the Rodnei Mts. (Rumania) in July 1983. The total catch comprises 94 small mammals belonging to 14 species (Insectivora, Rodentia). The most interesting among the findings are the 5th Rumanian evidence of the occurrence of the species *Sicista betulina* and the discovery of the new species for Rumania — the "mountain" form of the vole which is similar or identical with the species *Pitymys tatricus*.

INTRODUCTION

Rumania, due to its varied natural conditions, ranks, from the zoological point of view, among very interesting countries of southeast Europe. In spite of recent intensive mammal investigations of both local and foreign mammalogists (e.g. Hamar et al. 1974, Wagner 1976, Popescu et Barbu 1979, Simionescu 1979, Zima et al. 1981 etc.), there are still many areas within Rumanian territory which have, either minimally or not at all, been investigated. The northern part of the East Carpathian arch (Carpatii Orientali) ranks among such regions. Individual mountain ranges of the area mentioned above were, as for theriological aspects, studied very little (Éhik 1942a — Rodnei Mts.; Éhik 1942b — Calimani Mts.; Szabo 1960' — Maramuresului Mts., Rodnei Mts.; Simionescu 1968 — Ceahlau Mts.; Wagner l.c. — Gurghiului Mts., Harghita Mts., Rodnei Mts.), and therefore the aim of the following paper is to focus upon broadening the knowledge of small mammal fauna composition within one of the many mountain massifs of the East Carpathians — Rodnei Mts..

DESCRIPTION OF LOCALITIES UNDER STUDY

The Rodnei Mts. are the highest mountain range of the East Carpathians with the summit Pietrosul reaching the altitude of 2305 m a.s.l. Geologically they are formed by crystalline schists and metamorphic rocks locally penetrating to the surface. Forests are primarily of a virgin character with numerous windfalls of different stages of decay and a very dense undergrowth. *Fagus sylvatica* represents the dominant tree species of the mixed forest of the altitude of 600—800 m a.s.l. *Picea abies* gradually gains in numbers in the altitude above 800 m a.s.l. up to the alpine timberline in the altitude of 1500 m a.s.l. There was noted a numerous occurrence of *Abies alba*, within the spruce forest belt also of *Betula* sp. and *Sorbus* sp.. Subalpine grasslands above the alpine timberline are covered with the islands of vast stands of *Vaccinium myrtillus*, *Vaccinium uliginosum* and *Rhododendron myrtifolium*, with single scattered specimens of *Juniperus communis* and *Picea abies*, the slopes with the low, very dense stands of *Alnus incana* and *Pinus mugo*. The ridge itself and the summits often form bare rock faces, at the foothill with debris cones reinforced with vegetation. Practically all the accessible mountain parts, from foothills up to the highest sum-

mits, bear the signs of an intensive cattle, goat and sheep grazing with all its negative effects.

The catch of small mammals was carried out on the northeast slopes of the Rodnei Mts. (in the vicinity of a touristic base "Complexul turistic" Borsa- Flintina), on five localities (Fig. 1) in four altitude zones (800, 1200, 1500, 1900 m a.s.l.):

Locality No. 1 (800–850 m a.s.l.) – a mountain brook valley with vast pastures and adjacent edge of the mixed forest (spruce, beech, fir, birch, dense undergrowth); three smaller complexes of farm buildings (Fig. 2).

Locality No. 2 (1200 m a.s.l.) – a sparse spruce forest on mountain stream banks; low undergrowth of grasses and single uprooted trees.

Locality No. 3 (1200–1230 m a.s.l.) – microbiotop on the area of cca 150×80 m from three sides enclosed by a spruce forest and from the fourth by a rock face. Debris cones just under the rock reinforced by a low herb layer and in its middle part forested by *Pinus mugo*. Debris cone foothill is formed by huge boulders and remainders of trees (probably the remnants of the landslide of older origin), densely covered with mosses, ferns and young natural seeding of spruce; in this lower part of debris cone microclimatic air current was noted. Generally the locality reminded of the top part of the mountain range cut located in the spruce forest belt (Figs. 3–4).

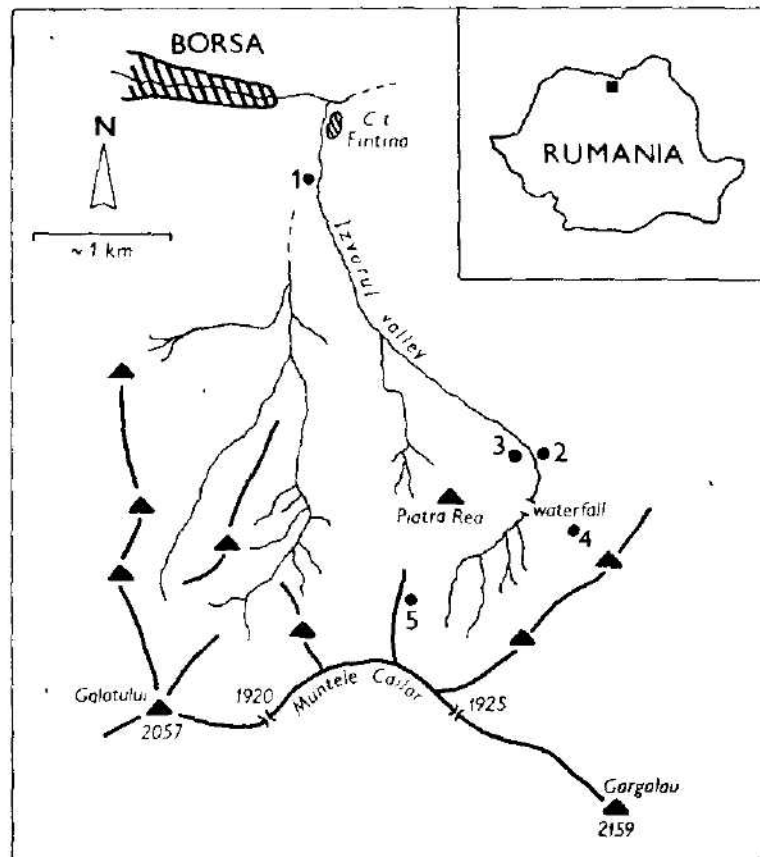


Fig. 1. The layout of the investigated eastern part of the Rodnei Mts. (according to Slouka and Kukačka 1977) – black points correspond to the individual localities.

Tab. 1. General survey of the caught species and their hypsometrical distribution

Locality No. Altitude (in m)	1 500-850	2 1200	3 1200-1230	4 1450-1500	5 1850-1900	Total
<i>Sorex araneus</i>	8	1	2	1	1	13
<i>Sorex minutus</i>	1	1	-	-	-	2
<i>Sorex alpinus</i>	1	-	-	-	1	2
<i>Neomys fodiens</i>	1	-	-	-	-	1
<i>Neomys anomalus</i>	1	-	-	-	-	1
<i>Talpa europaea</i>	-	-	-	1	-	1
<i>Clethrionomys glareolus</i>	11	2	-	6	-	19
<i>Pitymys subterraneus</i>	4	8	-	8	4	24
<i>Pitymys cf. tetracus</i>	2	-	3	-	-	5
<i>Microtus nivalis</i>	-	-	2	-	2	4
<i>Microtus agrestis</i>	-	-	-	-	1	1
<i>Apodemus sp.</i>	12	2	2	3	-	19
<i>Mus musculus</i>	1	-	-	-	-	1
<i>Sicista betulina</i>	-	-	-	-	1	1
Total catch	42	14	9	10	10	84
Number of traps	268	53	70	70	68	529
Catch size per 100 traps and night	15.7	26.4	12.9	27.1	14.7	17.8

Locality No. 4 (1450-1500 m a.s.l.) - a mountain spruce forest of a virgin character beside the alpine timberline, dense undergrowth (mainly ferns) and numerous windfalls.

Locality No. 5 (1850-1900 m a.s.l.) - a limestone face foothill of a lateral mountain ridge. Closely under this rock face the debris cones were covered with vegetation, in lower parts with scattered small trees *Juniperus communis*, *Picea abies* and *Alnus incana*. Intensive cattle and sheep grazing (trampling, browsing, erosion).

#### MATERIAL AND METHODS

529 snap traps were set during three nights (3rd - 6th July 1983). They were baited with carrots and bacon (5:1) and set mostly in a biological way. The total catch of 84 small mammals (Insectivora, Rodentia) involved 14 species (Tab 1). Usual biometrical data were stated among the caught specimens: G (weight in grammes), LC (length of the body from the tip of the nose to anus, in mm), LCd (length of the tail from the anus to the tip of the tail without the hair at the end, in mm), LTP (length of the hind foot without claws measured with the precision of 0.1 mm), LA (length of auricle). Cranial dimensions of selected genera (*Pitymys*, *Sicista*) were measured with the precision of 0.1 mm according to the methods of Zimová (in print):

LCb (condylobasal length): prosthion - line connecting the most aboral points of condyli occipitales; LaZ (zygomatic breadth): zygion - zygion; LaI (interorbital width): the shortest distance between orbits; LN (length of nasals): rhinion - nasion; LD (length of diastema): perpendicular distance between the line connecting the most aboral margins of alveoles of incisors and the line connecting the most oral points of crowns of  $M^1$  in upper jaw; LOSD (length of upper row of teeth) the most oral point of  $M^1$  - the most aboral point of  $M^3$  in the right half of upper jaw (measured on crowns); LM (length of mandible): the most oral point of corpus mandibulae - the most aboral point of processus angularis (measured on the right half of the mandible after its division); AM (height of mandible): length of perpendicular line from the coronion to the line connecting the most ventral point of processus angularis with the most ventral point of corpus mandibulae, LCD

(length of lower row of teeth): the most oral point of  $M_1$  — the most aboral point of  $M_2$  in the right half of lower jaw (measured on crowns).

All specimens treated in this paper are deposited in the collections of the Department of Systematic Zoology, Faculty of Science, Charles University, Prague.

#### SURVEY OF ASCERTAINED SPECIES

##### 1. *Sorex araneus* Linnaeus, 1766

The most frequent species of the order Insectivora was noted in all the localities (No. 1—5) in all the altitudes (800—1 900 m a.s.l.). The occurrence in all the investigated biotops gives an evidence of the wide ecological adaptability of the species, however, the biggest number of specimens was ascertained in the lower mountain parts — in the fir-beech-spruce vegetation belt (locality No. 1).

According to Popescu and Barbu (1979) the Common shrew belongs to the most common species of Rumanian mammals and is spread along the whole area of the country with the preference of shady and moist forests in the mountain regions. In the Rodnei Mts. it was located in the altitude of 600—1 700 m a.s.l. (Wagner 1976) and 1 900 m (Popescu et Barbu l.c.).

##### 2. *Sorex minutus* Linnaeus, 1766

The occurrence of the species was ascertained only in two localities (No. 1—2) in the altitude of 850 — 1 200 m a.s.l..

Popescu and Barbu (1979) rank the Pygmy shrew among the species with low abundance and limited occurrence on the Rumanian territory. However, the reason seems to be an incomplete research of the single Rumanian regions and a decreased success in catching the species within common inventarisation research (selectivness of snap traps — the same applies to our catch). Wagner (1976) noted this species in the Rodnei Mts. only up to the altitude of 800 m a.s.l..

##### 3. *Sorex alpinus* Schinz, 1837

The species was ascertained in both the extreme altitude localities (No. 1 and 5) — in the mixed forest at the mountain range foothill (850 m a.s.l.) and in the debris cone vegetation in the uppermost part (1900 m a.s.l.). However, the occurrence can be assumed also in other altitude zones of the Rodnei Mts., with the presence of the biotops suitable for the existence of the species mentioned above.

Body dimensions of the caught specimens (ad. male; juv. female):  $G = 10.2; 7.5$ ;  $LC \approx 76; 62$ ;  $LCd = 63; 65$ ;  $LTP = 14.9; 14.8$ .

The presence of the Alpine shrew was evidenced only in ten Rumanian localities (Popescu et Barbu 1979). In most cases these are, from the mammalogical point of view preferred, mountain areas (Retezatului Mts., Ciucas Mts., Bucegi Mts. etc.). Szabo (1960) was the only one to locate this species in the Rodnei Mts., in the altitude of 900 m a.s.l..

##### 4. *Neomys fodiens* Pennant, 1771

The Water shrew was caught only in the wet meadow in the valley, in the lower part of the mountain range (locality No. 1—800 m a.s.l.).

In Rumania this species is reported to have a limited occurrence (Popescu et Barbu 1979), in the Rodnei Mts. it was ascertained in the altitude of 1 400 — 1 700 m a.s.l. (Wagner 1976).

#### 5. *Neomys anomalus* Cabrera, 1907

The catch of a single specimen on the mountain brook bank between the pastures at the foothill (locality No. 1 — 850 m a.s.l.) gave the evidence of the presence of this shrew.

There are incomplete reports on its occurrence in Rumania, the same applies to previous species (Popescu et Barbu 1979). In the Rodnei Mts. Wagner (1976) states this species in the altitude of 600 — 800 m a.s.l..

#### 6. *Talpa europaea* Linnaeus, 1758

The species was noted in the spruce mountain forest at the borderline with a subalpine grassland (locality No. 4 — 1 450 m a.s.l.).

Wagner (1976) records this species in the Rodnei Mts. with the distribution up to 800 m a.s.l..

#### 7. *Clethrionomys glareolus* (Schreber, 1780)

One of the three most frequent rodent species was found in the forest biotops ranging from the mountain range foothill to the alpine timberline (localities No. 1,2,4 — 800—1 500 m a.s.l.). It was not ascertained in the *Pinus mugo* and *Alnus incana* stands on subalpine grasslands.

Wagner (1976) too, reports this species as common in the Rodnei Mts. in the altitudes between 600—1 400 m a.s.l. with dominant occurrence in the mixed forests with balanced proportion of deciduous and coniferous tree species (800—900 m a.s.l.). Szabo (1960) too, noted this species in the investigated mountain range.

#### 8. *Pitymys subterraneus* (de Sélys — Longchamps, 1836)

This most frequent, ecologically well adaptable species, was ascertained in all the altitude zones (localities No. 1,2,4,5 — 800 — 1 900 m a.s.l.). However, the abundance of species, from the occurrence in all the altitude zones, was the highest in the spruce vegetation belt (localities No. 2,4). Frequency of selected body dimensions see Tab. 2.

The Pine vole is stated to be the only Rumanian representative of the genus *Pitymys*. The revision of systematical position and the distribution of this genus in Rumania (Hamar et al. 1974) brought, on the basis of morphological and karyological research, only the subspecific division of the species *Pitymys subterraneus* into "mountain" subspecies *P.s. subterraneus* and "lowland" subspecies *P.s. dacius*. Apart from the already quoted authors (Hamar et al. l.c.), also Szabo (1960) and Wagner (1976) state the Pine vole in the Rodnei Mts. — from the spruce forest belt and subalpine grasslands (1 200 — 1 700 m a.s.l.).

#### 9. *Pitymys* cf. *tatricus* Kratochvíl, 1952

Another species of the genus *Pitymys*, most probably a new species for Rumania, was evidenced due to the catch of 5 specimens in two completely different biotops. The first two individuals were caught in the mixed forest (beech, spruce, dense undergrowth, large layer of decaying leaves) about 70 m

Tab. 2. Frequency of the selected body (LTP) and cranial dimensions (LCb, LaZ, LN, LD, LOSD, LOID) of the caught specimens of *Pygmy subterraneus* (P.s.) and *Pygmy* cf. *letricus* (P.t.)

LTP	13.1-13.5	13.6-14.0	14.1-14.5	14.6-15.0	15.1-15.5	15.6-16.0	16.1-16.5	16.6-17.0
P.s. 23	1	6	9	6	1	1	3	1
P.t. 5	-	-	-	-	-	-	-	-
LCb	17.1-18.0	18.1-19.0	19.1-20.0	20.1-21.0	21.1-22.0	22.1-23.0	23.1-24.0	24.1-25.0
P.s. 11	1	1	1	2	5	1	-	1
P.t. 1	-	-	-	-	-	-	-	-
LaZ	10.1-11.0	11.1-12.0	12.1-13.0	13.1-14.0	14.1-15.0			
P.s. 12	1	4	5	2	-			
P.t. 3	-	-	-	-	3			
LN	4.6-5.0	5.1-5.5	5.6-6.0	6.1-6.5	6.6-7.0			
P.s. 14	1	6	5	1	1			
P.t. 4	-	-	-	-	4			
LD	5.6-6.0	6.1-6.5	6.6-7.0	7.1-7.5	7.6-8.0			
P.s. 20	5	4	7	4	-			
P.t. 5	-	1*	-	-	4			
LOSD	3.8-4.0	4.1-4.3	4.4-4.6	4.7-4.9	5.0-5.2	5.3-5.5	5.6-5.8	5.9-6.1
P.s. 21	1	-	4	8	7	1	-	-
P.t. 5	-	-	-	1*	-	2	2	-
LOID	3.8-4.0	4.1-4.3	4.4-4.6	4.7-4.9	5.0-5.2	5.3-5.5	5.6-5.8	5.9-6.1
P.s. 24	-	1	4	6	12	1	-	1
P.t. 5	-	-	-	1*	-	-	3	-

\* Specimen ca 21 days old (M<sub>3</sub> isn't full developed - cf. Zirmová n. print).

Tab. 3. Body and cranial dimensions of *Pitymys* cf. *tatricus* (in mm)

No.	Sex	G	LC	LCd	LCd : LC	LTP	LA	LCb	LaL
BR-1676	♀	30.0	100	41	41.0%	16.3	9.5	def.	def.
BR-1680	♀	29.3	105	41	39.0%	16.3	10.3	24.7	14.2
BR-1741	♂	24.5	98	43	43.9%	16.8	def.	def.	14.5
BR-1742	♀	def.	102	42	41.2%	16.3	def.	def.	14.2
BR-1743*	♂	def.	def.	33	—	15.7	def.	def.	def.

LaI	LN	LD	LOSD	LM	AM	LOID	Notes
3.8	7.0	7.8	5.8	14.6	def.	5.8	uterus 28.2 × 1.5
3.9	6.9	7.7	5.8	14.6	7.0	5.7	3 embryos 6.0 × 3.0
3.7	6.7	7.7	5.5	13.9	def.	6.0	testes 9.5 × 7.3
4.0	7.0	7.9	5.7	14.5	7.2	5.8	2 embryo: 12.0 × 10.0
def.	def.	6.3	4.7	def.	def.	4.8	testes 2.6 × 1.8

\* Specimen ca 21 days old ( $M_3$  isn't full developed — cf. Zimová in print).

from the edge of the forest neighbouring with a vast meadow kept for farming (locality No. 1 — 850 m a.s.l.). The occurrence of other three specimens was notified in scanty vegetation of debris cone (trampling and browsing due to sheep grazing) in deforested biotop in the middle of the spruce forest belt (locality No. 3 — 1 230 m a.s.l.).

Larger body dimensions were characteristic for the caught specimens (see Tab. 3), in comparison with the species *Pitymys subterraneus*, and a striking ginger brown colouring of the dorsal part of the body which almost reminded of the colouring of the species *Clethrionomys glareolus*. The presence of six tubercles on the hind foot (6th tubercle evidently much smaller) was noticed at three specimens, 6th tubercle was missing at two remaining individuals. Also other body characters confirmed the classification within the genus *Pitymys* — shape of molars, presence of two pairs of mammae (female) only at the inguinal area, a small number of embryos of pregnant females. Frequency of selected body dimensions see Tab. 2.

Small amount of material, little knowledge of karyotype and complicated, still not solved, species systematics of the genus *Pitymys* does not allow a precise determination of the caught material. Considerable morphological differences of both the captured forms of the genus *Pitymys* in connection with the sympatric occurrence, however, provide an evident proof of their species difference. Both species of the voles lived parallelly in the locality No. 1, in the locality No. 3 was noted only *Pitymys* cf. *tatricus*. Considering a dominant position of *Pitymys subterraneus* in neighbouring spruce stands, thinking also here of sympatrical occurrence of both the species is made possible.

Morphological characters (colouring, length of the body and tail, length of the hind foot, cranial dimensions, the presence of 5 — 6 tubercles on a hind foot) place our material to the low line of the variability of the biometrical

data of the species *Pitymys tatricus* (cf. Kratochvíl 1970). A considerable number of described species of the genus *Pitymys* (and of subspecies, too) from neighbouring Hungarian and Rumanian localities — *Pitymys dacius* Miller, 1908; *Pitymys transsylvanicus* Éhik, 1924; *Pitymys dacus hungaricus* Éhik, 1926; *Pitymys subterraneus matrensis* Éhik, 1930; *Pitymys nyirensis* Éhik, 1930; *Pitymys klözeli* Éhik, 1942, makes the classification of the species even more difficult. The systematic categories mentioned above are described with the minimum of material and therefore it is very complicated to decide about the competence of their description or, on the other hand, about ranking them among the synonyms of "good" species. Hamar et al. (1974) class all the Rumanian specimens of the genus *Pitymys* within the species *P. subterraneus*, Wagner (1976) makes the species from Transylvania and the Carpathians, described by Éhik, synonymous with *P.s.subterraneus*.

Certain differences can be notified between the voles of the genus *Pitymys* mentioned above and the specimens ascertained by us: *P. dacius* — a type specimen from a submountain region (Prahova), short tail, smaller hind foot (Hamar et al. l.c., Niethammer et Krapp 1982); *P. transsylvanicus* — a type from alpine environment (Fagarasului Mts.), very small body and cranial dimensions (Éhik 1924); *P.d.hungaricus* — a type individual from lowlands (Budafók), dimensions at the upper line of the pine vole variability (Éhik 1926, cf. Kratochvíl l.c.); *P.s.matrensis* — described individuals from 940 — 1000 m a.s.l. (Matra Mts.), generally of smaller body and cranial dimensions (Éhik 1930); *P.nyirensis* — a type from lowland locality (Matészalka), short tail, smaller hind foot (Éhik 1930); *P.klözeli* — an alpine environment (Calimani Mts.), relatively similar body dimensions, short tail, generally smaller cranial dimensions (Éhik 1942b). On the basis of these differences it is not possible to classify the specimens from the Rodnei Mts. into any of the stated systematical units.

A precise species determination and more clear systematical position of the representatives of the genus *Pitymys* in the Rodnei Mts. cannot do without obtaining a larger amount of material and finding out karyological characteristics. Despite the results of cytotaxonomical research, even now it is possible to claim that also in the East Carpathian region there exists a form identical or very similar to the species *Pitymys tatricus*, until now considered an endemit of the West Carpathian Mts..

#### 10. *Microtus nivalis* Martins, 1842

The presence of the species was identified in two mountain altitude zones (spruce forest and subalpine belts), but in very similar biotops (localities No. 3 and 5 — 1200 — 1900 m a.s.l.) In both cases the individuals were caught on debris cones reinforced by vegetation, at the foot of rock faces.

The Snow vole is known in Rumania from the alpine regions of the East and South Carpathians (Kratochvíl 1981, Niethammer et Krapp 1982). Taking into account morphological differences (especially the shape M<sup>2</sup>) Éhik (1942a) described a new species *Microtus radnensis*. Despite the systematical position of the subspecies *M.n.radnensis* still not being explicitly confirmed, the majority of authors classifies it into a south Carpathian subspecies *M.n.ulpius* (Hamar 1960, Wagner 1976, Niethammer et Krapp l.c.). In the Rodnei Mts. the Snow vole has been recently stated by Wagner (l.c.) in the altitude of 700 — 2100 m a.s.l..



11 *Microtus agrestis* (Linnaeus, 1761)

The occurrence of the species was verified by the catch of the only specimen above the alpine timberline in the subalpine belt (locality No 5 — 1850 m a s l)

The catch of the Field vole in the high altitude corresponds with the hitherto conclusions of Rumanian mountain research, i.e. that the species is dependent only on the Carpathian area in the location above the beech forest belt, mostly in *Pinus mugo* stands and in the subalpine grasslands (H a m a r 1962, W a g n e r 1976) In the Rodnei Mts it was noted in the extreme locations of 800 m and 2100 m a s l (W a g n e r l c)

12 *Apodemus flavicollis* (Melchior, 1834) et *Apodemus sylvaticus* (Linnaeus 1758)

Owing to the difficulties of determination, both similar species were elaborated together. However, the evaluation of colouring and body dimensions (LC = 92 — 112, LCd = 97 — 113, LTP = 227 — 247) and the comparison with the material from other Rumanian localities points only towards the representation of the species *Apodemus flavicollis*. These mice were ascertained in all the localities of the forest belt (No 1 — 4, 800 — 1500 m a s l)

Both the species from the Rodnei Mts have already been mentioned. H a m a r et al (1966) considers *A flavicollis* to be a frequent species with increasing abundance from a subalpine belt up to the beech forest belt, whereas *A sylvaticus* is considered common in lower locations. W a g n e r (1976) too found out a similar hypsometrical occurrence of both the species—*A flavicollis* 600 — 1400 m a s l, *A sylvaticus* 600 — 800 m a s l

13 *Mus musculus* Linnaeus 1758

The House mouse was caught in the vicinity of farm buildings, near the brook flowing among the pastures, in the altitude of 800 m a s l (locality No 1). Body dimensions (male) G = 140, LC = 73, LCd = 65, LTP = 157, LA = 112

Progressive research and taxonomical revision of the species *Mus musculus* in the recent years have led towards the statement that there are several different species within the Balkan Peninsula region. According to O r s i n i et al (1983) the forms "*musculus*", "*spicilegus* North", "*spicilegus* South", and "*domesticus*" can be considered for this region. In the Carpathian area appear probably only the forms "*musculus*" and "*spicilegus* North". Since neither the question of nomenclature nor that of determining criteria has been fully solved yet, we label our specimen for the time being, *Mus musculus*. W a g n e r (1976) found out a synanthropical occurrence of *Mus musculus* in the Rodnei Mts (up to the altitude of 650 m a s l only)

14 *Sicista betulina* (Pallas 1779)

The occurrence of the Northern birch mouse was verified by the catch of a single specimen in debris cone vegetation of the subalpine belt (locality No 5 — 1900 m a s l). Body and cranial dimensions (male) G = 80, LC = 67, LCd = 93, LTP = 173, LA = 120, LCb = def, LaZ = 83, LaI = 38, LN = def, LD = 44, LOSD = 28, LM = 83, AM = 45, LOID = 28

The 5th finding of the species *Sicista betulina* in Rumania supplements the knowledge of its occurrence in the region of the East and South Carpathians

The Northern birch mouse has been, up to now, recorded in the Bucegi Mts (male, cca 2 000 m asl — Rauschert 1963), Rarau Mts (female, cca 1 000 m asl — Simionescu et Straton 1965) and Gurghiu Mts (2 specimens without specific data—Wagner 1976) Simionescu (1979) has recently published a survey on the occurrence of the representatives of the genus *Sicista* in Rumania but fails to mention Wagner's findings (lc)

#### DISCUSSION AND CONCLUSION

The Rodnei Mts, as regards their small mammal fauna, rank among the typical representatives of the Carpathian mountain ranges. In Rumania they represent mountain region with a considerably high number of ascertained species. The results of this paper and Wagner's study (1976) being summarized, the survey of evidenced representatives of Insectivora and Rodentia will reach the total of 20 species, out of which 14 species were mentioned above and then *Dryomys nitedula*, *Muscardinus arellanarius*, *Arvicola terrestris*, *Microtus arvalis*, *Apodemus agrarius*, *Apodemus sylvaticus* (Wagner lc). The majority of mammal species in our material has already been recorded in the investigated mountains and also in other mountain regions of the Carpathian arch. The catch of the Northern birch mouse (*Sicista betulina*) is of a special value since it enlarges the knowledge of this species occurrence on the Balkan Peninsula. However, the most important, from the zoogeographical point of view is the finding of the genus *Pitymys* representative probably closely related or identical with the species *Pitymys tatricus*. The form of the vole mentioned above having been verified in the East Carpathian region, an assumption can be offered that after a detailed investigation of other regions of the south part of Carpathian arch, also here the occurrence of similar "mountain" forms can be expected and thus the distribution of the voles from the group *Pitymys tatricus* in the whole Carpathian region could be proved.

The comparison with the other mountain ranges of the East (Ceahlau Mts — Simionescu 1968) and South Carpathian Mts (Fagarasului Mts — Hamar 1958, Retezatului Mts — Wagner lc, Bucegi Mts — Popescu et Yusuf 1980) gives an evidence that, from the faunistic point of view, the Rodnei Mts could be considered one of the best investigated Rumanian mountains. There are no substantial differences in the composition of small mammal fauna in individual mountain regions, and the contingent absence of certain species can be explained by the research of all the biotops of the particular mountain range hitherto not being fully carried out. The comparison of the orders of Insectivora and Rodentia representatives with the same groups of mammals from the area of the West Carpathian Mts (the High-Belanske and West Tatras — Mošanský 1974), from the mammalogical point of view, most fully investigated, leads to similar conclusions. Considering the occurrence of the form similar to the species *Pitymys tatricus*, the occurrence of the Alpine marmot (*Marmota marmota*) in the Tatra Mts represents the only difference. It is probable that the remaining species found in the West Carpathian Mts and well known from the foothill of the Rodnei Mts (*Crocodyra suaveolens*, *Sciurus vulgaris*, *Rattus norvegicus*, *Apodemus microps* — cf. distribution maps in Nethammer et Krapp 1978) will be ascertained in the Rodnei Mts in the course of following research.

The hypsometrical distribution of small mammals in single Carpathian mountains is again very similar, and minor differences depend mainly on

specific conditions of the particular mountain regions. Different spreading of vegetation belts (including the location of the alpine timberline and the maximal height of the mountain range) and anthropical factors, serve as decisive phenomena.

Quantitative data cannot, owing to the small amount of the material and a short time of the catch, be used in a conclusive way. Nevertheless, the species *Pitymys subterraneus*, *Clethrionomys glareolus*, *Apodemus* sp. and *Sorex craneus* can be considered the dominant species in the investigated mountain range, as well as in other Carpathian regions (cf. Hamar l.c., Mošanský l.c. Popescu et Yusuf l.c., Simionescu l.c.).

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The figures 2 – 4 will be found at the end of this issue.

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**NICODRILUS ICTERICUS AND EISENIELLA TETRAEDRA F. POPI  
(OLIGOCHAETA, LUMBRICIDAIE) RECORDED IN CZECHOSLOVAKIA**

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**Abstract:** The first record in Czechoslovakia of *Nicodrilus ictericus* (Savigny, 1826) and *Eiseniella tetraedra* f. *popi* Zicsi, 1960 were made in Děčín, NW Bohemia. The external morphology and anatomy of both species is described, ecology and zoogeography is discussed.

Several sites at the "Labské pískovce" Natural Protected Landscape were sampled for earthworms in May 1982. The lumbricids obtained during this study were collected by digging and hand-sorting, and all specimens were fixed in 80% ethanol and preserved in 4% formalin. Reference specimens are deposited in the author's collection at the Institute of Landscape Ecology in České Budějovice. Together with the common species, *N. ictericus* and *Eiseniella tetraedra* f. *popi* were found, new for Czechoslovakia. The following is a report of these records and a discussion of distribution and ecology of both species.

*Nicodrilus ictericus* (Savigny, 1826)

Locality: Děčín, 2. 5. 1982, 7 ex. (4 ad., 3 juv.), V, Pižl leg.

Description: Four adult specimens were examined. Length: all specimens strongly contracted, 63–83 mm. Width at segm. 44, 2.6–3.1 mm. Number of segments 141–165. Colour of live adults pinkish anteriorly, with clitellum bright yellow to orange-red, and postclitellate region gray. Formalin preserved specimens white to greyish. Prostomium closed epilobic. Setae closely paired. Genital tumescences pustules on individual A and B follicles of segm. 9–12, 30–33, 43–45; fused CD follicle pustules on 9th segment. Dorsal pores begin at 4/5. Nephropores minute, never identified with certainty except in 16–32 segm., alternating irregularly from slightly above B to mD. Male pores minute, present in cleft of tumescence at median half of BC. Female pores distinct though faint, in segm. 14, slightly dorsal to B. Clitellum saddle-shaped, on 34–43 (in one specimen on 34–41). Tubercula pubertatis band-like, in clitellate specimens recognizable only as colour variation of clitellum at segm. 34, 35–41, 42. Three pairs of spermathecal pores in area of C, at 7/8, 8/9 to 10/11.

Four pairs of seminal vesicles in 9–12; pairs in 11th and 12th much larger than those in 9th and 10th segments. Two pairs of spermathecae simple, with short duct, in segm. 9, 10. Calciferous glands one pair in segm. 10, vertical on each side of oesophagus. Crop in 15–16th segm., gizzard in 17–19th segments. Septa begin in 4/5, becoming increasingly muscularized until 9/10 or 10/11.

then thin and membranaceous posteriorly. Nephridia larger posteriorly than anteriorly.

Distribution: *Nicodrilus ictericus* has been previously recorded from Portugal (Heitor, 1968), a large number of widely-spaced localities in France (Bouché, 1972), across southern Belgium (Bouché, 1978), Holland

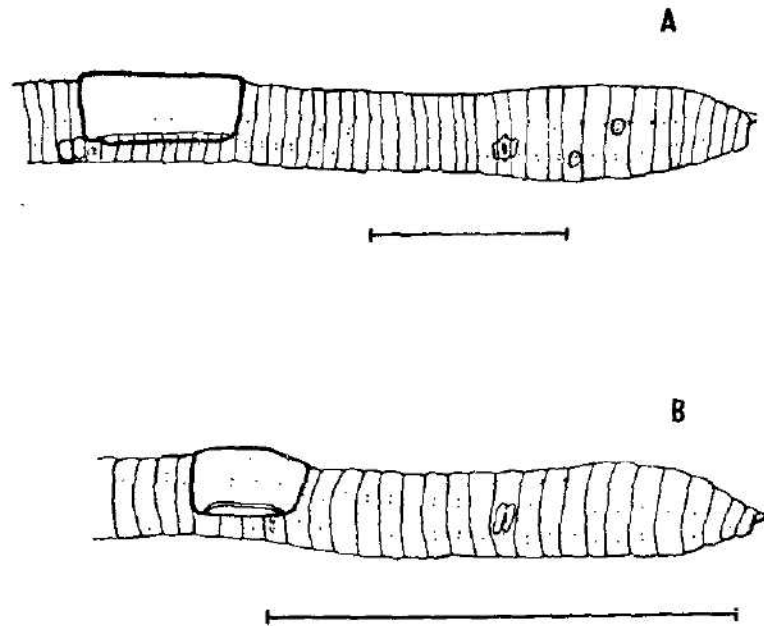


Fig. 1: A-*Nicodrilus ictericus*, lateral view, anterior part of body; B-*Eiseniella tetraedra f. popi*, lateral view, anterior part of body. Scale = 1 cm.

(Willeke, 1968), Ireland (Cotton, 1979) and at one locality in Canada (Schwert, 1977). Saussey (1966) stated in his monograph that the species has been recorded from northern Italy, Switzerland, West Germany and Great Britain, too. This species has also been introduced into USSR on the roots of citrus plants (Perel, 1979). In addition, Gates (1958) listed Denmark and mentioned that this species had been found with soil arriving into the United States from Denmark (Gates, 1968).

Remarks to systematics: The systematic position of this species was a subject of numerous controversies in the past. Lumbricid was placed in the genus *Eophila* Rosa, *Allolobophora* Eisen or *Aporrectodes* Örley. In her recent classification scheme Perel (1979) puts it in the genus *Nicodrilus*.

Ecology: Our material was obtained from a garden in a sample of 88 earthworm specimens. It lives in the following earthworm community (in brackets number of specimens and relative abundance): *Allolobophora chlorotica* (4 ex., 6.7%), *Nicodrilus caliginosus* (13 ex., 8.4%), *Nicodrilus ictericus* (4 ex., 6.7%), *Nicodrilus roseus* (1 ex., 1.7%), *Dendrobaena octaedra* (1 ex., 1.7%), *Dendrodrilus rubidus* (7 ex., 11.9%), *Eisenia foetida* (7 ex., 11.9%), *Lumbricus castaneus* (7 ex., 11.9%), *Lumbricus rubellus* (6 ex., 10.2%), *Lumbricus terrestris*

(3 ex., 5.1%), *Octolasion lacteum* (6 ex., 10.2%), *Allolobophora* and *Nicodrilus* spp. (22 ex.), immature *Lumbricus* spp. (4 ex.) and immature *Octolasion* sp. (2 ex.). All of the species collected with *N. ictericus* are typical from Czechoslovak orchards and gardens.

*Nicodrilus ictericus* is a soil-dwelling or hypogeic species, i. e. it lives within the soil and feeds upon its humic substances or sometimes on dead roots. It can withstand unfavourable environmental conditions by becoming inactive, resuming an active life as soon as temperature or soil moisture reach suitable levels again. *N. ictericus* prefers fine-grained acid siliceous soils (Saussey 1966). Soil type in our locality was brown meadow soil, i. e., of the same quality. This preference for a definite environment is perhaps an indication of a particular nutrition. The species is indeed a geophagous species which takes a great amount of mineral particles with organic nutrients, always larger than is required by other species of the genus *Nicodrilus* (Saussey, 1966).

These conditions easily explain the prevailing influence of the soil structure on its geographical distribution. It is probable that a group of ecological factors (pH, types of soils, amount of organic matter in the environment) determines the remarkable range of occurrence of this earthworm.

*Eiseniella tetraedra* f. *popi* Zicsi, 1960

Locality: Děčín, 30. 5. 1982, 1 ex., V. Pižl leg.

Description: Small worm, 27 by 1.9 mm, 46 segments, posterior amputees. Body cylindrical in front of clitellum, behind clitellum quadrangular in cross section. Colour brown with yellowish clitellum. Prostomium epilobous, tongue broad, open. First dorsal pore in 5/6. Setae closely paired, diverging a little posteriorly. Ventral setae of 10th segm. modified into genital setae. Clitellum saddle-shaped, from segm. 12 21 to 25 (= 4.5 segments). Epidermis also somewhat rough ventrally in clitellum region. Tubercula pubertalis longitudinally band-like, greyish translucent, on segments 22–1/2 25. Male pores on segment 12, minute, somewhat below C. Spermathecal pores single in intersegmental furrows 9/10 and 10/11, above line D and nearer to this than to mid-dorsal line. Nephropores unrecognizable.

Four pairs of seminal vesicles in 9–12. Vesicles of 11 and 12 segm. larger than anteriorly, constricted into two distinct portion. Two pairs of spermathecae dorsally in segments 9 and 11, small and roundish. Carciferous glands emerging from oesophagus ventrally in segm. 10. Gizzard weak, in segm. 17. Nephridia vesiculate, bladders slenderly sausage-like, transversely placed, rather short, not reaching to C. Septa 7/8–11/12 somewhat thickened.

Distribution: *Eiseniella tetraedra* f. *popi* has been described from Hungary (Zicsi, 1960). It has been recorded from Yugoslavia (Šapkarev, 1972), Finland (Terhivuo, Valovirta, 1977) and Poland (Plisko, 1973).

Remarks to systematics: *Eiseniella tetraedra* is one of the most variable species of Lumbricidae. *E. tetraedra* f. *typica* (Savigny, 1826) has the male pores in segment 13. The earthworms having male pores in segment 14 or 15 are regarded as forms of the species, viz f. *intermedia* (Cernovitov, 1934) and f. *hercynia* (Michaelsen, 1890), respectively. Specimens of *E. tetraedra* with male pores in segment 12 had been reported before the description of f. *popi* by Zicsi (1960), e. g., by Eisen (1874) and by Ribaucourt (1895).

The location of the clitellum and tuberculae pubertatis vary greatly, even within the specimens having their male pores in segment 12.

Michaelsen (1932) considered all *E. tetraedra* specimens with male pores in segment other than 13 and 15 to be anomalous. I am of the same opinion as Pool (1937) and Stöp-Bowitz (1969), that they represent rare forms, which have arisen from mutations taking place independently in different parts of the range. Since these mutations seem to be nowhere abundant, they and their offspring must be selected again more strongly than those of the type form. For the present, the mechanism of this selection is unknown (Terhivuo, Valovirta, 1977).

**Ecology:** Our specimen was collected from damp soil at the shore of a brook. The species composition of the earthworm community was following: *Allolobophora chlorotica* (3 ex., 6.8%), *Nicodrilus caliginosus* (7 ex., 15.9%), *Nicodrilus roseus* (2 ex., 4.5%), *Eiseniella tetraedra* f. *typica* (15 ex., 34.1%), *Eiseniella tetraedra* f. *popi* (1 ex., 2.3%), *Dendrobaena octaedra* (8 ex., 18.2%), *Dendrodrilus rubidus* (8 ex., 18.2%), immature *Allolobophora* and *Nicodrilus* (5 ex.) and *Dendrodrilus* (1 ex.).

The species is an amphibious litter-dwelling earthworm and it lives in the wet soil litter or limnically in purely aquatic habitat. It feeds on fresh organic matter and it spends the harsh periods of the year as cocoons (adults as well as immatures can not survive). The species occurs in very damp localities, under moss on rocks over which source water trickles, at the shores of brooks and rivulets, under stones, between roots of water plants, sometimes closely under, sometimes even on the level of the water surface.

Zajonc (1981 a) mentioned 49 species and forms of earthworms from Czechoslovakia. Together with the records of Bouché (1973), Pižl (1983 a, b) Zajonc (1981 b), and in the present paper, the list of Czechoslovak Lumbricidae contains 55 forms now.

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**MORPHOGENESIS OF THE MESOFEMORAL PROTUBERANCE IN SOME SPECIES OF THE GENERA NOTONECTA AND ENITHARES (HETEROPTERA, NOTONECTIDAE)**

Miroslav PAPAČEK

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**Abstract** The morphogenesis of the distinctive diagnostic character of the tribe Notonectini — the antepical posterodorsal mesofemoral protuberance — and the morphogenesis of the basal mesotibial depression, was described in detail in *Notonecta glauca* L. The findings were compared with the corresponding structures in *Notonecta viridis viridis* Delcourt, *Enithares glauca* Bolsano, *E. rhodopis* Hutchinson and *E. sobria* Stål; the differences were noted. The possibility of using the above character for the identification of nymphs of the genera *Notonecta* and *Enithares* and of fossil notonectids is discussed.

Adults of the tribe Notonectini (genera *Notonecta*, *Enithares* and *Enitharoides* have a posterodorsally localized, denticle-shaped antepical protuberance on the distal part of their mesofemora. The presence or absence of the protuberance is generally considered to be a character of taxonomic significance. It is, together with ventral abdominal chaetal system (cf. Papáček & Štys, 1985), a unique character of the tribe Notonectini. Rousseau (1921) used this diagnostic character to differentiate nymphs of *Notonecta* species from nymphs of *Anisops* species and it is also employed in a number of keys to the genera of Notonectidae as the major diagnostic character of the tribe (see Hungerford, 1933; Lansbury, 1965, 1968 and next). The antepical protuberance of the mesofemur was already depicted by Hope (1912; Taf. II, fig. 8a) in *Notonecta glauca* and Lehmann (1923) described it, together with other structures of the posterior edge of the apex of the femur and the posterior edge of the mesotibial base, as the cleaning apparatus of the rostrum. Statz (1950) also described it as having this function.

Some Tertiary notonectids probably already had a mesofemoral protuberance. Statz (1950) deduced its existence in a fossil 5th nymphal instar of *Notonecta primaeva* Heyden (Oligomiocene) from the presence of a posterior notch at the mesotibial base. Together with the fossil *Clypostemma xyphiale* Popov (Mesozoic, Cretaceous), in which no mesofemoral protuberance was found, Popov (1964, 1971) included the above back-swimmer in a new fossil subfamily Clypostemmatinae Popov (synonymous to Notonectini, according to Papáček & Štys (1985)).

Papáček and Štys (1985) discussed the evolution genesis of the mesofemoral protuberance in Notonectini and the use of this character for the identification of fossil notonectids. They indicate that its preservation and perceptibility in fossil impressions are doubtful, owing to its localization.

The presence of a mesofemoral protuberance in nymphs of the various Notonectini genera and changes in it during ontogenesis have not previously been studied in detail. Hungerford (1919) described and compared the legs of the nymphs of some nearctic species of the genus *Notonecta* and stated that a marked protuberance appeared on the mesofemora of the 4th instar *Notonecta undulata* Say. Papáček (1977, unpublished) described the appearance of a marked posterodorsal anteapical protuberance on the distal part of the mesofemora of the 4th instar in the genera *Notonecta* and *Enithares*.

#### MATERIAL AND METHODS

Material examined (in 70% alcohol):

(a) genus *Notonecta*: *Notonecta glauca* L., 1st to 5th nymphal instar and adults, *Notonecta viridis viridis* DeLcourt, 1st to 5th nymphal instar and adults

(b) genus *Enithares*: *E. glauca* Bolsano, 3rd to 5th nymphal instar; *E. rhodops* Hutchinson, 5th nymphal instar and adults; *E. sobria* Stål, 5th nymphal instar and adults.

The drawings were done from micropreparations (medium Euparal). The position (see Fig. 18) and size of the anteapical protuberance of the mesofemora were also measured in micropreparations of the middle legs. The terminology is explained in Figs. 12 and 17.

#### DESCRIPTION OF THE CLEANING APPARATUS AND ITS MORPHOGENESIS

(a) The cleaning apparatus of the rostrum of the adults.

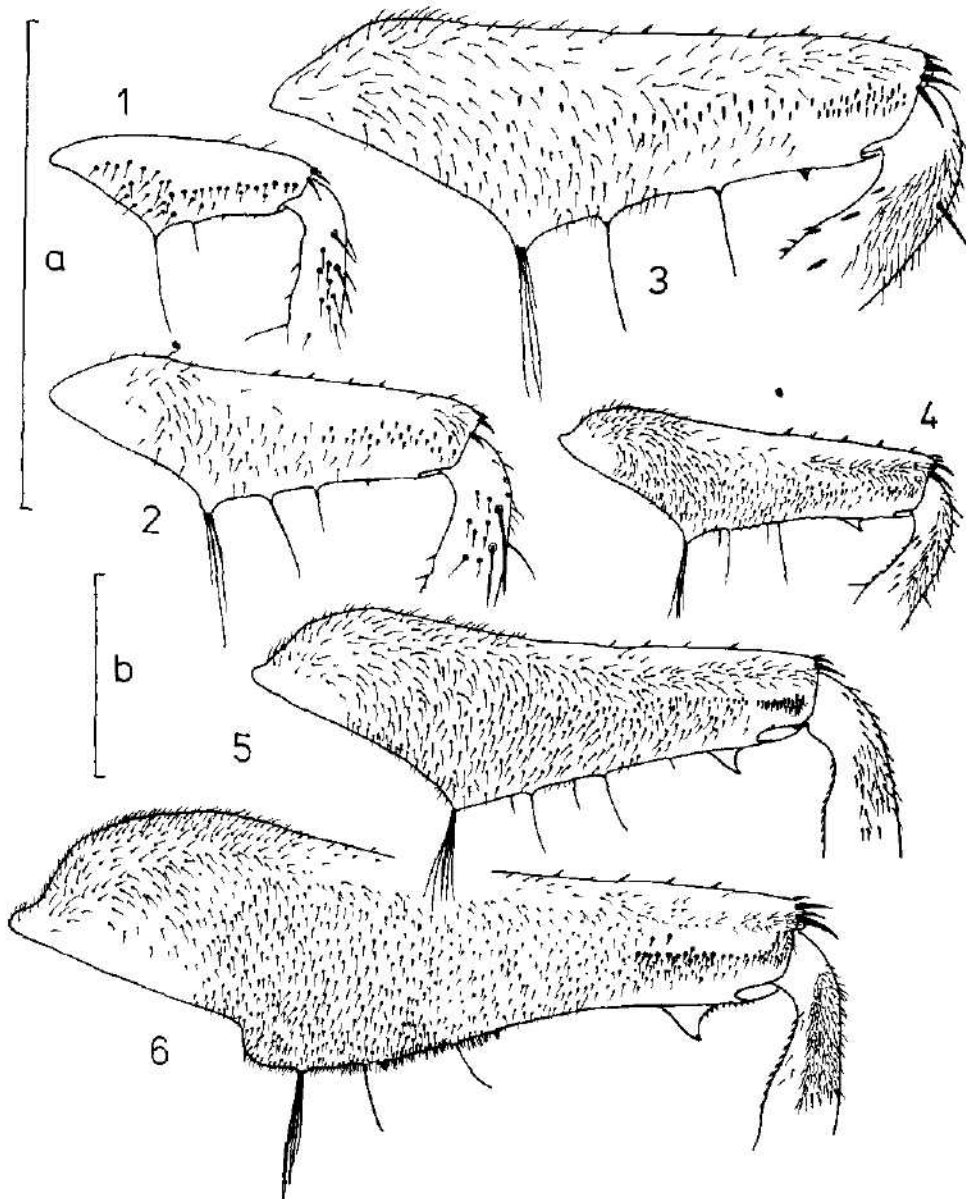
The cleaning apparatus of the rostrum in adult specimens of the genera *Notonecta* (see Fig. 12) and *Enithares* comprises the following structures on the second pair of legs: 1. An anteapical posterodorsal protuberance of the femur with a terminal spine. 2. A zone of more or less irregularly scattered spines localized submarginally to marginally on the hind edge of the femur and stretching distally from the protuberance almost to the apex of the femur. 3. A posterior depression at the base of the tibia which, from the ventral aspect, looks like a shallow notch. 4. A zone of short, thick spines which starts about one third of the way along the depression and is localized posterodorsally along practically the whole length of the tibia. The tips of the individual spines are directed distally.

The length of the tibial depression is approximately equal to the distance of the protuberance from the distal end of the femur. If the tibia is folded back towards the femur at an angle of about 15 degrees, the posterior edge of the femur, the tibia and the femoral protuberance form a slit-shaped, more or less oval opening whose edges are bordered by rows of spines. If the angle between femur and tibia is completely closed, the anteapical protuberance is tucked under the tibia and is ventrally invisible.

(b) Morphogenesis in *Notonecta glauca* L.

1st instar (Figs. 1, 7). An anteapical mesofemoral protuberance is not developed. On the dorsal surface, submarginally to the hind edge, about on third of the way along the hind edge of the femur from its apex, there is a peg-shaped spine (length =  $0.01 \pm 0.005$  mm). In a ventral view of the femur, the tip of this spine is seldom visible. At the base of the tibia there is a clearly discernible depression without distinct spines.

2nd instar (Figs 2, 8). An anteapical mesofemoral protuberance is not developed. The anteapical submarginal spine (length =  $0.02 \pm 0.005$  mm) on the dorsal surface is about one third of the way along the posterior edge of



Figs. 1 - 6: *Notonecta glauca* L.; ventral view of mesofemur and mesotibial base. Figs. 1, 2, 3, 4, 5 - 1st to 5th nymphal instar, Fig. 6 - adult. Scales a and b : 1.0 mm (a = Figs. 1, 2, 3; b = Figs. 4, 5, 8).

the femur from its apex. In a ventral view the tip of this spine is usually visible. Distally to the peg-shaped spine there are 3 smaller spines. The tibial depression, which is clearly discernible, lacks distinct spines.

3rd instar (Figs. 3, 9). An anteapical protuberance can be seen submarginally, about one third of the way along the posterior edge of the femur from its apex. It is inconspicuous (total height including the terminal spine =  $0.04 \pm 0.005$  mm) and has a terminal peg-shaped spine (length =  $0.02 \pm 0.003$  mm). In a ventral view of the femur the protuberance is not usually visible, but the terminal spine can always be seen. The tibial depression is now discernible; its single, scattered, peg-shaped spines are directed distally.

4th instar (Figs. 4, 10). The anteapical protuberance is about one quarter of the way along the hind edge of the femur from its apex. It is conspicuous (height =  $0.08 \pm 0.007$  mm, width at base =  $0.1 \pm 0.01$  mm) and is ventrally very clearly discernible, together with the terminal spine (length =  $0.03 \pm 0.005$  mm). Distally to the protuberance and submarginally to the hind edge of the femur there are 7 small spines, the last one of which is distinctly longer than the others. In the clearly discernible tibial depression the beginning of a postero-dorsally localized zone of pronounced spines can be seen.

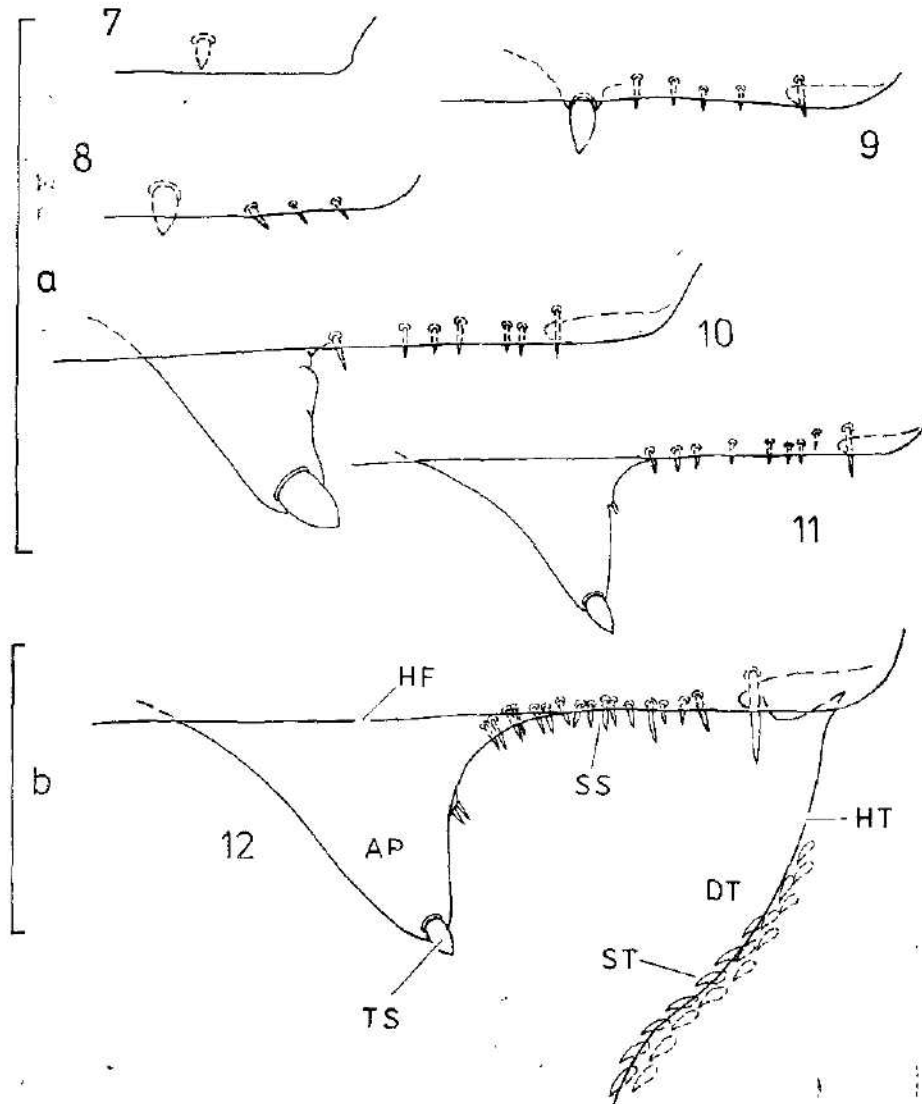
5th instar (Figs. 5, 11). The conspicuous, wide-based anteapical protuberance (height =  $0.12 \pm 0.02$  mm), width of base =  $0.22 \pm 0.03$  mm) is about one fifth of the way along the hind edge of the femur from its apex. At its apex there is a terminal spine (length =  $0.03 \pm 0.005$  mm). On the distal edge of the protuberance, about one third of the way up it, there is a minute submarginal spine. Distally to the protuberance, and submarginally to the hind edge of the femur, there are 9 to 10 spines, the last one of which is about three times larger than the others. A zone of pronounced spines begins in the postero-dorsal part of the tibial depression.

Adult (Figs. 6, 12, 17). The anteapical protuberance (height =  $0.19 \pm 0.01$  mm, width of base =  $0.4 \pm 0.02$  mm), with the terminal spine (length =  $0.03 \pm 0.005$  mm), is about one fifth of the way along the hind edge of the femur from its ventral apex. Submarginally to the distal edge of the protuberance, about one third of the way up it, there are two small spines. Distally to the protuberance, and submarginally to marginally to the hind edge of the femur there is a zone of spines, the last one of which is 3 to 4 times longer than the others. In a ventral view, most of the 17 spines in this zone are visible. The tibial depression is the same as in the 5th instar.

A peg-shaped spine corresponding to the terminal spine of the anteapical protuberance appears on the dorsal surface of the femur, submarginally to its hind edge, in the 1st and 2nd instar. A rudimentary anteapical protuberance appears in the 3rd instar, on the dorsal surface of the femur. In a ventral view of the femur, the protuberance is not clearly discernible until the 4th instar. The submarginal peg-shaped (= terminal) spine is relatively farther away from the end of the femur in the 1st, 2nd and 3rd instar than in older instars (see Fig. 18). The size of this spine in the 4th and 5th nymphal instar and the adult insect is the same. The cleaning comb localized distally to the femoral protuberance begins to be formed in the 2nd instar and the one in the tibial depression in the 3rd instar.

The morphogenesis of the structures of the mesofemoral anteapical pro-

tubérance and the tibial depression in *Notonecta viridis viridis* is similar to their morphogenesis in *N. glauca*. Minor differences are to be found in the size of the protuberance and the number of small submarginal spines.



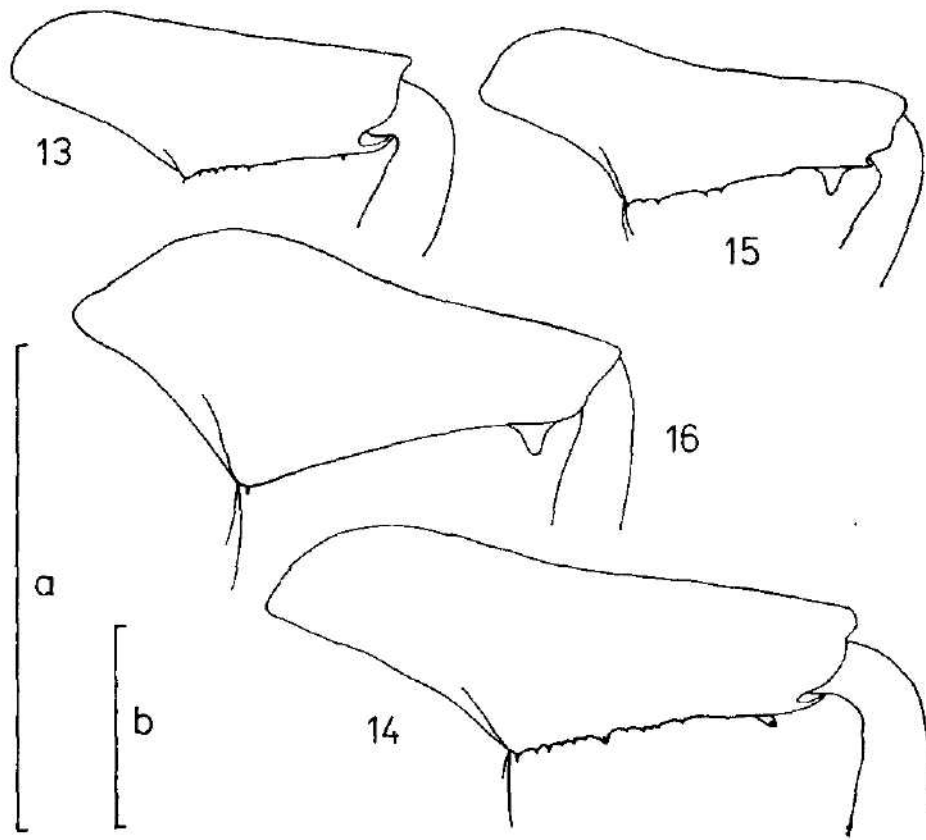
Figs. 7 - 12: *Notonecta glauca* L; ventral view of the anteapical posterodorsal protuberance of mesofemur and distal part of mesofemoral hind edge. Figs. 7, 8, 9, 10, 11 - 1st to 5th nymphal instar. Fig. 12 - cleaning apparatus of a rostrum on the middle leg of adult; Scales a and b: 0.25 mm (a = Figs. 7, 8, 9, 10; b = Figs. 11, 12). Lettering: AP = anteapical posterodorsal protuberance of mesofemur, HF = hind edge of mesofemora, HT = hind edge of mesotibia, SS = submarginal and marginal spinules of the distal part of mesofemur, ST = posterodorsal spinules of the mesotibial depression, TS = terminal spine of the anteapical protuberance, DT = mesotibial depression.

(c) Morphogenesis of structure in some species of the genus *Enithares*.

A complete developmental series of instars in one species was not available (see Material examined) for studying the given character in the genus *Enithares*, so that the following characteristics are incomplete.

3rd instar (Fig. 13). There is a rudimentary anteapical protuberance on the dorsal surface, submarginally to the hind edge of the femur, about one fifth of the way from its apex. The terminal spine is ball-shaped, with a point at the tip. In a ventral view of the femur it is almost always visible. The entire structure is relatively less developed than in the corresponding instar of the above *Notonecta* species. The posterior depression at the base of the mesotibia is inconspicuous.

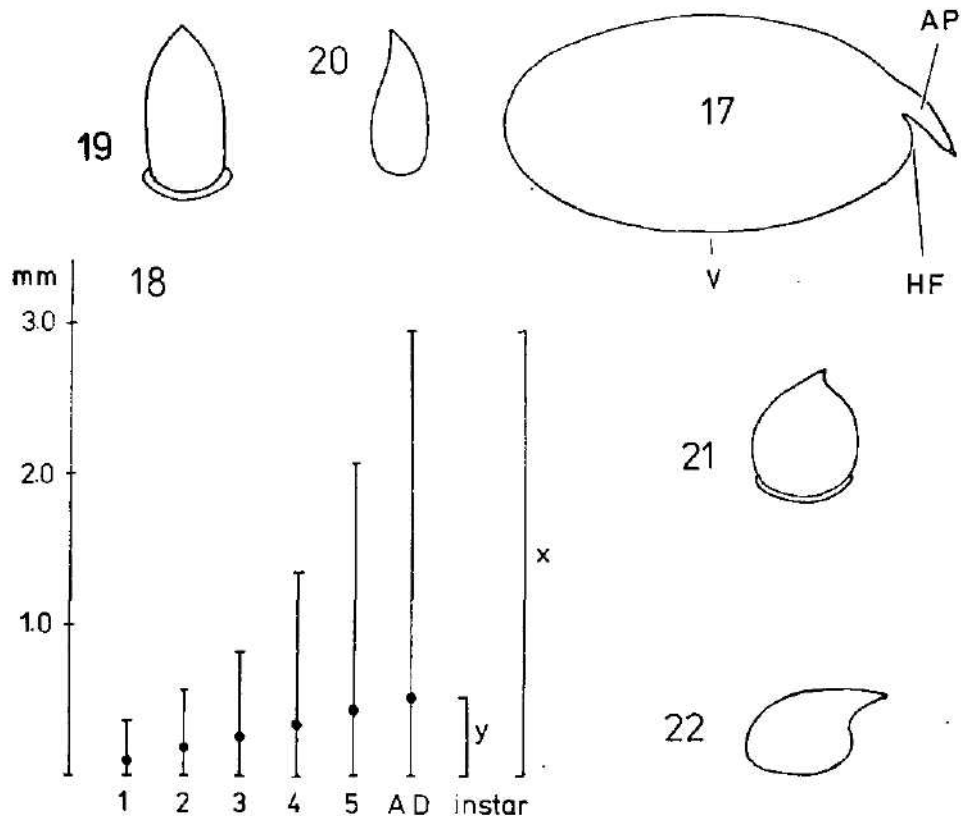
4th instar (Fig. 14). The anteapical protuberance of the mesofemora, with a ball-shaped terminal spine, can always be seen in a ventral view, about one fifth of the way along the hind edge of the femur from its apex. The posterior depression at the base of the tibia is inconspicuous.



Figs. 13 - 16: *Enithares*; ventral view of mesofemur and mesotibial base; strong schematized. Figs. 13, 14, 15 - 3rd to 5th nymphal instar *Enithares glauca*, Fig. 16 - adult of *Enithares sobria*. Scales a and b : 1.0 mm (a = Figs. 13, 14; b = Figs. 15, 16).

5th instar (Fig. 15). There is a pronounced anteapical protuberance, with a ball-shaped terminal spine, one fifth to one sixth of the way up the hind edge of the femur from its apex. On the distal edge of the protuberance and distally to the protuberance, there are small ball-shaped submarginal spines. In some species there may also be single conical hyaline spines on the protuberance. At the base of the mesotibia there is a distinct posterior depression; the spines on this surface are ball-shaped.

Adult (Fig. 16). There is conspicuous anteapical protuberance, with a ball-shaped terminal spine, about one fifth to one sixth of the way along the hind edge of the femur from its apex. The distally oriented comb of ball-



Figs. 17 - 22: 17 - the cross section of the right mesofemur at site of the anteapical protuberance, adult of *Notonecta glauca*; 18 - position of the anteapical protuberance on the mesofemora of nymphs and adult of the *Notonecta glauca*; 19 - terminal peg-shaped spine of the anteapical protuberance - *Notonecta*-type; 20 - spine of the basal mesotibial depression of *Notonecta*; 21 - terminal ball-shaped spine of the anteapical protuberance - *Enithares*-type; 22 - spine of the basal mesotibial depression of *Enithares*; (Figs. 17, 19, 20, 21, 22 - schemes without scale).  
 Lettering: AP = anteapical posterodorsal protuberance of mesofemora, HF = hind edge of mesofemora, V = ventral area of mesofemora, x = length of mesofemoral hind edge, y = distance from the anteapical protuberance to the mesofemoral apex.



-shaped spines is similar to the one in the 5th instar. At the base of the tibia there is a distinct depression, with ball-shaped spines (Fig. 22).

In the *Enithares* species studied, the mesofemoral protuberance is ventrally not clearly discernible until the 4th instar (in a rudimentary form it is already visible in the 3rd instar). In the earlier instars it lies closer to the apex of the femur than in the later instars. The posterior depression at the base of the mesotibia is not conspicuous up to the 5th instar. No marked differences in the morphogenesis of the character between *Enithares* species studied, were found.

#### (d) Differences

The basic structural scheme of the cleaning apparatus of the rostrum in the given *Notonecta* and *Enithares* species studied differs, as follows:

1. The axis of the anteapical protuberance generally forms an obtuse angle with the axis of the femur in the above species of *Notonecta*. In the 5th instar and adults of *Enithares* species it is usually perpendicular to the femur. In the 4th instar of *Enithares* species the axis of the protuberance forms an obtuse angle with the axis of the femur, as in all instars of the genus *Notonecta*.\*

2. In the given species of the genus *Notonecta*, the terminal spine of the anteapical protuberance (the 3rd, 4th and 5th instar and the adult) and the corresponding submarginal anteapical spine (1st and 2nd instar) are peg-shaped (see Fig. 19), like the other spines of the cleaning apparatus. In the given species of the genus *Enithares*, the spines are ball-shaped (see Fig. 21).

(3) The posterior depression at the base of the mesotibia is relatively larger in all the instars of the given *Notonecta* species than in the corresponding instars of the *Enithares* species.

### DISCUSSION AND CONCLUSIONS

A rudimentary mesofemoral anteapical protuberance appears in species of the genera *Notonecta* and *Enithares* in the 3rd nymphal instar. In both genera it does not become distinct and ventrally clearly discernible until the 4th instar. In 1st and 2nd instar *Notonecta* nymphs, there is only a posterodorsal submarginal spine on the part of the dorsal surface of the femur corresponding to the localization of the anteapical protuberance in later instars.

The presence of a mesofemoral protuberance can be used as a diagnostic character of the Notonectini tribe only for identification of (3rd), 4th and 5th nymphal instar and adults of the genera *Notonecta* and *Enithares*, 1st and 2nd instar nymphs cannot be identified as belonging to this on the basis of this character.

The mode of development of this structure in extant genera of Notonectini considered jointly with its universal absence in nymphs and adults of other genera of the family suggests that its presence is a synapomorphy of *Notonecta*, *Enithares* and *Enitharoides* while its absence in the fossil genus *Clypostemma* Popov is probably a plesiomorphy (cf. Papaček & Štys 1985).

The posterior depression at the base of the mesotibia in the *Notonecta* species studied is larger, in a strictly ventral view, than in the *Enithares*

\*) N. B. In some male nymphs of the 5th instar of *Notonecta viridis viridis*, the axis of the protuberance was found to be perpendicular to the axis of the femur. The above differences thus probably do not apply to other species of these genera.

species. Owing to the relative differences in the size of the depression, its presence on the mesotibia of fossil notonectids can be used only as an auxiliary diagnostic character. I agree with Statz (1950, pl. xi, Fig. 48 and p. 62), who used this character for generic assessment of the Oligocene fossil back-swimmer *Notonecta primaeva* Heyden.

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**OCCURRENCE OF THE ENDOPARASITIC HELMINTHS IN TENCH (*TINCA TINCA*) FROM THE MÁCHA LAKE FISHPOND SYSTEM**

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**Abstract.** Examinations of 195 specimens of tench (*Tinca tinca* (L.)) from the Mácha Lake fishpond system, N. Bohemia, Czechoslovakia (the Elbe R. basin), carried out during the whole year has shown that the endohelminth fauna of tench is represented here by 13 species (3 Trematoda, 3 Cestoda, 5 Nematoda and 2 Acanthocephala). In addition to data on the prevalence and intensity and the occurrence of these helminths in other fishes of this locality, the paper describes for some species seasonal changes in the degree of infection and maturation as also the preference to the various size groups of the fish hosts. These questions are discussed in relation to the helminth life cycles and ecological conditions in the locality. The intermediate hosts of the trematode *Phyllodistomum elongatum* (*Anodonta cygnea*) and the nematode *Skrjabillanus tincae* (*Argulus foliaceus*) are recorded from Czechoslovakia for the first time.

This paper is a continuation of the author's previous studies on the bionomy of fish endohelminths in the Mácha Lake fishpond system; following the elaboration of the helminth faunas of pike and carp (Moravec, 1979, 1984), the present results represent long-term observations on the occurrence of endohelminths in the population of tench (*T. tinca* (L.)), economically the second most important species of freshwater fish (after carp) in pond breedings in Czechoslovakia. The characterization of the Mácha Lake fishpond system has been given in an earlier paper (Moravec, 1979). The present paper is part of a broader investigation into the parasite-host relationships in fish populations in this locality.

MATERIALS

All fishes were collected by electrofishing in the connecting canal between the fishponds Břehyně and Mácha Lake. The occurrence of endohelminths was followed in tench (*Tinca tinca* (L.)), length 7–30 cm (age 0+–5); regular monthly samples of the fish were taken from March 1981 until April 1982 and this material was completed by dissections of tench in the various seasons in 1965–66 and 1975–77, a total of 195 specimens of tench was examined. At the same time, 1178 fishes belonging to 13 species were examined from this locality (see Moravec, 1984a), and, for orientation only, several samples of benthic invertebrates were also examined. In addition to endohelminths, occasional findings of some ectoparasites were recorded from tench in this locality: *Dactylogyrus macracanthus* Wegener, 1909, *Gyrodactylus tincae* Malmberg, 1956, *Piscicola geometra* (Linnaeus, 1761), *Ergasilus sieboldi* Nordmann, 1832, *Argulus foliaceus* (Linnaeus, 1758) and *Anodonta* sp. glochidiae.

Tab. 1. Survey of *Tinca tinca* examined from the Mácha Lake fishpond system and their infection by *Asymphylogora tincae*, *Khavira baltica*, *Skrybillanus tincae* and *Pholometra ovata*

Month	No. of tench examined	<i>Asymphylogora tincae</i>		<i>Khavira baltica</i>		<i>Skrybillanus tincae</i>		<i>Pholometra ovata</i>		Body length of tench in cm (mean, range)
		No. of tench infected (Prevalence)	Intensity (mean, range)	No. of tench infected (Prevalence)	Intensity (mean, range)	No. of tench infected (Prevalence)	Intensity (mean, range)	No. of tench infected (Prevalence)	Intensity (mean, range)	
January	16	14 (87%)	23 (1-178)	0 (0%)	—	0 (0%)	—	1 (6%)	2 (2)	14 (10-23)
February	24	15 (63%)	27 (1-100)	3 (13%)	2 (1-4)	8 (33%)	—	1 (4%)	1 (1)	19 (11-28)
March	19	15 (79%)	39 (1-156)	3 (16%)	1 (1)	4 (21%)	2 (1-4)	1 (5%)	1 (1)	18 (11-25)
April	22	14 (64%)	74 (1-420)	3 (14%)	1 (1)	1 (5%)	2 (2)	2 (9%)	4 (1-6)	16 (8-25)
May	16	10 (62%)	112 (1-340)	2 (13%)	2 (1-2)	1 (6%)	3 (3)	2 (12%)	20 (4-30)	18 (12-27)
June	14	6 (43%)	34 (2-135)	0 (0%)	—	0 (0%)	—	3 (21%)	2 (1-2)	16 (12-26)
July	10	6 (60%)	6 (1-17)	0 (0%)	—	0 (0%)	—	4 (40%)	1 (1)	16 (12-21)
August	16	8 (50%)	70 (24-191)	1 (6%)	3 (3)	1 (6%)	1 (1)	3 (19%)	7 (3-13)	18 (14-23)
September	13	9 (69%)	35 (4-178)	1 (8%)	1 (1)	2 (15%)	3 (1-4)	5 (38%)	4 (2-7)	20 (13-29)
October	8	6 (75%)	102 (5-255)	0 (0%)	—	2 (25%)	7 (6-7)	1 (13%)	1 (1)	18 (14-27)
November	21	18 (86%)	26 (1-123)	1 (5%)	2 (2)	8 (38%)	5 (1-16)	3 (14%)	2 (1-4)	19 (11-27)
December	16	14 (87%)	18 (3-113)	2 (13%)	2 (1-2)	3 (19%)	2 (1-5)	2 (12%)	1 (1)	18 (7-30)
Total	195	135 (69%)	44 (1-420)	16 (8%)	1 (1-4)	30 (15%)	3 (1-16)	28 (14%)	4 (1-36)	19 (7-30)

SURVEY OF ENDOPARASITIC HELMINTHS OF TENCH

Trematoda

1. *Phyllodistomum elongatum* Nybelin, 1926 (Fig. 1 A—C)

These trematodes were rarely found in tench of all sizes examined (body length 12—30 cm), being localized in them in the urinary system (ureters,

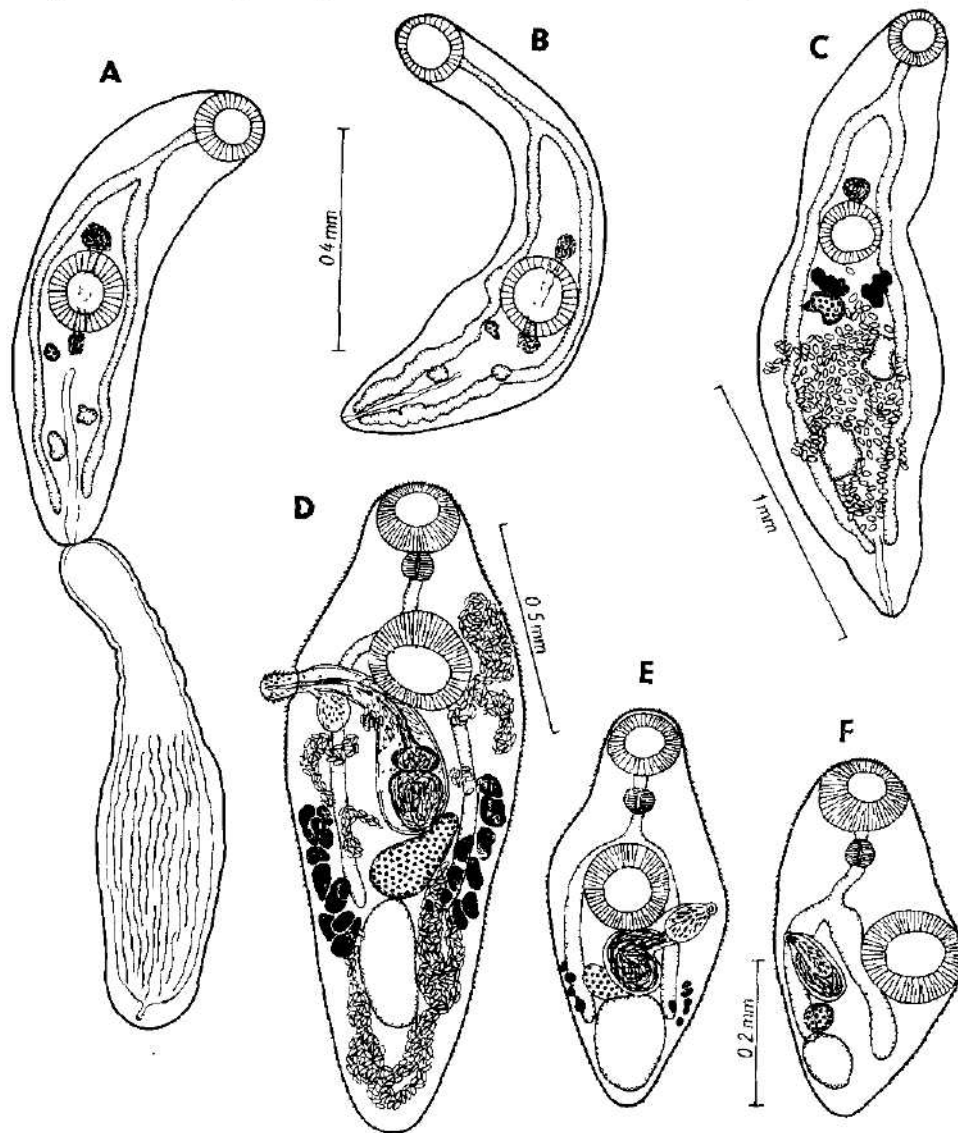


Fig. 1. A—C — *Phyllodistomum elongatum* Nybelin, 1926 (A — rhopalocercous cercaria from *Anodonta cygnea*; B, C — smallest and largest specimens from *Tinca tinca*); D—F — *Asymphylogora tincae* (Modeer, 1790) (D, E — largest and smallest specimens from *T. tinca*; F — metacercaria from *Bithynia tentaculata*).

urinary bladder); the prevalence was 5.1%, intensity 1—30 (average 6) trematodes per fish. The findings were from February, August, September, November and December and in all these months except September trematodes containing eggs were present; both the smallest juveniles (length 0.7—0.9 mm) and the largest gravid specimens (length 2—2.5 mm) were found in July. In view of the sporadic occurrence in tench, it was not possible to establish seasonal changes in the occurrence and maturation of *Ph. elongatum*. According to various authors (see Chubb, 1979), this parasite occurs in fishes during all seasons and no seasonal changes in maturation were found in it; the distribution of *Ph. elongatum* infections in tench, as recorded in this study, as well as the fact that gravid trematodes were found both in winter and summer agree with these data. Also the related species *Ph. folium*, a frequent parasite of pike in this locality, does not show here distinct seasonal changes in its occurrence and maturation (Moravec, 1979). In the locality, tench was the only host in which gravid specimens of *Ph. elongatum* were found; the parasite was recorded here as well from *Cyprinus carpio* (prevalence 3.2%, intensity 1—22) and *Scardinius erythrophthalmus* (prevalence 4.4%, intensity 1—3), but only juvenile specimens. According to the literature, numerous species of cyprinids serve as the hosts of *Ph. elongatum* (Pigulevskiy, 1953).

The development of *Ph. elongatum* was studied by Castagnolo et al. (1972) and Orecchia et al. (1975) in Italy who found the mussel *Anodonta cygnea* to serve as the intermediate host; large-tailed rhopalocercous cercariae develop in the latter. The source of infection for fishes are the metacercariae encysted inside the transformed tail and floating in water. In one of the five *A. cygnea* (shell length 12 cm) examined occasionally from the Mácha Lake fishpond system in April 1982, *Ph. elongatum* sporocysts and fully developed cercariae (Fig. 1 A) were found. The proper cercarial body (according to the stained total mounts in Canada balsam) was 0.789—1.102 mm long and 0.245—0.313 mm wide; size of oral sucker 0.123—0.144 × 0.111—0.141 mm, of acetabulum 0.147—0.171 × 0.126—0.159 mm; size ratio of suckers 1 : 1.13—1.18; measurements of the primordium of ovary 0.030—0.042 × 0.018—0.042 mm, of testes 0.030—0.075 × 0.030—0.048 mm; tail 0.993—1.088 mm long and 0.272—0.353 mm wide. The body of cercariae without tail was approximately as long as that of the smallest trematodes from tench (smallest trematode from tench (Fig. 1B): body length 0.924 mm, width 0.286 mm; diameter of oral sucker 0.136 mm, of acetabulum 0.162 mm, size ratio of both suckers being 1 : 1.18).

## 2 *Asymphylodora tincae* (Modeer, 17900) (Fig. 1 D—F)

This trematode was the most frequent parasite of tench in the locality; overall prevalence was 69%, intensity 1—420 (average 44) specimens per fish. The trematodes were localized throughout the length of the intestine, preferring, however, its middle and posterior thirds. In addition to tench, an accidental finding of one juvenile specimen of *A. tincae* (body length 0.97 mm) was only recorded from *Rutilus rutilus* (prevalence 1.5%) in April 1982; it indicates a high degree of host specificity in this parasite.

*A. tincae* was recorded in tench of all size groups throughout the year, with prevalence ranging from 43 to 87% (see Table 1). The distribution of trematodes within the tench population showed a high degree of overdispersion, this being

apparently associated with uneven infection of snails (*Bithynia*) by *A. tincae* metacercariae; the latter are the source of infection for fishes.

Fig. 4A shows that *A. tincae* attacks all size groups of tench and that there are no substantial differences in the values of prevalence. The intensity of infection fluctuates considerably, but it is distinctly lower in the group of

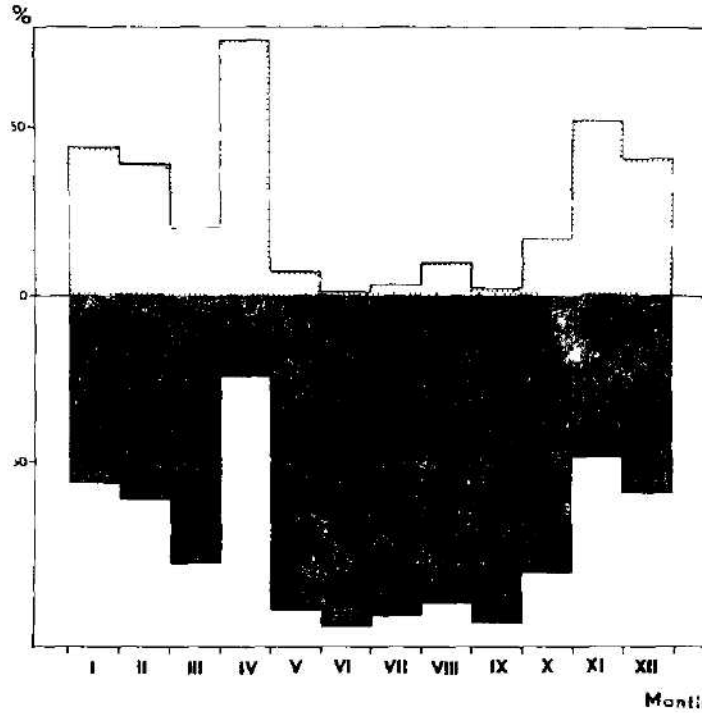


Fig 2. Monthly changes in state of *Asymphylodora tincae* maturity in tench of the Mácha Lake pond system during the year. The data are expressed as percentages of the total number of trematodes found per month: young trematodes without eggs (body length 0.4–1.0 mm) (stippled) and gravid trematodes with eggs (body length 1.0–1.7 mm) (black).

smallest tench (length up to 11 cm) than in other groups. The smallest examined fish harbouring adult trematodes with eggs measured 6.5 cm (age 0<sup>+</sup>); it confirms a rapid maturation of these trematodes in fishes as already noted by Wierzbicka (1970); Zietse et al. (1981) found experimentally that the trematodes produced eggs as early as 7–10 days following the infection of tench by metacercariae. Komarova (1951) observed a clear-cut seasonal cycle of *A. tincae* maturation in *T. tinca* of the R. Dnieper in the Ukraine; immature trematodes occurred in fishes only in January and April, while adults were present all the year round, but most frequently in July; the author explains it by the annual life span of the trematodes. On the other hand, Wierzbicka (1970) reported *A. tincae* as a species not exhibiting a distinct seasonal cycle in maturation; the author has reported that both the youngest and fully mature forms of *A. tincae* occurred in tench in ponds and lakes in northern Poland during all seasons, with a certain increase in number of young trematodes in autumn, winter and spring.

As indicated in Fig. 2, the seasonality of *A. tincae* maturation in the environment of the Mácha Lake pond system is similar to that found by W i e r z b i c k a (1970) in Poland. New infections are acquired here by fishes during the whole year, but especially in a period from October until April, this being reflected by increased numbers of juvenile trematodes in tench; undoubtedly, also the

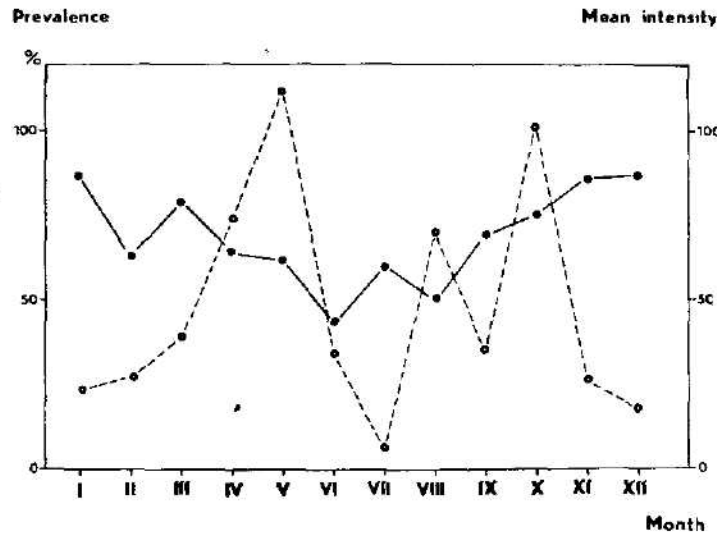


Fig. 3. Variation of the values of prevalence (—) and mean intensity of infection (-----) of *Asymphylogora tincae* in tench of the Mácha Lake pond system during the year.

slowing down of parasite's development is applied in this cold period, balancing a substantial decrease of the food consumption of tench and by this the parasite recruitment in winter months. Acquisition of new infections by fishes during the whole year is possible by the all-year availability of metacercariae in the snail intermediate hosts that constitute a significant component of the tench's diet (Z i e t s e et al., 1981). The proportion of juvenile trematodes in fishes is distinctly lower in a warmer period from May until September, this being apparently related with faster development of the trematodes.

Fig. 3 shows the seasonal dynamics of *A. tincae* occurrence in tench. Roughly it can be seen that the values of prevalence are higher in a cold period from October until March, this being probably associated with the increased recruitment; the drop in prevalence during warmer seasons may be due to a quicker passing out of old trematodes from the hosts. A sudden increase of mean intensity in the spring and autumn reflects probably acquisition of new infections during those seasons, whereas the summer (July) and winter (November—February) decreases are evidently related with the parasites' passing out of the host's body, namely due to the old age of the trematodes or high water temperatures (a summer decrease) and the loss of these parasites as a result of the host's starvation in winter months (a winter decrease) (see Z i e t s e et al., 1981).



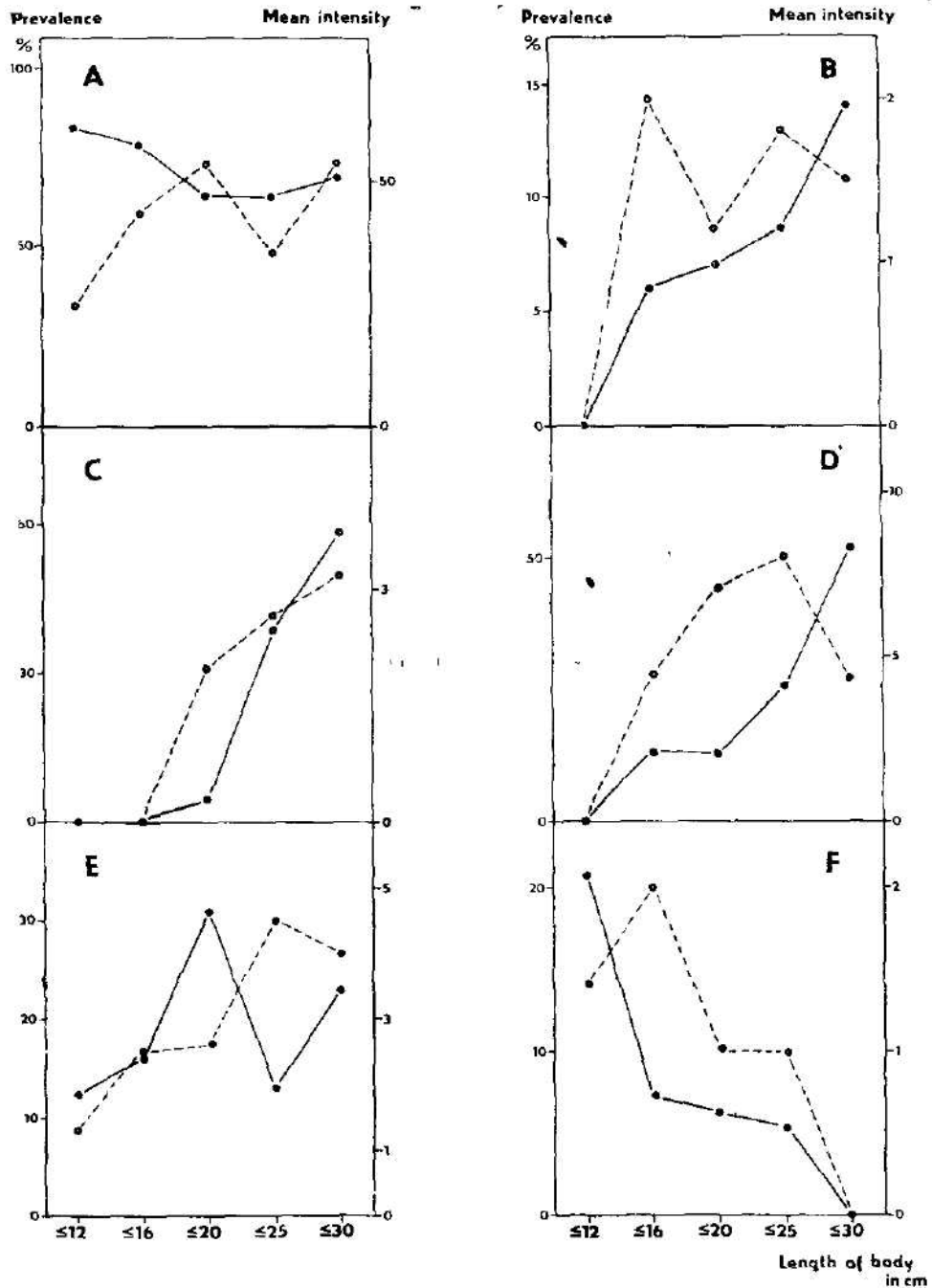


Fig. 4. Relationship of prevalence (—) and mean intensity of infection (----) to body length of tench: A - *Asymphylodora tincae*, B - *Khawia baltica*, C - *Skrjabillanus tincae*, D - *Philometra ovata*, E - *Pseudocapillaria brevispicula*, F - *Neoechinorhynchus rutili*.

Although this parasite often occurred in tench in large numbers (up to 420 specimens), no apparent damage to the intestine of host fishes was observed. Most authors (e.g. Schäperclaus, 1954, Zietse et al., 1981) consider this species to be relatively harmless. However, the pathogenicity of *A. tincae* has not yet been studied in detail; according to Bauer (1961) a changed blood picture is observed in heavily infected tench.

Recently the life history of *A. tincae* has been studied in detail by Van Den Broek and De Jong (1979) and Zietse et al. (1981) in a small lake in Holland. The authors found the prosobranchiate snail *Bithynia tentaculata* to serve as the first intermediate host in which a tailless cercarial stage (cercariaeum) develops that usually encysts in gastropods. The second intermediate host harbouring encysted metacercariae is again *B. tentaculata* and probably also some species of pulmonate snails; these serve as a source of infections for fishes. A small part of the cercariae that penetrated into *B. tentaculata* is able to develop into progenetic specimens.

*B. tentaculata* is a very common snail in the Mácha Lake fishpond system (see also Flasar, 1964), undoubtedly representing here an important part of the tench diet. In June 1983, 58 specimens of *B. tentaculata* from the fishpond Břehyně were examined of which one (prevalence 1.7%) proved to be infected by 6 encysted metacercariae of *A. tincae*; the latter could be assigned to this species, because *A. tincae* is the only representative of the genus present in the locality. These metacercariae were not found in other species of the aquatic snails (20 specimens of 4 species) examined from here.

The found metacercariae (Fig. 1 F) were localized in spherical, hyaline thin-walled cysts. The body length of stained and in Canada balsam mounted metacercariae is 0.489–0.571 mm, width 0.272–0.326 mm. Cuticle densely spinose. Size of oral sucker 0.108–0.117 × 0.120–0.138 mm, of acetabulum 0.147–0.156 × 0.156–0.162 mm. Size of pharynx 0.045–0.048 × 0.045–0.051 mm. In addition to oesophagus and gut caeca, also large cirrus sac and developing testis and ovary present; vitellaria hitherto not distinguishable. Eggs not present in uterus.

### 3. *Diplostomum spathaceum* (Rudolphi, 1819) — metacercariae

The metacercariae of *D. spathaceum* located in the lens of the eye were, in comparison with other cyprinids, infrequent parasites of tench in the locality; these were found in February, March, June, August, October and December in the tench 19–26 cm long, with the overall prevalence 5.3% and intensity 1–3 (average 2) specimens per fish. Besides tench, *D. spathaceum* was recorded here in numerous other fish species: *Abramis brama* (prevalence 90%, intensity 5–120), *Rutilus rutilus* (prevalence 60%, intensity 1–210), *Leuciscus cephalus* (1 specimen found in 1 fish examined), *Gobio gobio* (prevalence 88%, intensity 2–30), *Leucaspius delineatus* (1 specimen found in 1 fish examined), *Cyprinus carpio* (prevalence 33%, intensity 1–19), *Carassius carassius* (prevalence 25%, intensity 1), *Scardinius erythrophthalmus* (prevalence 1.5%, intensity 1), *Esox lucius* (prevalence 1.4%, intensity 1–12) and *Gymnocephalus cernuus* (prevalence 50%, intensity 1–5).

The first intermediate hosts of *D. spathaceum* are snails of the genus *Lymnaea*, the main definitive hosts in Czechoslovakia are gulls (see Vojtek, 1974).

4. *Khawia baltica* Szidat, 1941

The first record of this specific parasite of tench in Czechoslovakia has only recently been reported by Moravec (1984c). It was found as an infrequent parasite of tench in this locality, the overall prevalence being 8.2%, the intensity of infection 1–4 (average 1) cestodes per fish. They were most frequently localized in the middle third of the host's intestine, less often in its anterior and posterior thirds.

It is obvious from Fig. 4 B that the prevalence was distinctly increasing with the body size (age) of the fish, while the mean intensity values fluctuated irregularly; the body of the smallest tench harbouring the cestodes was 14 cm long.

So far there are no data in the literature concerning seasonal cycles of *K. baltica* occurrence and maturation. In tench of this locality, very young cestodes (length 3–8 mm) were recorded only in cooler winter and spring months (December, February, March, May), while gravid specimens with eggs in uteri (body size 25–56 mm) were found during all seasons (April, May, August, September, November, December). Even though it has not been possible to establish the seasonal maturation cycle of *K. baltica* in tench of this locality more precisely due to a limited number of the cestodes, it is obvious that these parasites mature in tench and lay their eggs throughout the year; apparently, new infections in tench occur also during the whole year, but mainly in winter and spring, as it is indicated by findings of juvenile cestodes.

The pathogenicity of *K. baltica* has not yet been studied, some other caryophyllids (e.g. *Khawia sinensis* and *Caryophyllaeus fimbriceps* parasitizing carp) are known as highly pathogenic to their fish hosts.

The life cycle of *K. baltica* is not known. However, it can be assumed that it is similar to that in other caryophyllids, i.e. that it involves obligate intermediate hosts, the oligochaetes of the families Naididae and Tubificidae (Demshin and Dvoryadkin, 1980).

5. *Neogryporhynchus cheilancristrotus* (Wedl, 1855) — plerocerci

Single findings of these larval cestodes, parasitic in the anterior part of fish intestine, were recorded from tench of all size groups (body length 13–30 cm) in January, February, November and December; the prevalence was 2.6%, intensity 1 plerocercus per fish. The body size of plerocerci was  $0.422\text{--}0.720 \times 0.272\text{--}0.367$  mm, size of their suckers  $0.060\text{--}0.075 \times 0.060$  mm, length of larger hooks 0.060–0.066 mm, of smaller hooks 0.039–0.045 mm. In addition to tench, these larvae were found in the locality also in *Cyprinus carpio* (prevalence 2.6%, intensity 1). Even though *N. cheilancristrotus* was found in tench only in the cold period from November to February, apparently the parasite is present in fishes all the year round, this being suggested by the findings from carp in June and July (Moravec, 1984a).

Two intermediate hosts are required for the development of this parasite: the first one are copepods (e.g. *Mesocyclops*) in which the so called cercoscolex develops, the second one are fishes, mainly cyprinids, in the intestine of which the parasite attains the larval stage called plerocercus (Jarecka, 1970). The cestodes mature in the intestine of fish-eating birds (*Ardea* spp.).

#### 6. *Proteocephalus percae* (Müller, 1780) juv.

Very young specimens of this cestode were found in the anterior and middle parts of intestine of tench, 12—26 cm long. All findings are from autumn and winter months (September, November, January); the cestodes from September measured only 0.5 mm, while their body length in November and January was 1.3—4 mm. The overall prevalence in tench was 3.1%, intensity 1—2 cestodes per fish. The same larvae were recorded here from *Cyprinus carpio* (prevalence 1.6%, intensity 1—2) in November (Moravec, 1984a). Since the only member of the genus *Proteocephalus* in the locality is *P. percae* maturing in *Perca fluviatilis* (prevalence 29%, intensity 1—64) and *Gymnocephalus cernuus* (prevalence 16%, intensity 15), it was possible to assign the larvae to this species. As postcyclic hosts serve *Esox lucius* in this locality (Moravec, 1979).

The development of *P. percae* requires an intermediate host, various species of copepods. The source of infection for tench are probably only the intermediate hosts, although the possibility of a secondary infection by accidental feeding on small perch by larger tench cannot be excluded; apparently, the cestodes can survive in the intestine of tench and carp for a certain period, mainly during cool seasons, being perhaps able to grow up a little; they probably perish due to increased water temperatures in the spring.) The findings of juvenile *P. percae* in cyprinids are from the same period when new infections of this seasonally maturing parasite occur in the definitive hosts, perch (see Moravec, 1979, Chubb, 1982).

### Nematoda

#### 7. *Skrjabillanus tincae* Shigin et Shigina, 1958

This specific tissue parasite of tench was found rather often in *T. tinca* of this locality (overall prevalence 15%, intensity 1—16 (average 3) nematodes per fish). The parasites were localized most frequently under the serose cover of posterior part of the swimbladder or in the urinary system (mesonephros, ureters, urinary bladder) of host fishes, rarely also on the surface of the heart or intestine; no differences in localization were found among differently advanced nematodes. The males of *S. tincae* were less common than females, the ratio of both sexes being approximately 1:4.

So far there are no data in the literature on the seasonal dynamics of *S. tincae*. According to present observations, it appears that the seasonal dynamics of *S. tincae* occurrence and maturation in tench exhibits obvious seasonal cycles in this locality. As it follows from Table 1, the nematodes were not recorded in tench in June and July; starting from August, the values of prevalence gradually increase up to November; after a sudden winter decrease (December, January) the prevalence again rises in February to decrease gradually again in April—May; finally the infections disappear from fishes in June and July. As far as the state of nematode maturity is considered, only very young nematodes (the length of young females some 3 mm) were found in August and September, whereas all the samples from October until May (except April) contained gravid females of *S. tincae* with larvae in their uteri. Therefore, it is possible to presume that new infections in tench occur here mainly in the late summer and autumn (August—November) and probably also

in February—March; the gravidity is attained by *S. tincae* females in cool seasons from October until May; having released the larvae into the host's tissues the females perish. The winter drop of prevalence in December and January may be associated with the death of the nematodes maturing already in the autumn as also with a substantially limited or arrested acquirement of new infections in the winter. This pattern of the seasonal cycle of *S. tincae* is probably also related with seasonal changes in populations of the branchiurid intermediate hosts.

It is obvious from Fig. 4C that *S. tincae* infections exhibit a distinct dependence on the body size (age) of host fishes. The length of the smallest tench harbouring this parasite was 17—18 cm (age 2 years); the prevalence and mean intensity increase with fish size, reaching maximum values in the largest fishes (older than 3 years). Similar dependence was found by Tikhomirova (1975) in the skrjabillanids *Skrjabillanus scardinii* and *Molnaria intestinalis* parasitic in rudd; the author explains it by the gradually increasing contacts between host fishes and branchiurid intermediate hosts.

The life cycle of *S. tincae* has not yet been studied in detail. Only Tikhomirova (1980) mentions that she succeeded in studying a part of the *S. tincae* development and that the third-stage larvae of this parasite were found in the proboscis of branchiurids. Without giving additional data the author reports that the development of all skrjabillanids follows the same pattern in which one intermediate host, the branchiurid of the genus *Argulus*, is involved. While sucking the blood of fish these ectoparasites swallow the nematode larvae which develop in their body cavity to the third larval stage, this already being infective for fishes. During repeated sucking of the infected branchiurid on fish, these infective larvae penetrate through the crustacean's mouth organs into the skin of fish; they migrate from there into internal organs of the fish host to develop further and mature there.

One hundred and thirty specimens of *Argulus foliaceus* were examined from this locality, being collected on the skin of various cyprinids and pike in various seasons; skrjabillanid larvae were found in 7 of them (prevalence 5%) with the intensity of infection 1—3 larvae per branchiurid; all these were found within the cold period from November until April (November, January, February, March, April). The larvae, localized freely in the branchiurid's hemocoel (most frequently in the cephalothorax, rarely in the abdominal furca), have already been described by Moravec (1978) who considered them advanced larvae of *Molnaria erythrophthalmi* (= *M. intestinalis*). However, these larvae are morphologically distinctly different from the infective larvae of *M. intestinalis* as described by Tikhomirova (1975) and their common occurrence in the intermediate hosts suggests a large population of these nematodes in the locality under investigation; while tench is one of the most frequent fishes in the Mácha Lake fishpond system, the occurrence of rudd is relatively rare here. Hence it is obvious that the above mentioned type of larvae from *Argulus* represents the third-stage larva of *S. tincae* and not that of *M. intestinalis*; however, the appurtenance of these larvae to *S. tincae* requires experimental verification.

The pathogenicity of *S. tincae* has not yet been studied; however, it can be supposed that these nematodes may cause a damage to the mesonephros, and ureters and negatively influence their function in highly infected fishes.

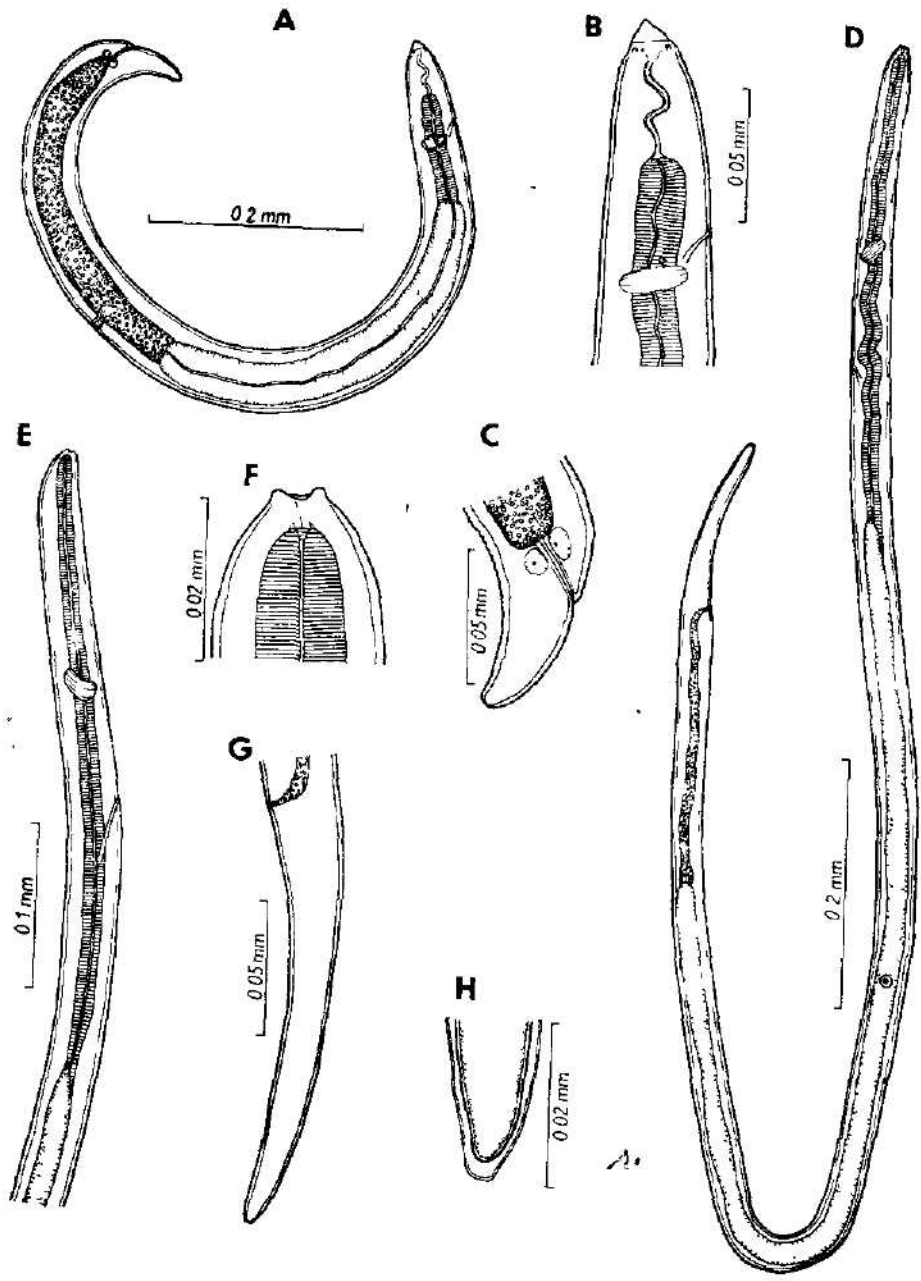


Fig. 5. A-C - *Agamospirura* sp. larva from the intestine of *T. tinca* (A - general view, B - head end, C - tail); D-H - larva of *Philometra ovata* from *T. tinca* (D - general view, E - anterior body end, F - head end, G - tail, H - tail tip in a larva just undergoing the moult).

### 8. *Philometra ovata* (Zeder, 1803) (Fig. 5 D—H)

This nematode species was fairly frequently found in tench in this locality, both as adults (males and retarded females) and four-stage larvae; all the nematodes were localized under the serose cover of posterior part of the swimbladder of host fishes. The overall prevalence was 14%, intensity 1—36 (average 4) nematodes per fish. Whereas the larvae were found during the whole year (they were recorded from all months), the males and retarded females occurred only in a warmer period from spring to autumn (April, May, June, July, August, September). The ratio of all found larvae and adults was approximately 1:2.

The morphology of adults was characteristic of the species *Ph. ovata* (see Moravec, 1971): Body length of males was 2—3 mm, maximum width 0.054 mm; length of larger spicule 0.255—0.300 mm, of smaller spicule 0.171—0.210 mm, of gubernaculum 0.060—0.075 mm. Retarded females were 1.8—2.6 mm long and 0.041 mm wide, provided with vulva covered by cuticle, situated 0.54—0.82 mm from posterior extremity.

The larvae were assigned to this species principally on the basis of the oesophagus length, this being relatively very long, like in the third-stage larva of *Ph. ovata* (see Moravec, 1980); for example, it is much longer than that in the larvae of *Skrjabillanus*. These whitish larvae (Fig. 5 D—H) were 1.59—1.62 mm long and 0.030—0.033 mm wide. Head end bearing four well developed, forwardly directed papilla-like protrusions. Whole oesophagus measuring 1.24—1.35 mm, its posterior part being overlapped by granular oesophageal gland 0.87—0.94 mm long. Distance of nerve ring 0.15—0.17 mm, of excretory pore 0.24—0.26 mm. Tail conical, 0.12—0.14 mm long; its tip rounded, provided with small, slightly outlined caudal mucrones in some larvae.

This species was recorded here for the first time from tench by Moravec (1978). However, *T. tinca* is not a suitable host for *Ph. ovata* and, accordingly, the females of the parasite cannot attain gravidity in it; this type of host can be considered a paradenitive host according to Odening's (1976) conception. Bream (*A. brama*) serves as the principal definitive host of *Ph. ovata* in this locality (prevalence 89%, intensity 1—270 nematodes), whereas roach (*R. rutilus*) as only its subsidiary host (prevalence 7.5%, intensity 2—5 nematodes); the female parasites become gravid in the abdominal cavity of both bream and roach.

Records of *Ph. ovata* in tench during winter and spring suggest a long-term surviving of the parasite's larvae in this host as also the capacity of their further development up to maturity under increased water temperatures in the period from spring until autumn; however, the adult nematodes live probably only shortly in tench, this being suggested by their absence in the winter. As it is seen in Fig. 4D, the *Ph. ovata* prevalence in tench increases with the size (age) of fishes, whereas the mean intensity first increases to reach its maximum in fishes 20—25 cm long, decreasing again in larger fishes. Decreased intensity values in the largest fishes are probably associated with quantitative changes in their food composition, i.e. with smaller proportion of copepod intermediate hosts in their diet.

The life cycle of *Ph. ovata* involves intermediate hosts that are various species of cyclopoid copepods (Molnár, 1966; Moravec, 1980). Maturation of this parasite in the definitive host is strictly seasonal, showing an obvious annual cycle (Molnár, 1966). According to own observations, the

gravid females with larvae in their uterus are present in *A. brama* of the Mácha Lake fishpond system in the period from the end of May until early July (unpublished).

#### 9. *Raphidascaris acus* (Bloch, 1779) — larvae

Larvae of this pathogenic parasite were occasionally found in the liver, abdominal cavity and intestine of tench 12—28 cm long in all seasons (January, April, June, September, November, December); the prevalence was 4.6%, intensity 1—3 larvae per fish. The larvae were mostly encapsulated in a thin connective envelope, all of them representing early third-stage larvae (the smallest larvae were about 1 mm long). In addition to tench, *R. acus* larvae were recorded in this locality also from *Abramis brama* (prevalence 29%, intensity 1—1500), *Scardinius erythrophthalmus* (prevalence 13%, intensity 1—2), *Rutilus rutilus* (prevalence 8.9%, intensity 1—7), *Esox lucius* (encysted larvae: prevalence 1.8%, intensity 1—9), *Anguilla anguilla* (encysted larvae: prevalence 0.7%, intensity 27) and *Perca fluviatilis* (prevalence 0.3%, intensity 1).

The intermediate hosts of *R. acus* are various fish species, mainly cyprinids, whereas numerous invertebrates (largely larvae of Chironomidae and Oligochaeta) serve as the paratenic hosts of preinfective larvae (Moravec, 1970); according to some authors (e.g. Supryaga and Mozgovoy, 1974), also invertebrates may become intermediate hosts of *R. acus*. Considering that in contrast e.g. from carp the diet of tench of this locality did not contain any fish, it can be assumed that invertebrates constitute the only source of *R. acus* infection for tench; accordingly, tench serve as obligate intermediate hosts for *R. acus*. The parasite's definitive hosts in this locality are mainly *Esox lucius* (prevalence 17%, intensity 1—53), less often *Anguilla anguilla* (prevalence 3%, intensity 1—2).

#### 10. *Agamospirura* sp. — larva (Fig. 5 A—C)

A single larva, encysted on the surface of the intestinal mucosa of one tench (body length 15 cm) (prevalence 0.2%), was found in June 1981. The larval body is light in colour, 0.912 mm long and 0.063 mm wide, with fine transverse striation of cuticle. Mouth surrounded by two lateral, triangular lips 0.015 mm long, each of them bearing at its base 2 minute papillae. Vestibule, starting from base of lips, measures 0.042 mm, length of muscular oesophagus 0.102 mm, of glandular one 0.417 mm. Nerve ring 0.105 mm, excretory pore 0.090 mm, and simple deirids 0.105 mm from anterior extremity. Tail conical, 0.054 mm long, with rounded tip. Primordium of vulva located 0.369 mm from posterior end of body.

The morphology of the larva indicates that it belongs to the family Acuariidae, but closer identification was not possible; adult nematodes are parasitic in birds. The life-cycles of nematodes of this family involve obligate intermediate hosts (invertebrates); fishes (in this case tench) serve undoubtedly as only paratenic hosts.

#### 11. *Pseudocapillaria brevispicula* (Linstow, 1873)

The bionomy of *P. brevispicula* in this locality has already been dealt with in the previous author's paper (Moravec, 1983). It can be summarized that this intestinal parasite was found here in 21% tench examined with



the intensity 1—11 nematodes per fish; however, the principal host is carp (*C. carpio*) (prevalence 62%, intensity 1—35). New infections are acquired by fish throughout the year and also adult nematodes occur in their fish hosts all the year round. However, the normal development of eggs in female uteri and the oviposition occur only during a warmer period from April until October. As indicated in Fig 4E, the highest prevalence was found in tench 16—20 cm long, whereas the intensity gradually increased with the body size of fish hosts to attain its maximum in fishes 20—25 cm long, a light increase of intensity was recorded in a group of the largest fishes (length above 30 cm). These differences are probably associated with the volume of taken food and the proportion of oligochaetes in it in individual size groups of fishes. The development of this pathogenic parasite is not sufficiently known at present; according to own observations (Moravec, 1983), new infections seem to be acquired by fishes via aquatic oligochaetes serving as either intermediate or paratenic hosts; Lomakin and Trofimenko (1982) admit the possibility of a direct development of *P. brevispicula* without intermediate hosts.

#### Acanthocephala

##### 12. *Neoechinorhynchus rutili* (Müller, 1780)

The occurrence and seasonal maturation of this parasite in carp of this locality have been dealt with in the author's previous paper (Moravec, 1984b). Its principal host is carp here (prevalence 48%, intensity 1—60); in tench it was recorded less often (prevalence 14%, intensity 1—5), and then always only juvenile and young forms (the most advanced females to body length 3 mm, with fragmented ovaries, without eggs). Rare findings of *N. rutili* in tench were recorded in all months, except for May, June, August and September. As it can be seen in Fig. 4F, the infestation of tench depends considerably on the body size of fishes; both the prevalence and intensity attained their maximum values in the smallest tench examined (body length less than 16 cm) and then are gradually decreasing; *N. rutili* was not recorded at all from the group of the largest tench (length above 30 cm). Apparently, it is associated with the fact that the intermediate hosts of *N. rutili* are minute ostracods, serving as food mainly to small tench, while older (larger) fishes prefer larger-sized food items.

In carp of this locality *N. rutili* exhibits an obvious seasonal cycle of maturation, when gravid females of the parasite lay their eggs only during May (Moravec, 1984b). In addition to carp and tench, this parasite was found in some other fish species of the Mácha Lake pond system, but as juvenile and young forms only: in *Abramis brama* (prevalence 11%, intensity 1—13), *Rutilus rutilus* (prevalence 9%, intensity 1—3), *Scardinius erythrophthalmus* (prevalence 2.9%, intensity 1—13), *Gobio gobio* (prevalence 6.2%, intensity 1), *Esox lucius* (prevalence 1.8%, intensity 1) and *Perca fluviatilis* (prevalence 0.9%, intensity 1—2).

##### 13. *Acanthocephalus lucii* (Müller, 1776)

Occasional findings of this acanthocephalan in the intestine of tench (body length 12—29 cm) (prevalence 4.1%, intensity 1—4) were recorded mainly during a colder period from November until March, only in one case it was found in August; the worms, all representing young males and juvenile females

(body length 4.2—5.5 mm), were rarely attached to the intestinal wall of the host fish, but were mostly unattached and in one case a dead acanthocephalan was even found; the parasites were located along the whole length of intestine. It can be deduced from these findings that tench acquire infection only while feeding on intermediate hosts, the isopods *Asellus aquaticus*; in them the parasite attains the same developmental stage and size (see Moravec, 1984a) that were found in the acanthocephalans recovered from tench; apparently, the acanthocephalans are only shortly passaged through the intestine of these fish hosts.

In the locality, the main hosts of *A. lucii* are *Perca fluviatilis* (prevalence 62%, intensity 1—159), *Gymnocephalus cernuus* (prevalence 33%, intensity 1—2), *Anguilla anguilla* (prevalence 31%, intensity 1—18) and *Esox lucius* (prevalence 63%, intensity 1—53) in which the parasite females become gravid. The facultative hosts are here, in addition to tench, also *Cyprinus carpio* (prevalence 21%, intensity 1—36), *Abramis brama* (prevalence 2.5%, intensity 1—8) and *Gobio gobio* (prevalence 5%, intensity 1). The crustacean *Asellus aquaticus* was found to be the only intermediate host of *A. lucii* in this locality (Moravec, 1979).

#### CONCLUSIONS

Although tench represents commercially a very important fish for freshwater fisheries, only little attention has so far been paid to the investigation of ecology of its endohelminths; most available data on the parasite fauna of tench are included in faunistical papers and then mostly in those of a broader view. The same concerns the data from Czechoslovakia, where information on the endohelminth occurrence in tench can be found in about thirty papers (e.g. Dyk, 1954, Dyk and Lucký, 1963, Ergens, 1960, 1961, 1962, Lucký and Dyk, 1964, Moravec, 1971, 1978, Vojtek, 1959, Vojtková, 1959, Žitňan, 1966, 1971). Review of this literature has shown that a total of 24 endohelminth species (Trematoda 10, Cestoda 6, Nematoda 5, Acanthocephala 3) were recorded in tench (*T. tinca*) from Czechoslovakia; however, data on the occurrence of some of these parasites in tench (e.g. *Phyllodistomum folium* and *Caryophyllaeus laticeps*) can be considered as unreliable and these will have to be verified. The given list of the endohelminths of tench relates, however, to the various environmental types inhabited by this fish, including both standing and streaming waters.

In comparison with it, a total of 13 species was found in the Mácha Lake fishpond system, this indicating a considerable richness of the parasite fauna of tench in this locality; in contradistinction from other Czechoslovak localities, the following endohelminth species have been recorded in tench only from here: *Proteocephalus percae* juv., *Philometra ovata*, *Agamospirura* sp., *Neoechinorhynchus rutili* and *Acanthocephalus lucii*. In the endohelminth fauna of tench there prevail adult parasites (8), larval stages and juvenile forms being represented by only 5 species.

According to the degree of their host specificity, the parasites of tench can be divided approximately into 4 groups: 1. strictly specific species occurring only in tench (*Asymphylogora tincae*, *Khawia baltica*, *Skrjabillanus tincae*), 2. species occurring and maturing also in other cyprinids (*Phyllodistomum elongatum*, *Pseudocapillaria brevispicula*), 3. species occurring also in fishes of other families, for which tench serves as an obligate host (*Diplostomum*

*spathaceum*, *Neogryporhynchus cheilancristrotus*, *Raphidascaris acus*, *Neochinorhynchus rutili*, and 4. species for which tench is only a facultative host; the latter group is rather heterogenous, including the species for which, in this case, tench serves as either a paratenic host (*Proteocephalus percae*, *Agamospirura* sp., *Acanthocephalus lucii*) or a pardefinitive host (*Philometra ovata*). It follows from a comparison among the individual groups that most species (9) belong to obligate parasites of tench; for 4 species of them tench is the only or the principle host in the locality. On the other hand, the group of facultative parasites is represented by only 4 species.

The composition of the endohelminth fauna of tench shows a considerable similarity to that of carp in this locality (see Moravec, 1984a), the latter being somewhat richer in species (16 species). Out of a total of 13 species found in tench, 9 (70%) are also parasitizing carp, these belonging largely to the groups 2 and 3, for which both the fish species are obligate hosts; one half of the facultative parasites of tench (group 4) was also found in carp (except *Ph. ovata* and *Agamospirura* sp.). Such resemblance in the qualitative composition of the parasite fauna of tench with that of carp is not surprising, because both the cyprinid species have a similar mode of life and, feeding on benthic invertebrates, they are, to a certain extent, food competitors.

It is obvious from Fig. 4 that the rates of infestation of the various size groups of tench show distinct differences; however, the data concern only 6 commonest species, whereas it was not possible to compare the values in remaining species due to their rare occurrence in tench. The found differences are both qualitative and quantitative: while all 6 parasite species were present in tench with body length 16–25 cm, 3 species (*K. baltica*, *S. tincae*, *Ph. ovata*) were absent in the smallest tench (shorter than 12 cm), 1 species (*S. tincae*) in fishes with length 12–16 cm and 1 species (*N. rutili*) in the largest tench (length 25–30 cm). In some species there is an obvious increase in the values of prevalence (and mostly also in mean intensity) with increasing size of host fishes (*K. baltica*, *S. tincae*, *Ph. ovata*) or, on the contrary, their distinct gradual decrease (*N. rutili*); however, no distinct correlation was apparent for other species (*A. tincae*, *P. brevispicula*). These quantitative changes in infestation of the individual size (age) groups of fishes are determined by many factors, being associated mainly with changes in the ecology and ethology of these hosts.

Out of the parasites recorded in tench from the Mácha Lake system, seasonal changes in occurrence and maturation could be considered in some species only. *A. tincae*, *Ph. ovata* and *P. brevispicula* occurred in tench throughout the year, while *S. tincae* was absent from fishes during June and July. Pronounced seasonal cycles in maturation were found only in nematodes *S. tincae* and *P. brevispicula*; the gravid females (with larvae in uteri) of the first species were obtained only in a period from October until May, whereas the gravid females (with mature eggs) of the second one were present in the locality only in a warmer period from April until October. On the other hand, the trematode *A. tincae* did not exhibit any distinct seasonal changes in maturation and, in spite of certain quantitative differences, both the oviposition and recruitment occurred throughout the year.

There are many species among the endohelminths recorded in tench from the Mácha Lake fishpond system that are known as the pathogenic fish parasites (*D. spathaceum*, *N. cheilancristrotus*, *P. brevispicula*, *R. acus*, *N. rutili*, *A.*

*lucii*). Even though the degree of infection of tench by these parasites is not too high in this locality at present, these could become the cause of considerable economic losses under changed ecological conditions. Moreover, the pathogenicity of some other species (*A. tincae*, *K. baltica*, *S. tincae* a.o.) has not yet been elucidated. The results of the present paper also confirm a considerable epizootological significance of tench for the distribution and maintainance of the parasites of carp (the most important fish in pond breedings) in the given environment.

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The plates will be found at the end of this issue.

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**SUPPLEMENTARY OBSERVATIONS ON DACTYLOGYRUS VOLFI  
(DACTYLOGYRIDAE: MONOGENEA) FROM GILLS OF CAPOETA TETRAZONA**

Jiří ŘEHULKA

Received November 28, 1983

**Abstract.** The species *Dactylogyrus volfi* Lucký, 1970, is presented by supplementary description and illustration. The hard parts of the opisthaptor and copulation apparatus were studied in 33 individuals to determine their metric variability and complement the original description of the species. Simultaneously, pathogenic effect of intensive infestation by the fluke associated to generalized mycobacteriosis in *Capoeta tetrazona* Bleeker, 1855, was studied.

The description of *Dactylogyrus volfi* was presented by Lucký, 1970 who collected the trematods from gills of the current aquarium species *Capoeta tetrazona* Bleeker, 1855, originating from fresh waters in Thailand, Sumatra, and Borneo. The topic of the present study was morphology and metric variability of the hard parts of its opisthaptor and copulation apparatus.

*D. volfi* Lucký, 1970, was collected from fish suffering from mycobacteriosis to which a strong infestation of gills by the flukes was associated, with consequent general weakness and death. The sampled parasites were fixed by a glycerol-formol mixture and picric acid. Hard parts of the opisthaptor, copulation apparatus and vaginal fortification were examined by phase-contrast microscopy. For histological purposes, tissues were fixed by 4% neutral formaldehyde, and, paraffin slides, dyed by hematoxylin-eosine and Ziehl-Neelsen's dye.

In an aquarium of 300 litres occupied by *Capoeta tetrazona* Bleeker, 1855, and *Cheirodon axelrodi* Schultz, 1956, all 22 mature *Capoeta* successively died within a fortnight, manifesting loss of pigmentation, emaciation, and, several days prior to death, loss of appetite and separation from brood. Remarkable symptoms were deviation of operculum and enlargement of gills. By parasitological examination of gills infestation by *Dactylogyrus volfi* Lucký, 1970, was found, amounting the maximum of 80 parasites; histological examination of the enlarged gills detected inflammatory granuloma and edematous imbibition. Granuloma were present in every visceral organ of the host. Histological preparations dyed by Ziehl-Neelsen's method contained acidoresistant rods. The rest of fish who displayed neither symptoms nor mycobacterial noduli, were infested by not more than 3–5 flukes.

**Description:** Comparing the collected trematods with type material rendered by the author of the species description (Lucký, 1970), it was felt that data concerning hard parts of the opisthaptor, and particularly of marginal hooks were too schematized. That is the reason for presenting Fig. 1.

Parameters (in  $\mu\text{m}$ ) of the hard parts of opisthaptor and copulation apparatus in 33 exemplars of *D. volfi* Lucký, were confronted with values by Lucký (1970) which are quoted in brackets. As can be seen from the following data, of complementing significance were findings concerning the variance in total length of marginal hooks (18–33), length of the central bar (22–31), and, total length of the copulation apparatus (16–25).

Total length of the comparatively fine anchors was 28 — 33  $\mu\text{m}$  (30 — 32), length of their shaft 26 — 29 (27 — 30), length of point 3 — 5 (3 — 5). Length of the inner root was 5 — 7 (5 — 7), of the outer root 4 — 6 (4 — 5). The ventral bar was straight and slightly enlarged laterally. Its length was 21 — 23 (20 — 22), its width 3 — 4 (4 — 6). The dorsal bar, in the shape of a cross, was 21 — 23 (18 — 23) wide, and 25 — 31 (22 — 26) long. Total length of marginal hooks ranged from 19 to 33 (18 — 25).

The copulation apparatus consisting of a slightly bend copulation tube enlarged at the base, a very fine basal part, and an S-shaped supporting part, was 16 — 21 (20 — 25) long.

Absence of inflammatory response and lack of alterations on gill epithelium at sites of parasites indicated that *Dactylogyrus volfi* Lucký, displayed no primary pathogenic effect (Fig. 2 and 3). Intensive parasitisation was to be observed merely in fish suffering from mycobacteriosis, apparently as the consequence of the host's weakness resulting bacterial infection.

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The figures 1–3 will be found at the end of this issue.

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**DRIFT OF THE JIHLAVA RIVER AS AFFECTED BY THE OPERATION OF THE  
WATER WORKS AT DALEŠICE**

Jana TRNKOVÁ

Received April 5, 1983

**Abstract:** During 1976–1980 investigations of the drift composition of the Jihlava River were conducted below the waer works at Dalešice. Samples were taken about 1 km below the dam of the auxiliary reservoir. The research was started even before the filling of the reservoir in 1976. In total, 54 taxa were ascertained, the highest number of 29 in 1977, the lowest number of 8 in 1976. 35 taxa were of benthic origin (64.8%), the others aquatic animals amounted to 9 taxa (16.7%), 10 taxa (18.5%) were represented by terrestrial invertebrates. During the individual years of the period under study benthic organisms participated by 50.0 to 62.3% of taxa, 44.8 to 95.9 of individuals and 41.2 to 98.3% of biomass. In the years when being present in the drift, the other aquatic invertebrates accounted for 10.3 to 26.3%, 0.9 to 50.4% and 0.1 to 17.6% of taxa, individuals and biomass, respectively. Their share was enhanced considerably in 1980, predominantly by the incidence of plankton, which is characteristic for streams below valley reservoirs.

Terrestrial organisms represented 5.3 to 50.0%, 0.1 to 32.1% and 2.4 to 57.3% of taxa, individuals and biomass, respectively. The greatest share in abundance and biomass was found in Diptera, esp. in representatives of the fam. Chironomidae, predominantly during 1977–1978 when the stream was mostly affected by the construction and test operation of the water works.

INTRODUCTION

Drift, as a community drifted by water, is of great importance in rivers for the renewal of benthic communities and as a nutrition source for fish. In streams below valley reservoirs it is composed partly of flowing water organisms originated from the river, partly of stagnant water organisms originated from the valley reservoir and partly of terrestrial species of invertebrates.

In 1976–1980, during the construction, filling, test and permanent operation of the water works at Dalešice, investigations were carried out to estimate qualitative and quantitative composition of the drift below the auxiliary reservoir, as well as the benthic communities of the Jihlava River. The results of the study, which continues also at present, will be used for evaluating a possible future influence of the nuclear power plant at Dukovany on the stream of the Jihlava River.

It is my pleasant duty to extend my thanks to RNDr. E. Wohlgemuth CSc. for his valuable advice and assistance in field work and in the determination of material and to RNDr. B. Losos CSc. for the determination of the fam. Chironomidae.

MATERIAL AND METHODS

Drif samplings were taken at monthly intervals during the period under study as far as the wather level in the river allowed it. The samples were taken about 1 km below the auxiliary reservoir of the water works at Dalešice in the locality of the



Tab. 1. Composition of drift in 1976 (number of individuals per 100 m<sup>3</sup> of water)

Taxon — Species	Month							Total	%
	J	J	A	S	O	N	D		
<b>Coelenterata</b>									
<i>Hydra attenuata</i> (Pal.)	—	28	—	432	—	42	—	502	23.1
<b>Gastropoda</b>									
<i>Ancylus fluviatilis</i> Mul	—	—	—	8	11	—	9	28	1.3
<b>Araneae</b>									
Dytinidae g. sp. div.	—	28	—	—	—	14	—	42	1.9
<b>Ephemeroptera</b>									
<i>Baetis vernus</i> Curt.	38	222	116	23	—	—	37	436	20.1
<b>Homoptera</b>									
Aphididae g. sp. div.	95	389	—	—	—	—	—	484	22.3
Tassudae g. sp. div.	—	28	—	—	—	—	—	28	1.3
<b>Hymenoptera</b>									
Cynipidae g. sp. div.	—	—	116	—	—	28	—	144	6.6
<b>Diptera</b>									
Chironomidae g. sp. div.	19	—	463	15	11	—	—	508	23.4
<b>Total, individuals</b>	152	695	695	478	22	84	46	2 172	100.0
<b>Total, taxa</b>	3	5	3	4	2	3	2	8	—

Hohelno Mill, simultaneously with the samplings of macrozoobenthos (Trnková 1983).

During the construction, filling, test operation and permanent influence of the valley reservoirs this locality showed considerable variations. The original barbel zone was changed into a section typical for the streams below water reservoirs, low water temperature was stabilized all the year round. The water discharge and depth varied considerably due to the construction of the water works exerting their unfavourable effect on the biocoenoses of aquatic organisms (Peňáz et al. 1978, Trnková 1980).

Drift samples were taken in the following way. In about 1/3 of the width of the stream the water was led through a gutter, 2 m long, into a system of two sieves, 5 by 5 and 1 by 1 mm mesh sizes, taking down the numbers of organisms collected in the sieves during 2 hours time and the amount of water that passed the sieves during that time. If the animals were not too damaged by the water flow, which was manifested in terrestrial species above all, they were determined in species, after fixation in 4 per cent formaldehyde. If no other data are reported, larval stages of the orders Ephemeroptera, Trichoptera and Diptera were ascertained. The following values were estimated: abundance (number of individuals per 100 m<sup>3</sup> of water), dominance (percentual representation of a taxon in the total number of individuals) and biomass (weight of individuals per 100 m<sup>3</sup> of water).

## RESULTS

The data on drifting organisms during 1976 to 1980 are summarized in Tabs. 1 to 8. Totally, 54 taxa were ascertained, 33 taxa were common with the benthos sampled in the same locality in the period under study (Trnková

1983). Moreover, 2 benthic species were recorded, 9 and 10 taxa were formed by other aquatic and terrestrial invertebrates, respectively.

In 1976 the mean number of individuals per 100 m<sup>3</sup> of water amounted to 310, with the maximum of 695 individuals (July, August) and minimum of 22 (October). In total, 8 taxa were ascertained, the mean number of taxa was 3, the maximum number reached 5 taxa in July, the minimum number was 2 taxa, which were found in October and December.

The average value of biomass per 100 m<sup>3</sup> was 0.105 g, the maximum value was ascertained in July (0.385 g), the minimum one in October (0.008 g).

The most numerous group of aquatic organisms were Diptera, accounting for 24.3% of all individuals. Ephemeroptera exhibited the greatest share in the biomass production (30.6%) from aquatic organisms.

In 1977, the mean number of individuals per 100 m<sup>3</sup> of water was enhanced by 2 orders, reaching the value of 3753.2, predominantly by the sampling in June in which 34668 individuals were ascertained. To the contrary, in April and November the number of individuals was only 92. Totally, 29 taxa were determined, 5 on the average, the maximum number of 16 taxa was ascertained in June and the minimum number of 1 taxon in October. Diptera formed 88.8% of all individuals.

In the year, the average value of biomass per 100 m<sup>3</sup> was extremely high attaining 12.076 g, the highest weight was determined in the sampling of June, 108.859 g, the lowest value being found in that of April, 0.071 g. Trichoptera and Diptera participated nearly in all biomass (50.5 and 44.6%, respectively).

In 1978, the mean abundance per 100 m<sup>3</sup> of water was 1503 individuals, the highest number of animals being ascertained in May (12221), the lowest in July (24). The drift involved 16 taxa, the average value was 3, the highest number of taxa was ascertained in May (11), only 1 taxon was found in the samplings of January, April, September and December. The share of Diptera in abundance reached 91.4% in that year.

The average value of biomass per 100 m<sup>3</sup> of water was 1.955 g, the maximum of 15.223 g being ascertained in May and the minimum of 0.085 g in December. 57.7% of biomass were shared by Diptera, 30.2% by Trichoptera.

In 1979, the mean number of aquatic invertebrates per 100 m<sup>3</sup> of water was 1837, the greatest number was observed in June (5973), the least one in September (37). In total, 14 taxa were recorded, 4 on the average, the highest number was reached 7 in June, the lowest one of 1 was ascertained in November. 67.6% of individuals were shared by Diptera.

The average value of biomass per 100 m<sup>3</sup> of water was 3.285 g, the weight of individual samples varied from 0.030 g per 100 m<sup>3</sup> (September) to 13.750 g per 100 m<sup>3</sup> (June). The greatest share in biomass, 70.8%, was formed by Diptera, as well.

During the last year of the period under study, 1980, the mean number of individuals per 100 m<sup>3</sup> of water amounted to 4919, the abundance varied from 70 individuals in June to 13079 individuals in September. From the total number of 19 taxa the average value was 7, the greatest of 15 taxa was exhibited in September and the least of 2 in December. The greatest shares in the total value were represented by Cladocera and Diptera (46.2 and 42.8%, respectively).

The average value of biomass per 100 m<sup>3</sup> of water was 1.982 g, the highest weight of 2.921 g was comprised in the sample of September, the lowest of

Tab. 2 Composition of drift in 1977 (number of individuals per 100 m<sup>3</sup> of water)

Taxon — Species	Month												Total	%		
	M	A	M	J	J	A	S	O	N	D						
Coelenterata														39	0.1	
<i>Hydra attenuata</i> (Pal)					39										39	0.1
Oligochaeta															15	+
<i>Lamnodirus</i> sp															15	+
<i>Tubificoides tubificus</i> (Mul)			15													
Copepoda															176	0.5
<i>Drepanomus castor</i> (Jurine)	107													69		
Araneae															260	0.7
G sp div				260												
Collembola															124	0.3
<i>Podura aquatica</i> L.				124												
Ephemeroptera															194	0.5
<i>Baetis vernus</i> Curt				86								85				
<i>Potamanthus luteus</i> (L.)			8												8	+
Trichoptera																
<i>Rhyacophila nubila</i> (Zet.)		15		2 339								34		46	2 434	6.5
Homoptera															206	0.5
Aphididae g sp div				174						15						
Issidae g sp div				174											174	0.5
Hymenoptera																
Ichneumonidae g sp. div				174											174	0.5
Thysanoptera																
G sp div			15												15	+
Coleoptera																
Dytiscidae g sp div (larva)					39							17			56	0.2
<i>Gyrinus substriatus</i> Steph					86										86	0.2
<i>Platambus maculatus</i> (L.)			15		174								23		212	0.6
<i>Deporaus betulae</i> (L.)															39	0.1
Diptera																
<i>Dacnusa thienemanni</i> Kief	107			484								17			558	1.9
<i>Eukiefferella bavarens</i> Coeugh.										30					30	0.1
<i>Cricotopus algarum</i> (Kieffer)										77					77	0.2
<i>Cricotopus</i> sp			23	174											197	0.5
<i>Rheotanytarsus gr. effusus</i>													174		174	0.5

<i>Orithoedatus</i> sp.	107	62	193	347	1042	45	136	—	—	69	2 001	5 3
<i>Orithoedatus saricola</i> (Kief.)	—	—	—	—	—	15	—	—	—	—	15	—
<i>Orithoedatus sarosus</i> (Tok.)	—	—	—	—	—	—	17	—	—	—	17	0 1
<i>Orithoedatus</i> g. sp. div.	—	—	—	29 688	—	30	—	—	—	—	29 718	72 2
Tanytarsariæ g. sp. div.	—	—	—	174	—	—	—	—	—	—	174	0 5
Chironomariæ g. sp. div.	—	—	—	86	—	—	—	—	—	—	86	0 2
<i>Dicranota</i> sp.	—	—	15	174	—	—	—	—	—	60	258	0 7
Total, individuals	321	92	284	34 669	1 236	135	323	174	92	207	37 532	100 0
Total, taxa	3	3	7	16	5	5	7	1	3	3	29	—

Tab. 3. Composition of drift in 1978 (number of individuals per 100 m<sup>3</sup> of water)

Taxon — Species	Month												Total	%		
	J	A	M	J	A	S	O	N	D							
Araneae																
<i>G. sp. div.</i>	—	—	46	—	—	—	46	—	—	—	—	—	—	—	92	0.7
Isopoda																
<i>Aesellus aquaticus</i> (L.)	40	—	—	—	—	—	—	—	—	—	—	—	—	—	40	0.3
Ephemeroptera																
<i>Raëtia rhodani</i> (Pict.)	—	—	—	—	—	—	46	33	142	—	—	—	—	—	221	1.6
<i>Potamanthus luteus</i> (L.)	—	—	—	—	68	—	—	—	—	—	—	—	—	—	68	0.5
Trichoptera																
<i>Arctobola nervosa</i> Curt.	—	—	46	12	—	—	—	—	—	—	—	—	—	—	46	0.3
<i>G. sp. div. (puppa)</i>	—	—	—	—	—	—	—	—	—	—	—	—	—	—	12	0.1
Homoptera																
Aphididae g. sp. div.	—	—	232	—	—	—	—	—	—	—	—	—	—	—	232	1.7
Hymenoptera																
Ichneumonidae g. sp. div.	—	—	46	—	—	—	—	—	—	—	—	—	—	—	46	0.3
Thysanoptera																
<i>G. sp. div.</i>	—	—	232	—	—	—	—	—	—	—	—	—	—	—	232	1.7
Coleoptera																
<i>Frasocuris phellandrii</i> (L.)	—	—	139	—	—	—	—	—	—	—	—	—	—	—	139	1.0
<i>Xantholinus tricolor</i> (Fabr.)	—	—	46	—	—	—	—	—	—	—	—	—	—	—	46	0.3
Diptera																
<i>Cricotopus</i> sp.	—	—	231	—	—	163	—	33	—	—	—	—	—	—	427	3.2
<i>Orthocladus</i> sp.	—	—	1 481	12	—	—	231	—	—	—	—	—	—	—	1 724	12.8
Orthocladinae g. sp. div.	—	139	9 352	—	—	—	—	—	—	—	—	—	—	—	9 491	70.2
Tanytarsinae g. sp. div.	—	—	—	—	339	—	—	—	—	—	—	—	—	—	339	2.5
<i>Antocha vitripennis</i> (Meig.)	—	—	370	—	—	—	—	—	—	—	—	—	—	—	370	2.8
Total, individuals	40	139	12 231	24	407	163	323	66	142	13 525	100.0					
Total, taxa	1	1	11	2	2	1	3	2	1	16	—					

0.430 g in that of June. 41.1 % and 30.2 % of the total weight were represented by Ephemeroptera and Diptera, respectively.

The data on the drift summarized in Tabs. 1 to 8 indicate that the highest abundance per 100 m<sup>3</sup> of water was ascertained in 1980, the lowest one in 1976, the highest number of taxa in 1977, the lowest in 1976. The greatest average value of biomass was ascertained in 1977, the least one in 1976.

In the period under study the number of individuals and biomass were enhanced. The greatest share in this increase was taken by representatives of the fam. Chironomidae, in which the negative effect of the discharge variation and other physico-chemical changes in the stream during the construction and test operation of the water works at Dalešice was the least. In 1977, the highest value of biomass was associated with the occurrence of Trichoptera larvae with a relative high weight.

The maximum value of abundance, number of taxa and biomass were found during the spring and summer months, the minimum in the autumn period, which is in harmony with the natural condition in non-affected streams.

The drift condition of the period under study is shown in Tab. 9, where the representation of the most important taxonomic and economic groups per number of taxa, abundance and biomass is expressed as percentages, and in Tab. 10, where the values of abundance, number of taxa and biomass are given in such a way that the initial year of the drift evaluation, 1976, is considered 100 %, and the values from the following years are related to the values of that year.

#### DISCUSSION

The construction and operation of the water works at Dalešice were responsible for significant affecting the stream of the Jihlava River below the reservoir. Contrary to the macrozoobenthos (Trnková 1980, 1983) which, in spite of showing enhanced abundance per 1 m<sup>2</sup> of bottom at the end of the period under study, exhibited a decrease in biomass nearly to a half of the value in 1976, the abundance and biomass per 100 m<sup>3</sup> of water increased 16 to 19 times in the drift. The share of stagnant water organisms was enhanced essentially, above all that of plankton species below the reservoir, both in abundance and biomass. It is in harmony with the data by Obr (1963, 1972) from the Orava River, by Peňáz et al. (1968) from the Svratka River, etc.

In association with it, decrease in the representation of benthic species was observed, which prevailed in the drift during 1977—1978.

At the end of the period under study the share of terrestrial invertebrates in the abundance and biomass was very low, in comparison with the year 1976. The data in the literature on the share of terrestrial species in the total number of drifting organisms are different, from 0.4 % (Szczepanski ex Starmach 1978) to 11.3 % (Bernier ex Starmach 1978). In the Jihlava River this share was much more higher, amounting to 5.3 to 50.0 % during the individual years.

The most important part of the drift of the Jihlava River was composed of the larvae of the orders Ephemeroptera, Trichoptera and Diptera. Ephemeroptera represented 0.1 to 20.1 % of all individuals, 6.9 to 12.5 % of taxa and 0.2 to 41.2 % of biomass in the individual years. During the years when being present in the drift, Trichoptera shared in abundance and number of taxa only by 0.4 to 6.5 % and 3.4 to 15.2 %, resp. Nevertheless, their representation in

Tab. 4. Composition of drift in 1979 and 1980 (number of individuals per 100 m<sup>3</sup> of water)

Taxon — Species	1979.						1980					
	Month		Total	Aver. value	%	N	Month		Total	%	D	
	J	A					J	S				
Coelenterata	—	—	—	—	—	—	—	—	—	—	—	
<i>Hydra attenuata</i> (Pol.)	—	—	—	—	—	—	—	—	—	—	—	
Araneae	—	—	—	—	—	—	—	—	—	—	—	
G. sp. div.	139	—	139	27.8	1.5	—	—	—	—	—	—	
Cladocera	—	—	—	—	—	—	—	—	—	—	—	
<i>Daphnia magna</i> Straus	—	—	—	—	—	—	—	—	—	—	—	
<i>Bosmina longirostris</i> Mul.	—	—	—	—	—	—	—	—	—	—	—	
Copepoda	—	—	—	—	—	—	—	—	—	—	—	
<i>Diaptomus castor</i> (Jurinč)	—	—	—	—	—	—	—	—	—	—	—	
Ephemeroptera	—	—	—	—	—	—	—	—	—	—	—	
<i>Raceta rhodana</i> (Pict.)	556	926	1 720	344.0	18.7	185	14	59	87	160	1.1	
<i>Potamanthus luteus</i> (L.)	—	—	—	—	—	—	38	—	—	28	0.2	
Trichoptera	—	—	—	—	—	—	—	—	—	—	—	
<i>Hydropsila sparsa</i> Curt.	—	—	—	—	—	—	—	—	—	—	—	
<i>Polycentropus flavomaculatus</i> (Pict.)	—	—	—	—	—	—	—	—	—	—	—	
<i>Rhyacophala nubila</i> (Zet.)	—	—	—	—	—	—	—	—	—	—	—	
Hymenoptera	—	—	—	—	—	—	—	—	—	—	—	
Ichnumonidae g. sp. div.	—	463	463	92.6	5.1	—	7	—	—	7	0.1	
Homoptera	—	—	—	—	—	—	—	—	—	—	—	
Aphididae g. sp. div.	—	231	231	46.2	2.5	—	—	—	—	—	—	
Coleoptera	—	—	—	—	—	—	—	—	—	—	—	
<i>Helochares lucidus</i> (Forst.)	139	231	370	74.0	4.0	—	—	—	—	—	—	
Thysanoptera	—	—	—	—	—	—	—	—	—	—	—	
G. sp. div.	—	53	53	10.6	0.6	—	—	—	—	—	—	
Heteroptera	—	—	—	—	—	—	—	—	—	—	—	
<i>Sagara striata</i> (L.)	—	—	—	—	—	—	7	—	—	7	0.1	
Diptera	—	—	—	—	—	—	—	—	—	—	—	
<i>Damesa thienemanni</i> Kief.	139	—	139	27.8	1.5	—	—	—	—	—	—	
<i>Eubaefferella alpestris</i> Goeigh.	278	—	278	55.6	3.0	—	—	—	—	—	—	
<i>Eubaefferella bavaria</i> Goeigh.	—	—	—	—	—	19	—	—	—	—	—	
<i>Thienemannimyia</i> sp.	—	—	—	—	—	—	—	—	—	—	—	
<i>Orthocladius</i> sp.	417	—	417	83.4	4.6	—	—	—	—	—	—	
Orthocladiinae g. sp. div. (imago)	—	694	747	149.4	8.1	—	—	—	—	—	—	

	7	6	4	2	1	185	9 183	836.6	100.0	70	13 079	1 600	14 758	100.
<i>Synorthocladus semivirens</i> (Kieff.)	—	—	—	—	—	—	—	—	—	—	—	—	—	20
<i>Microcricotopus bicolor</i> Zet.	—	—	—	—	—	—	—	—	—	—	—	—	—	39
<i>Macropspectra</i> gr. <i>praecox</i>	—	—	—	—	—	—	—	—	—	—	—	—	—	59
<i>Parachironomus varus</i> Goetgh.	—	—	—	18	—	—	18	3.8	0.2	—	—	—	—	—
<i>Chironomidae</i> g. sp. div. (imago)	4 305	—	—	—	—	4 305	861.0	40.9	—	—	—	—	—	—
<i>Lanophora reparia</i> (Fal.)	—	231	53	—	—	—	284	56.8	3.1	—	—	—	—	—
<b>Total, individuals</b>	5)973	2 776	212	37	185	9 183	836.6	100.0	—	70	13 079	1 600	14 758	100.
<b>Total, taxa</b>	7	6	4	2	1	14	4.0	—	—	5	15	2	19	—

Tab. 5. Biomass of drift per 100 m<sup>3</sup> of water in 1976 (g)

Taxon	Month												Total	%
	J	J	A	S	O	N	D							
Coelenterata	—	0.003	—	0.005	—	—	0.003	—	—	—	—	0.011	—	1.5
Gastropoda	—	—	—	0.002	0.003	—	—	0.004	—	—	—	0.009	—	1.2
Araneae	—	0.017	—	—	—	—	0.027	—	—	—	—	0.044	—	6.0
Ephemeroptera	0.042	0.090	0.058	0.008	—	—	—	0.027	—	—	—	0.225	—	30.6
Homoptera	0.023	0.275	—	—	—	—	—	—	—	—	—	0.298	—	40.5
Hymenoptera	—	—	0.023	—	—	—	0.056	—	—	—	—	0.079	—	10.8
Diptera	0.004	—	0.058	0.002	0.005	—	—	—	—	—	—	0.069	—	9.4
<b>Total</b>	0.069	0.385	0.139	0.017	0.008	—	0.086	—	—	0.031	—	0.735	—	100.0



Tab. 7. Biomass of drift per 100 m<sup>3</sup> of water in 1978 (g)

Taxon	Month												Total	%
	J	A	M	J	A	S	O	N	D					
Araneae	—	—	0.144	—	—	—	0.208	—	—	—	—	—	0.352	2.0
Isopoda	0.845	—	—	—	—	—	—	—	—	—	—	—	0.845	4.8
Ephemeroptera	—	—	—	—	0.031	—	0.070	0.059	0.085	—	—	—	0.254	1.4
Trichoptera	—	—	4.995	0.328	—	—	—	—	—	—	—	—	5.323	30.3
Homoptera	—	—	0.144	—	—	—	—	—	—	—	—	—	0.144	0.8
Hymenoptera	—	—	0.148	—	—	—	—	—	—	—	—	—	0.148	0.8
Thysanoptera	—	—	0.120	—	—	—	—	—	—	—	—	—	0.120	0.7
Coleoptera	—	—	0.093	—	—	—	0.139	—	—	—	—	—	0.232	1.3
Diptera	—	0.093	9.579	0.023	0.230	0.090	0.130	0.034	—	—	—	—	10.179	57.9
Total	0.845	0.093	15.223	0.351	0.261	0.090	0.556	0.090	0.085	—	—	—	17.597	100.0

Tab. 6. Biomass of drift per 100 m<sup>3</sup> of water in 1977 (g)

Taxon	Month												Total	%
	M	A	M	J	J	A	S	O	N	D				
Coccolerata	—	—	—	—	0.035	—	—	—	—	—	—	—	0.035	+
Oligochaeta	—	0.003	0.010	—	—	—	—	—	—	—	—	—	0.013	+
Copepoda	0.011	—	0.008	—	—	—	—	—	—	0.007	—	—	0.026	+
Araneae	—	—	—	2.352	—	—	—	—	—	—	—	—	2.352	2.0
Collembola	—	—	—	0.165	—	—	—	—	—	—	—	—	0.165	0.1
Ephemeroptera	—	—	0.011	0.035	—	—	0.136	—	0.012	—	—	—	0.194	0.2
Trichoptera	—	1.029	—	60.104	—	—	0.750	—	0.039	—	—	—	60.922	50.5
Homoptera	—	—	—	0.085	—	0.056	0.017	—	—	—	—	—	0.168	0.1
Hymenoptera	—	—	—	0.625	—	—	—	—	—	—	—	—	0.625	0.5
Thysanoptera	—	—	0.022	—	—	—	—	—	—	—	—	—	0.022	1+
Coleoptera	—	—	0.052	2.198	0.069	—	0.007	—	0.021	—	—	—	2.345	2.0
Diptera	0.320	0.039	0.098	44.280	0.506	0.071	0.375	0.104	—	8.104	—	—	53.897	44.6
Total	0.331	0.071	0.201	109.852	0.610	0.127	1.285	0.104	0.072	8.111	—	—	120.754	100.0

Tab. 9. Composition of drift in the period 1976—1980

	1976			1977			1978			1979			1980		
	%n	%b	%s	%n	%b	%s	%n	%b	%s	%n	%b	%s	%n	%b	%s
Ephemeroptera	20.1	30.6	12.5	0.3	0.2	6.9	2.1	1.4	12.5	18.7	13.5	7.1	1.3	41.2	10.5
Trichoptera	—	—	—	6.5	50.5	3.4	0.4	30.3	12.5	—	—	—	2.9	8.6	15.2
Diptera	23.4	9.4	12.5	88.8	47.6	41.4	91.4	57.9	31.3	67.6	70.8	42.8	42.1	30.2	36.8
Benthic organisms	44.8	41.2	57.8	95.9	95.3	58.6	94.2	94.4	62.5	86.3	84.8	50.0	46.3	80.0	63.2
Other water organisms	23.1	1.5	12.5	0.9	0.1	10.3	—	—	—	—	—	—	50.4	17.6	26.3
Terr-estic organisms	32.1	57.3	50.0	2.2	2.6	20.7	5.8	5.6	37.5	9.6	5.7	28.1	0.1	2.4	5.3

n = number of individuals, b = biomass, s = number of taxa

Tab. 8. Biomass of drift per 100 m<sup>3</sup> of water in 1979 and 1980 (g)

Taxon	1979						1980						
	J	J	A	S	N	Total	Average value	%	J	Month S	D	Total	%
Coelenterata	—	—	—	—	—	—	—	—	—	0.153	—	0.153	2.6
Araneae	0.347	—	—	—	—	0.347	0.069	2.1	—	—	—	—	—
Cladocera	—	—	—	—	—	—	—	—	0.091	0.297	—	0.388	6.5
Copepoda	—	—	—	—	—	—	—	—	—	0.030	—	0.030	0.5
Ephemeroptera	1.167	0.463	0.085	—	0.500	2.215	0.443	13.5	0.339	0.189	1.919	2.447	41.2
Trichoptera	—	—	—	—	—	—	—	—	—	0.513	—	0.513	8.6
Hymenoptera	—	0.208	—	—	—	0.208	0.042	1.3	—	—	0.142	0.142	2.4
Homoptera	—	0.347	—	—	—	0.347	0.069	2.1	—	—	—	—	—
Thysanoptera	—	—	0.037	—	—	0.037	0.008	0.2	—	—	—	—	—
Heteroptera	—	—	—	—	—	—	—	—	—	—	0.476	0.476	8.0
Coleoptera	1.000	0.648	—	—	—	1.648	0.330	10.0	—	—	—	—	—
Diptera	11.236	0.324	0.032	0.030	—	11.622	2.324	70.8	—	1.739	0.059	1.798	30.2
<b>Total</b>	<b>13.750</b>	<b>1.990</b>	<b>0.154</b>	<b>0.030</b>	<b>0.500</b>	<b>16.424</b>	<b>3.285</b>	<b>100.0</b>	<b>0.430</b>	<b>2.921</b>	<b>2.396</b>	<b>5.947</b>	<b>100.0</b>

Tab. 10. Average value of basic parameters of drift in the period under study (%)

	1976	1977	1978	1979	1980
Abundance	100.0	1 209.5	484.3	591.9	1 585.3
Number of taxa	100.0	382.5	200.0	175.0	237.5
Biomass	100.0	11 500.9	1 861.9	3 128.6	1 887.6

biomass amounted to 8.6 to 50.5 %. The dominant species included Diptera, esp. representatives of the fam. Chironomidae attaining 23.4 to 91.4 % of all individuals, 12.5 to 42.8 % of taxa and 9.4 to 70.8 % of biomass. These data from the Jihlava River are in general accordance with those, for example, by Berner (ex Starmach 1978).

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**NEW RHAGIDIIDAE (ACARINA: PROSTIGMATA) FROM CAVES OF THE U. S. A.**

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**Abstract.** *Rhagidia varia* sp. n., *Poecilophysis extraneostella* sp. n., and *Foveacheles paralleloseia* sp. n. are described as new species. *Poecilophysis wolmsdorfensis* (Willmann) and *Rhagidia diversicolor* (C. L. Koch) are reported from the Nearctic region for the first time. Troglophilic *Robustocheles hilli* (Strandtmann) has been the most abundant and common species collected in the caves. Other species found in caves were *Foveacheles tuktoyaktukensis* Zacharda, *Poecilophysis pratensis* (C. L. Koch) and *P. weyerensis* (Packard).

INTRODUCTION

Soil mites of the family Rhagidiidae frequently occur in caves of the whole Holarctic region. Most of them are troglophilic, but also included are many genuine troglotitic species having distinct morphological adaptations to life in caves, troglomorphisms (Zacharda, 1979, 1980, Zacharda and Elliott, 1981).

In the U.S.A. the cave rhagidiids were studied by Packard (1888), Banta (1907), Holsinger (1965), Elliott and Strandtmann (1971), Elliott (1976) and Zacharda (1982). Thanks to Dr. John R. Holsinger, Old Dominion University, Norfolk, Virginia, who collected most material and kindly offered his collection to me, I have examined the Rhagidiidae from 57 cave localities in Virginia, West Virginia, Tennessee, Kentucky, Washington, Georgia, Arizona and Indiana. The data on cave distribution of *Robustocheles hilli* have also been complemented with some material kindly loaned by Dr. William R. Elliott, Austin, Texas.

The deposition of the material: The material of the Rhagidiidae mentioned in this paper has been deposited in the Acarology Laboratory, the Ohio State University, Columbus, Ohio.

SYSTEMATIC PART

Genus *Rhagidia* Thorell, 1872

*Rhagidia* Thorell, 1872, Oefvers. K. Vetensk Akad. Forh. 28: 700.

*Rhagidia*: Zacharda, 1980, Acta Univ. Carol. Biol. (1978), 5 – 6: 556 – 557.

Subgenus *Noerperia* Canestrini, 1886

*Norperia* Canestrini, 1886, Atti Ist. veneto Sci., Ser. 6, 4: 697.

*Noerperia*: Zacharda, 1980, Acta Univ. Carol. Biol. (1978), 5 – 6: 565.

1. *Rhagidia (Noerneria) varia* sp. n. (Figs. 1 — 2)

**Diagnosis:** Rhagidial setae in rhagidial organs I and II strikingly long and slender. Inner margin of digitus mobilis with distinct praebasal teeth on inner side. Solenidion on tibia I dorsodistal, just beside small rhagidial seta. Dorsodistal lanceolate seta on tibia II large and in broadly open insertion pit.

**Description:** 3 ♀ examined. Body length 774, 994 and 1012  $\mu\text{m}$ , ratio of leg I length to body length: 1.40.

**Dorsum** (measurements of dorsal chaetotaxy in  $\mu\text{m}$ ): iv, ev — 60, filiform trichobothria 130, sc — 165, ih — 73, eh — 170,  $d_1$  — 60,  $d_2$  — 66, il — 77, el — 59, is — 122, es — 66. Chaetotaxy pattern typical for the family. **Venter:** Epimeral formula of chaetotaxy 3-1-6-3, trochanteral formula 1-1-2-2.

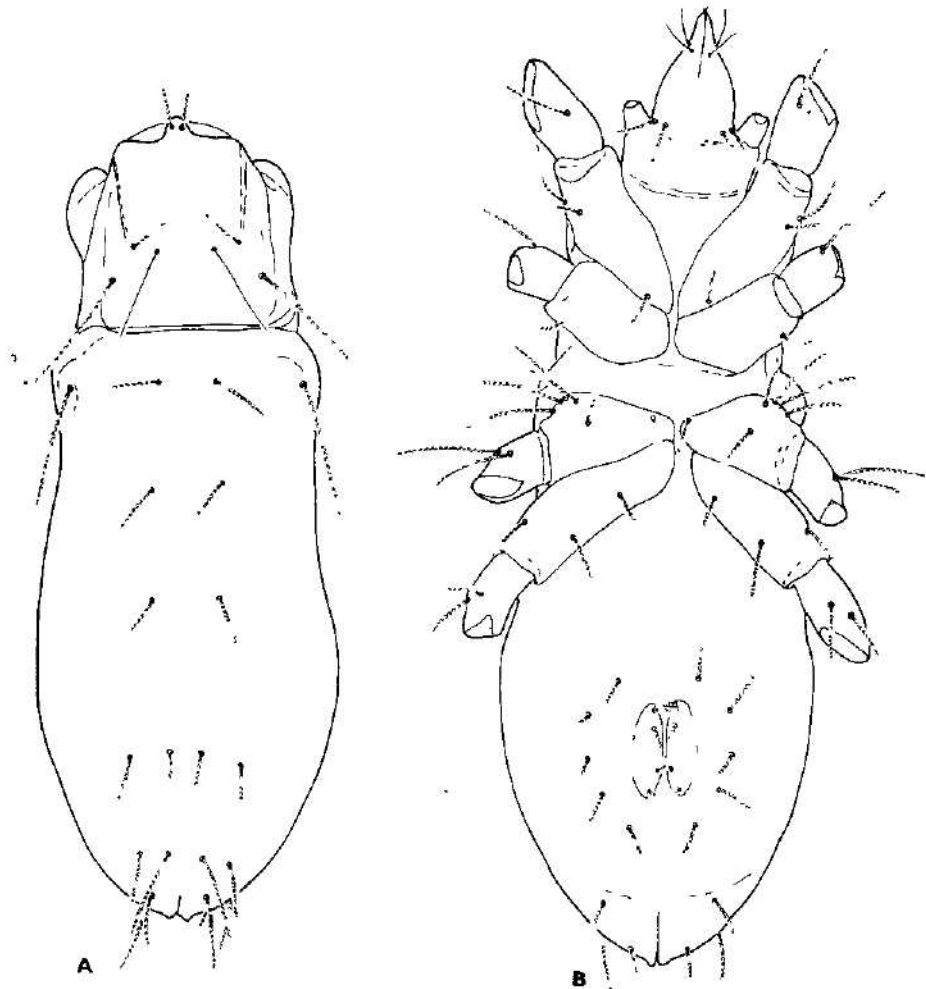


Fig. 1. *Rhagidia varia*: A — dorsum, B — venter.

5 pairs of progenital and 5 pairs of paragenital setae. Progenital lip 130  $\mu\text{m}$  long.

Gnathosoma: Hypostome longitudinally oval and slender, internal malae spini-form, external malae membranous, length of hypostome to breadth: 1. 33, 1.42.

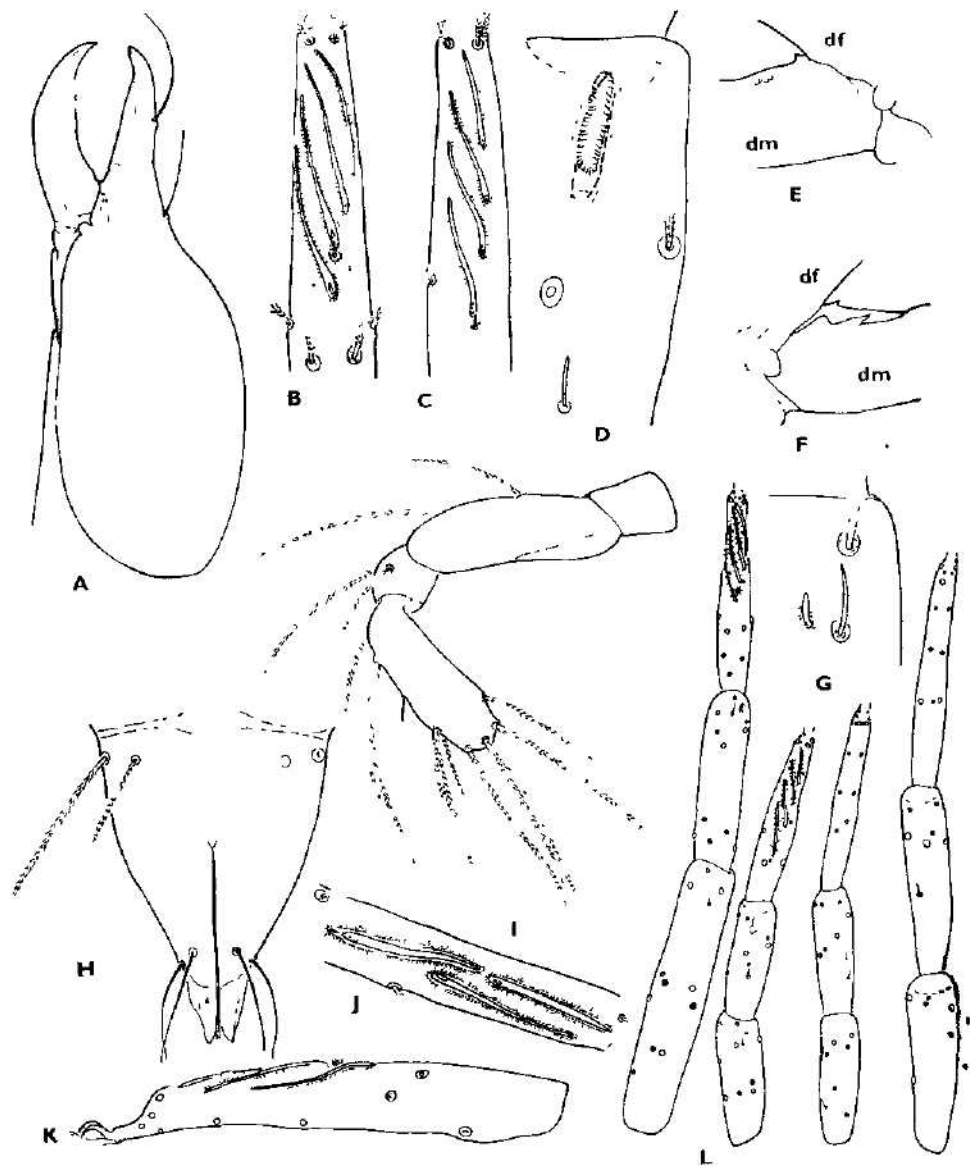


Fig. 2. *Rhagidia varia*: A - chelicera, B - rhagidial organ I, C - rhagidial organ II, D - location of solenidion and lanceolate seta on tibia II, E, F - praebasal teeth on inner margin of cheliceral digitus mobilis (dm), df - digitus fixus, G - locations of solenidion and rhagidial seta on tibia I, H - hypostome, I - pedipalpus, J - variation of rhagidial organ II, K - tarsus I in lateral view, L - locations of solenidia and chaetotaxy on legs I - IV.



Chelicerae typical for the Rhagidia, cheliceral setae inserted dorsally. Proximal cheliceral seta inserted above joint of digitus mobilis and not reaching insertion pit of the distal cheliceral seta that is overlapping apex of digitus fixus. Inner margin of digitus mobilis finely serrate and with larger praebasal teeth on inner side of movable digit. Apex of fixed digit 3 — cusped. Length of chelicera 245, 280, 273  $\mu\text{m}$ , breadth 77, 98, 91  $\mu\text{m}$ , length of digitus mobilis 91, 87, 98  $\mu\text{m}$ , length of proximal and distal cheliceral setae 28, 35, 42 and 45, 45, 56  $\mu\text{m}$ , respectively, distance between bases of these setae 38, 38, 49  $\mu\text{m}$ . Ratio of chelicera length to breadth: 3.18, 2.65, 3.0, length of digitus mobilis to that of chelicera: 0.37, 0.33, 0.35, length of digitus mobilis to chelicera breadth: 1.18, 0.88, 1.07.

Terminal palpal segment oval, with 10 ciliated setae and 1 erect spiniform solenidion, ratio of length to breadth: 2.45, 2.22, 2.90.

Tarsus I slender, gently rounded distally, length to breadth: 5.21, 6.60. Slender empodium overlapping claws, clawlets not observed.

Rhagidial organ I consisting of 4 very long, slender, separated and oblique rhagidial setae, stellate seta between first and second proximal rhagidial setae.

Rhagidial organ II consisting of 3 — 4 separated oblique rhagidial setae. Small spiniform seta proximal.

Solenidia: Tibia I with 1 dorsodistal spiniform solenidion just beside small cryptic rhagidial seta. Genu I with 1 small, distiventral solenidion. Tibia II with 1 small, erect laterodorsal, proximal solenidion. Lanceolate seta large, troglomorphic, in broadly open insertion pit. Genu II with 1 small distiventral solenidion. Tibia III with 2 tandem laterodorsal, proximal solenidia, genu III with 1 long, dorsoproximal solenidion. Tibia IV with 1 long, dorsoproximal (proximomedial) solenidion.

Males: 3 specimens examined. Length of body 827, 836, 800  $\mu\text{m}$ , ratio of leg I length to body length: 1.48, 1.87.

Dorsum (measurements of chaetotaxy in  $\mu\text{m}$ ): iv — 56, 61, 52, ev — 56, 61, 52, tr — 126, 140, 98, sc — 154, 149, 140, ih — 66, 70, eh — 157, 167, 140, d<sub>1</sub> — 42, 75, 66, d<sub>2</sub> — 38, 75, 66, il — 66, 105, 87, el — 49, 70, 59, is — 119, 140, 70, es — 66, 70.

Venter: Epimeral formula of chaetotaxy 3-1-(5) 6-3, trochanteral formula 1-1-2-2, 6 pairs (6 4) of progenital and 5 pairs of paragenital setae.

Gnathosoma: The morphology of hypostome and chelicera as in female, length of chelicera 252, 281, 238  $\mu\text{m}$ , breadth 80, 97, 77  $\mu\text{m}$ , length of digitus mobilis 84, 97, 84  $\mu\text{m}$ , length of proximal and distal cheliceral setae 31, 44, 32 and 52, 61, 49  $\mu\text{m}$ , respectively, distance between bases of these setae 38, 35, 35  $\mu\text{m}$ , ratio of chelicera length to breadth: 3.15, 2.89, 3.09, length of digitus mobilis to that of chelicera: 0.33, 0.34, 0.35, length of digitus mobilis to chelicera breadth: 1.05, 1.09, 1.0.

Palps, tarsi, rhagidial organs and solenidia as in females.

Material examined: 1 ♀, holotype, 1 ♂, paratype, Butler Cave, Butler-Sinking Creek System, N of Burnsville, Both Co., Virginia, 2 Nov. 1968, J. R. Holsinger leg., coll. Acarology Laboratory, the Ohio State University; 1 ♀, paratype, Hill Cave, 5 mi. E Sunbright, Scott Co., Virginia, 3 Aug. 1967, J. R. Holsinger and J. Tichenour leg., coll. as in the holotype; 1 ♀, paratype, Sam Bells Cave, 0.8 mi. NW Dublin, Pulaski Co., Virginia, 24 July 1979, J. R. Holsinger and V. Tipton leg., coll. as in the holotype; 1 ♂, paratype, Blue Springs Cave, near Mill Point, Pocahontas Co., West Virginia, 2 Sept. 1967, J. R. Holsinger and R. Baroody leg., coll. as in the holotype; 1 ♂, the Hole Gibbs entrance section near Frankford, Greenbrier Co., West Virginia, 22 June 1966, J. R. Holsinger leg., coll. as in the holotype.

Differential diagnosis: *Rhagidia* (*Noerneria*) *varia* differs from the other species of the genus in all the diagnostic characters given above.

Discussion: The variability of the rhagidial organ II is a relatively frequent phenomenon in the Rhagidiidae (cf. Zacharda, 1980: 580, 647, 728, etc.). But in the case of *Rhagidia varia* it would be desirable to study this variability in light of geographical distribution. Maybe a phenomenon of a cave vicariation (Zacharda, 1980: 647 — 658.) could be verified also in this species.

The morphological characters, such as the elongated rhagidial setae and the large lanceolate seta in the broadly open depression are probably troglomorphisms (Zacharda, 1980: 509., or Zacharda, 1982: 280.). But the other morphological characters are not distinctly troglomorphic. Moreover, it is not known whether this species also occurs outside caves. Therefore it remains still obscure whether it is, or not, a genuine troglobitic species, or a troglobitic species "in statu nascendi", or only a troglophilic one.

The species has been named "*varia*" according to its very variable rhagidial organs II.

## 2. *Rhagidia* (*Noerneria*) *diversicolor* (C. L. Koch, 1838) (Fig. 4 — E, F, G)

*Scyphius diversicolor* C. L. Koch, 1838, Deutschlands Crustaceen, Myriapoden und Arachniden. Fasc. 17, 22. Regensburg.

*Rhagidia diversicolor*: Willmann, 1936, Zool. Anz. 116: 297 — 298.

*Rhagidia diversicolor*: Zacharda, 1980, Acta Univ. Carol. Biol. (1978), 5 — 6: 570 — 574.

Description: 1 ♀ examined. Length of body 968  $\mu\text{m}$ , ratio of leg I length to body length: 1.35.

Dorsum (measurements in  $\mu\text{m}$ ): iv — 70, ev — 97, tr — torn off, sc — 176, ih — torn off, eh — 202, d<sub>1</sub> — 88, d<sub>2</sub> — torn off, il — 158, el — 70, is — 185, es — 79. Venter: Epimeral formula of chaetotaxy 3-1-6-3, trochanteral formula 1-1-2-2. 5 pairs of progenital and 5 pairs of paragenital setae. Length of progenital lip 140  $\mu\text{m}$ .

Gnathosoma: Ratio of length of hypostome to breadth: 1.18, length of chelicera 269  $\mu\text{m}$ , breadth 98  $\mu\text{m}$ , length of digitus mobilis 91  $\mu\text{m}$ , length of proximal and distal cheliceral setae 31 and 63  $\mu\text{m}$ , respectively, distance between bases of these setae 21  $\mu\text{m}$ . Ratio of chelicera length to breadth: 2.74, length of digitus mobilis to that of chelicera: 0.33, length of digitus mobilis to breadth of chelicera: 0.92. Ratio of length of tarsus I to breadth of that: 5.33, the same ratio for palpus: 3.09.

Rhagidial organs I and II and location of solenidia typical for *Rhagidia diversicolor*.

Material examined: 1 ♀, Harpers Cave, 5 mi. E. Hendricks, Tucker Co., West Virginia, 19 May 1973, J. R. Holsinger and D. Culver leg., coll. Acarology Laboratory, the Ohio State University.

Discussion: This is the first record of *Rhagidia diversicolor* in the North America. This species was found in caves also in Central Europe (Zacharda, 1980: 574.).

## Genus *Poecilophysis* Cambridge, 1876

*Poecilophysis* Cambridge, 1876, Proc. zool. Soc. London: 261 — 263.

*Poecilophysis*: Zacharda, 1980, Acta Univ. Carol. Biol. (1978), 5 — 6: 599 — 601.

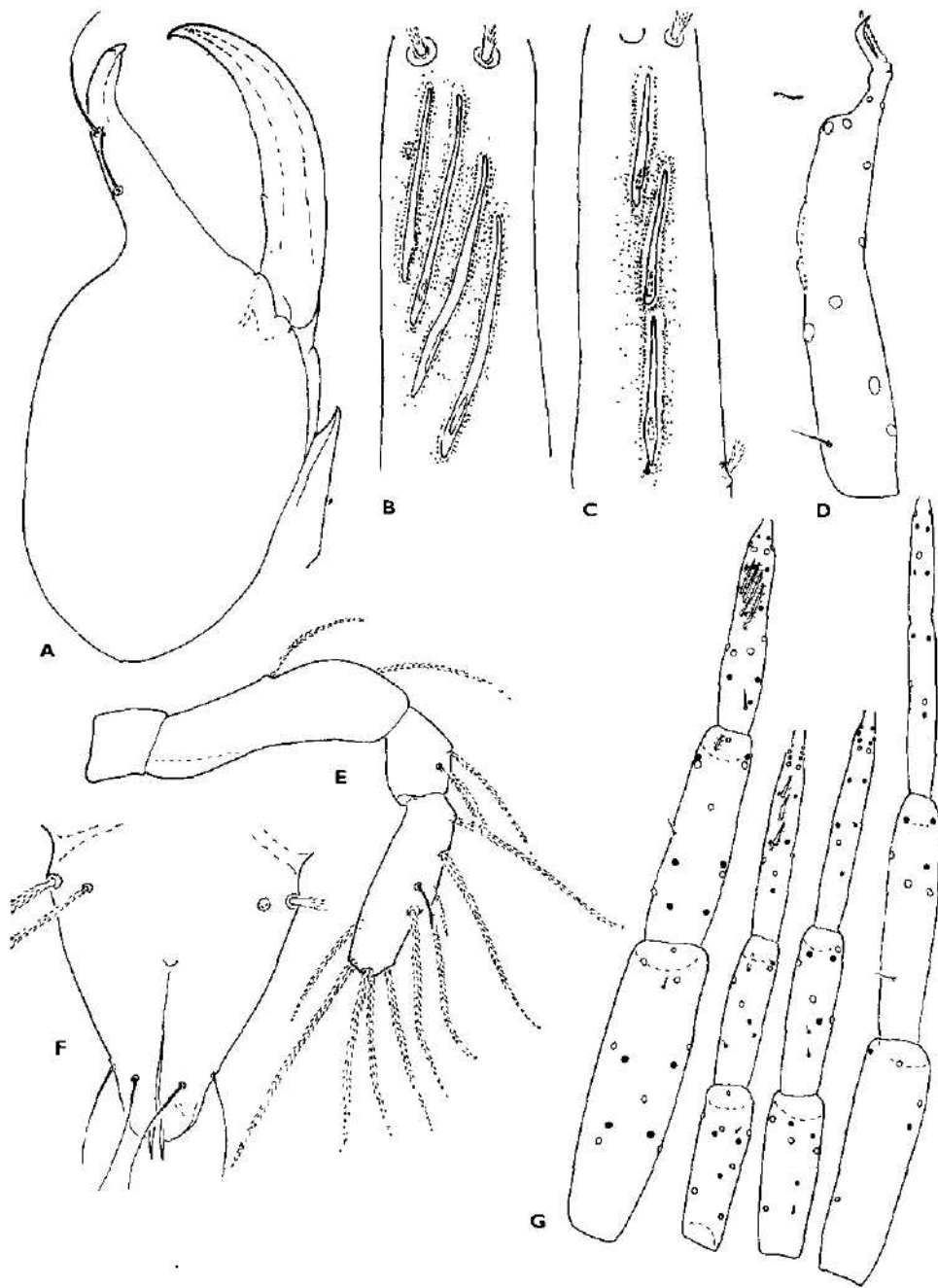


Fig. 3. *Poecilophysis extraneostella*: A - chelicera, B - rhagidial organ I, C - rhagidial organ II, D - tarsus I in lateral view, E - pedipalpus, F - hypostome, G - locations of solenidia and chaetotaxy on legs I - IV.

*Dentocheles* Zacharda, 1980, Acta Univ. Carol. Biol. (1978), 5 — 6: 621.

1. *Poecilophysis* (*Dentocheles*) *extraneostella* sp. n. (Fig. 3)

**Diagnosis:** Stellate seta lateral to distal rhagidial seta on tarsus I. Apex of proximal cheliceral seta reaching or overlapping basis of distal cheliceral seta. Inner margin of digitus mobilis with small, blunt praebasal tooth and with fine serration distally.

**Description:** 6 ♀ examined. Length of body 978 — 1305  $\mu\text{m}$ , ratio of leg I length to body length: 1.30 — 1.59.

**Dorsum:** chaetotaxy pattern typical for family (all setae torn off in the studied specimens).

**Venter:** Epimeral formula of chaetotaxy 3-1-6-4, trochanteral formula 1-1-2-2. 5 pairs of progenital and 5 pairs of paragenital setae. Length of progenital lip 140 — 167  $\mu\text{m}$ .

**Gnathosoma:** Hypostome broadly oval, internal malae spiniform, external malae membranous. Ratio of length of hypostome to breadth: 1.21 — 1.36. Chelicerae with large slender shears, apex of proximal cheliceral seta reaching, or overlapping basis of distal cheliceral seta. Inner margin of digitus mobilis finely serrate, with small blunt praebasal tooth. Length of chelicera 272 — 334  $\mu\text{m}$ , breadth 132 — 158  $\mu\text{m}$ , length of digitus mobilis 149 — 185  $\mu\text{m}$ , length of proximal and distal cheliceral setae 30 — 39 and 70  $\mu\text{m}$ , respectively. Distance between bases of these setae 26 — 35  $\mu\text{m}$ . Ratio of chelicera length to breadth: 2.06 — 2.46, length of digitus mobilis to that of chelicera: 0.50 — 0.58, length of digitus mobilis to chelicera breadth: 1.12 — 1.31.

**Terminal palpal segment** oval, with 10 ciliated setae and 1 erect, long, spiniform solenidion, ratio of length to breadth: 3.0 — 3.7.

**Tarsus I** slender, gently rounded distally, ratio of length to breadth: 5.16 — 6.0. Slender empodium overlapping claws, clawlets not observed.

**Rhagidial organ I** consisting of 4 oblique, separated rhagidial setae, stellate seta lateral to distal rhagidial seta. **Rhagidial organ II** consisting of 3 separated tandem rhagidial setae (sometimes 2 rhagidial setae can be in confluent insertion pit). Small spiniform seta proximal.

**Solenidia:** Tarsus I with 1 long, dorsoproximal solenidion. Tibia I with 1 medio-lateral solenidion and dorsodistal rhagidial seta, genu I with 1 distiventral solenidion. Tibia II with 1 dorsoproximal solenidion and dorsodistal lanceolate seta in deep depression with small terminal pore. Genu II with 1 lateroventral, distal solenidion. Tibia III with 2 dorsoproximal tandem solenidia, genu III with 1 dorsoproximal, small solenidion. Tibia IV with 1 long dorsoproximal solenidion.

**Male:** 2 specimens examined. Length of body 1002, 1048  $\mu\text{m}$ , ratio of leg I length to body length: 1.30. Sometimes 6 pairs of progenital setae. Otherwise the same morphological characters as in the female.

**Material examined:** 1 ♀, holotype, Bowling Cave near Ben Hur, Lee Co., Virginia, 28 July 1967, J. R. Holsinger, J. Tichenour and D. Finley leg., coll. Acarology Laboratory, the Ohio State University; 2 ♀, 2 ♂, 1 tritonymph, paratypes, otherwise the same data as in the holotype; 5 ♀, paratypes (some of them fragmentary), Steeles Cave, 5 mi. S of Union, Monroe Co., West Virginia, 31 August 1967, J. R. Holsinger leg., coll. as in the holotype.

**Differential diagnosis:** *Poecilophysis* (*Dentocheles*) *extraneostella*

differs from the other representatives of the subgenus *Dentocheles* in the diagnostic characters given above

**DISCUSSION** *Poecilophysis extraneostella* seems to be morphologically very close to *P. weyerensis* (Packard). Similarly as in *P. weyerensis*, it has no distinct troglomorphisms and therefore it should be considered only a troglomorphic species. It might occur also outside caves in moist, dark and cool habitats. This species has been named "*extraneostella*" according to the location of its stellate seta.

### 2 *Poecilophysis (Dentocheles) pratensis* (C. L. Koch, 1835)

*Scyphus pratensis* C. L. Koch, 1835, Deutschlands Crustaceen, Myriapoden und Arachniden Fasc. 1, 14, Regensburg

*Poecilophysis pratensis* Oudemans, 1905, Abh. Ver. Bremen, 18, 202, 203, 241

*Rhagidia pratensis* Willmann, 1932, Mitt. Hohl. Karstforsch., 5

*Rhagidia whartoni* Strandtmann, 1971, Pacific Insects, 13 (4), 107, 110 – 111

*Poecilophysis (Dentocheles) pratensis* Zacharda, 1980, Acta Univ. Carol. Biol. (1978), 5 – 6, 621 – 626. There further references

**MATERIAL EXAMINED** 1 ♀, Laurel Creek Cave near Greenville, Monroe Co., West Virginia, 1 Sept. 1967, J. R. Holsinger et al. leg., coll. Acarology Laboratory, the Ohio State University

**DISCUSSION** *Poecilophysis pratensis* is a very common troglomorphic species that has also been found in a cave in Europe (Thor, Willmann, 1941, 102). It seems to be distributed over the entire Holarctic region (Zacharda, 1980).

### 3 *Poecilophysis (Dentocheles) weyerensis* (Packard, 1888)

*Bryobia*? or *Penthaleus*? *weyerensis* Packard, 1888, Mem. natn. Acad. Sci., 4, 4<sup>9</sup>

*Rhyncholophus cavernarum* Packard, 1888, *ibid.*

*Rhagidia weyerensis* Holsinger, 1965, Acarologia, 7, 4, 655 – 658

*Poecilophysis (Dentocheles) weyerensis* Zacharda, 1980, Acta Univ. Carol. Biol. (1978), 5 – 6, 627 – 630

**MATERIAL EXAMINED** 2 ♀, Buck Hill Cave near Natural Bridge, Rockbridge Co., Virginia, 11 May 1965, J. R. Holsinger leg.; 1 ♀, Craighead Caverns (Lost Sea Cave) (commercial cave), Monroe Co., Tennessee, March 1956, T. Barr leg.; 1 ♀, Sensabaugh Saltpetre Cave just W. Kingsport, Hawkins Co., Tennessee, 15 April 1967, J. R. Holsinger leg., coll. Acarology Laboratory, the Ohio State University

**DISCUSSION** *Poecilophysis weyerensis* is a troglomorphic species rarely occurring in the U.S.A. and Europe where it has so far been found only in Czechoslovakia (Zacharda, 1980).

### Subgenus *Wankelia* Zacharda, 1980

*Wankelia* Zacharda, 1980, Acta Univ. Carol. Biol. (1978), 5 – 6, 642

### 4 *Poecilophysis (Wankelia) wolmsdorfensis* (Willmann, 1936) (Fig. 4 — A — D)

*Rhagidia terricola longipes* Pax, Maschke, 1935, Pax, Beitr. Biol. Glatz. Schneeberg, 1, 13

*Rhagidia reflexa wolmsdorfensis* Willmann, 1936, Zool. Anz., 116, 302

*Rhagidia wolmsdorfensis* Willmann, 1941, Stud. Karstforsch. Hohlenk., Biol. Ser., 8, 53

*Poecilophysis (Wankelia) wolmsdorfensis* Zacharda, 1980, Acta Univ. Carol. Biol. (1978), 5 – 6, 642 – 645

Description 1 ♀ examined Length of body 1351  $\mu\text{m}$ , ratio of leg I length to body length 118  
 Dorsum (measurements in  $\mu\text{m}$ ) iv — 79, ev — 105, tr — 246, sc — 246, ih — 88, eh — torn,  $d_1$  and  $d_2$  — 97, il — 123, el — torn off, is — 149, es — 79  
 Venter Epimeral formula of chaetotaxy 3-1-6-3, trochanteral formula 1-1-2-2  
 5 6 progenital setae and 5 pairs of paragenital setae

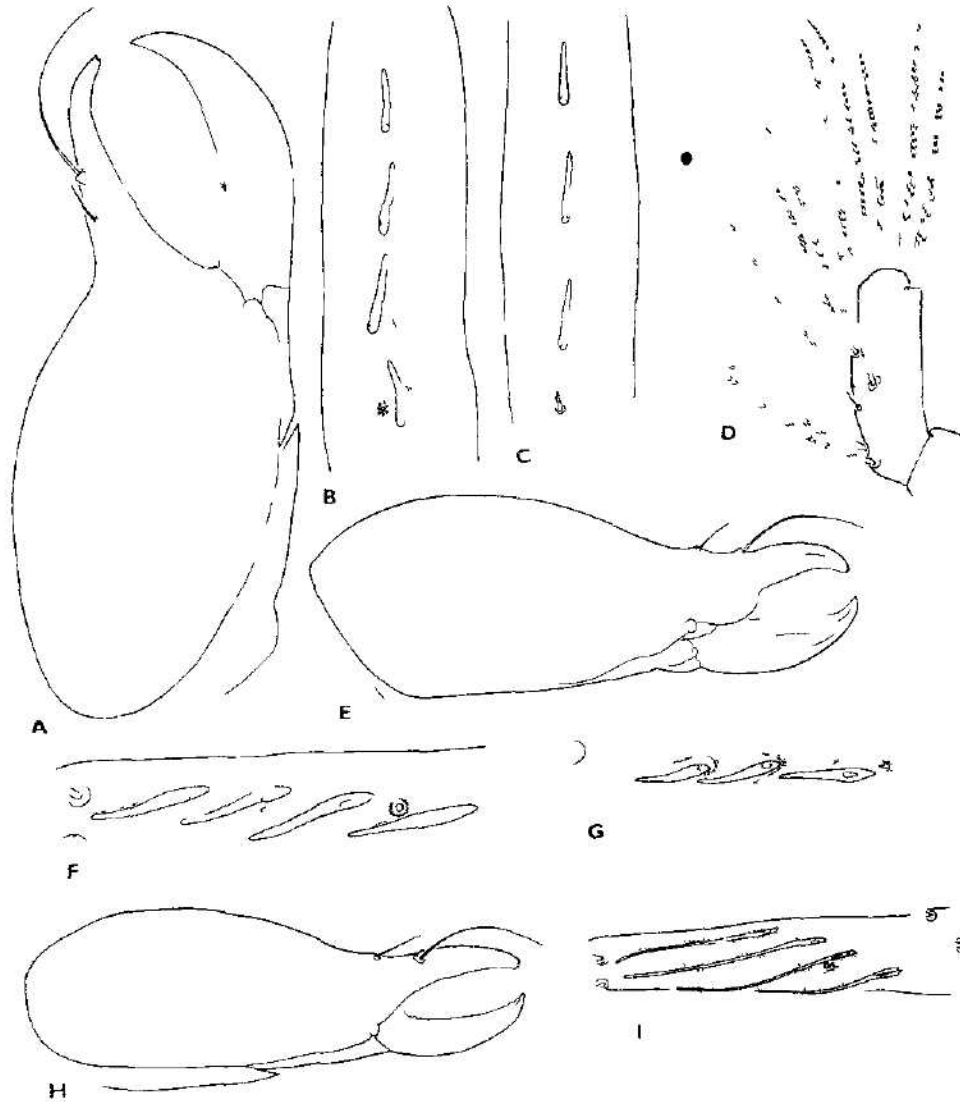


Fig. 4 *Poecilophysys wolmsdorfensis* A — chelicera, B — rhagidial organ I, C — rhagidial organ II, D — terminal palpal segment, *Rhagidia diversicolor* E — chelicera, F — rhagidial organ I, G — rhagidial organ II, *Foveacheles cf. holsingeri* H — chelicera, I — rhagidial organ I

Gnathosoma: Ratio of length of hypostome to breadth: 0.93. Length of chelicera 332  $\mu\text{m}$ , breadth 133  $\mu\text{m}$ , length of digitus mobilis 150  $\mu\text{m}$ , length of proximal and distal cheliceral setae 10 and 35  $\mu\text{m}$ , respectively, distance between bases of these setae 25  $\mu\text{m}$ . Ratio of chelicera length to breadth: 2.49, length of digitus mobilis to that of chelicera: 0.45, length of digitus mobilis to breadth of chelicera: 1.12.

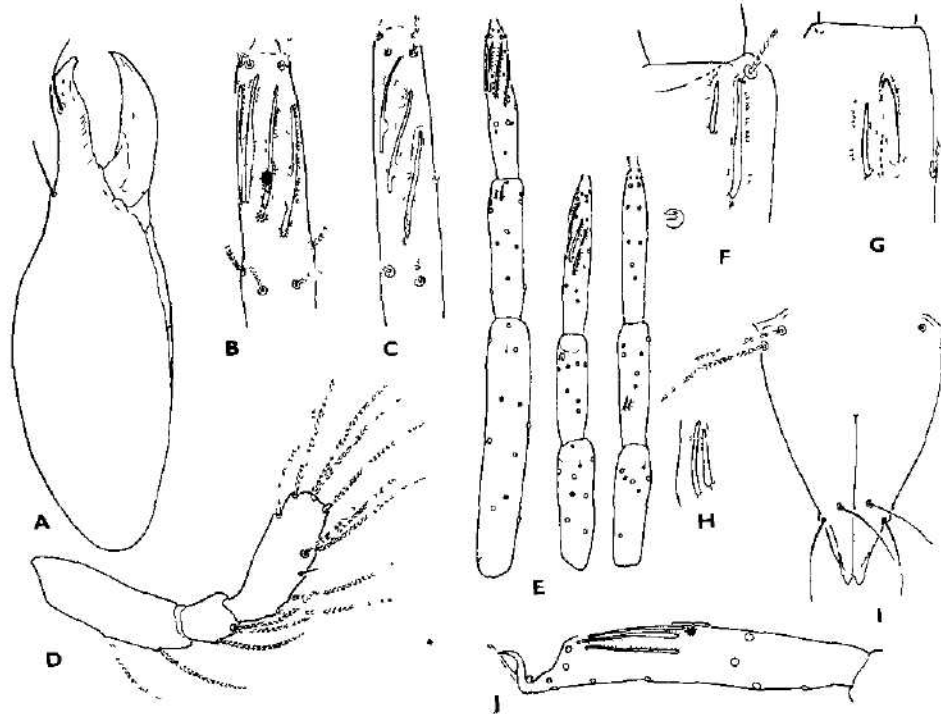


Fig. 5. *Foveacheles parallelseta*: A - chelicera, B - rhagidial organ I, C - rhagidial organ II, D - pedipalpus, E - locations of solenidia and chaetotaxy on legs I - III, F - locations of solenidion and rhagidial seta on tibia I, G - locations of solenidion and lanceolate seta on tibia II, H - recumbent parallel solenidia on tibia III, I - hypostome, J - tarsus I in lateral view.

Terminal palpal segment with 11 (!) ciliated setae and 1 erect spiniform solenidion. Ratio of length to breadth: 3.0.

Ratio of length of tarsus I to breadth: 7.16.

Rhagidial organs I and II typical for the species (Zacharda, 1980: 644.).

Material examined: 1 ♀, 1 tritonymph, Devils Kitchen Cave, 27 mi. ESE Mingo, Randolph Co., West Virginia, 20 May 1973, J. R. Holsinger and D. Culver leg., coll. Acarology Laboratory, the Ohio State University; 2 ♀, Lost Cave near Alderson, Greenbrier Co., West Virginia, 27 April 1969, J. R. Holsinger and R. Baroody leg., coll. Acarology Laboratory, the Ohio State University.

Discussion: These specimens are the first findings of *Poecilophysus wolmsdorfensis* in the Nearctic region. Similarly as in Europe, this species occurs probably only in caves and has some troglomorphisms.

Genus *Foveacheles* Zacharda, 1980

*Foveacheles* Zacharda, 1980, Acta Univ. Carol. Biol., (1978), 5 — 6: 661.

Subgenus *Trofocheles* Zacharda, 1982

*Trofocheles* Zacharda, 1982, Pacific Insects, 3 — 4: 275

1. *Foveacheles (Trofocheles) paralleloseta* sp. n. (Fig. 5)

**Diagnosis:** Rhagidial organ consisting of 4 very long, slender and almost parallel rhagidial setae. Stellate seta proximal to 2nd proximal rhagidial seta. Rhagidial organ II consisting of 3 separated, oblique, long and slender rhagidial setae. Tibia I and II with dorsodistal recumbent solenidia. Dorsodistal lanceolate seta on tibia II large, in broadly open insertion pit.

**Description:** 1 ♀ examined. Length of body 774  $\mu\text{m}$ , ratio of leg I length to body length: 1.42.

**Dorsum** (measurements in  $\mu\text{m}$ ): most of setae torn off, filiform trichobothria 123, ih — 53, d<sub>1</sub> and d<sub>2</sub> — 44, il — 70, el — 35, is — 105, es — 53.

**Venter:** Epimeral formula of chaetotaxy 3-1-6-3, trochanteral formula 1-1-2-2. 4/5 progenital setae, 5 pairs of paragenital setae. Progenital lip 88  $\mu\text{m}$  long.

**Gnathosoma:** Hypostome slenderly oval, internal malae not observed, external malae membranous, ratio of length of hypostome to breadth: 1.40. Chelicerae slender, proximal cheliceral seta opposite joint of digitus mobilis and not reaching insertion pit of distal cheliceral seta. Inner margin of digitus mobilis finely serrate. Apex of fixed digit 2 — cusped. Length of chelicera 245  $\mu\text{m}$ , breadth 77  $\mu\text{m}$ , length of digitus mobilis 77  $\mu\text{m}$ , length of proximal and distal cheliceral setae 24 and 38  $\mu\text{m}$ , respectively. Distance between bases of these setae 42  $\mu\text{m}$ . Ratio of length of chelicera to breadth: 3.18, length of digitus mobilis to that of chelicera: 0.31, length of digitus mobilis to breadth of chelicera: 1.0. Terminal palpal segment oval, with 10 ciliated setae and 1 spiniform solenidion. Ratio length to breadth: 2.50. Tarsus I slender, gently rounded distally, ratio of length to breadth: 6.0. Slender empodium distinctly overlapping claws, basal clawlets not observed.

Rhagidial organ I consisting of 4 separated, almost parallel slender rhagidial setae, stellate seta proximal to 2nd proximal rhagidial seta. Rhagidial organ II consisting of 3 separated, oblique rhagidial setae, small spiniform seta proximal.

**Solenidia:** Tibia I with 1 dorsodistal, recumbent solenidion just beside larger rhagidial seta "2 parallel rhagidial setae", genu I with 1 spiniform distiventral solenidion. Tibia II with 1 dorsodistal recumbent solenidion just beside large lanceolate seta inserted in broadly open depression. Genu II with 1 small spiniform distiventral solenidion. Tibia III with 2 parallel recumbent dorso-proximal solenidia, genu III with 1 laterodorsal, distal (!) solenidion. Leg IV broken off

**Material examined:** 1 ♀, holotype, Sam Six Cave, 4 mi. W Wytheville, Wythe Co., Virginia, 25 Aug. 1967, J. R. Holsinger leg, coll. Acarology Laboratory, the Ohio State University.

**Differential diagnosis:** *Foveacheles (Trofocheles) paralleloseta* resembles closely the Hawaiian cave species *F. (T.) tenorioae* Zacharda, 1982, but differs in the arrangement of the rhagidial setae. *F. tenorioae* has also a more proximal location of the proximal cheliceral seta and different location of the solenidia on the leg III.



**Discussion:** The morphology of the rhagidial organs and the lanceolate seta on the tibia II are evaluated as troglomorphisms, but it is still in question whether this species is genuine troglobitic, or only troglophilic.

2. *Foveacheles (Propriorhagidia) tuktoyaktukensis* Zacharda, 1980

*F. (P.) tuktoyaktukensis* Zacharda, 1980, Acta Univ. Carol. Biol., (1978), 5 - 6: 692 - 694

**Description:** 1 ♀ examined. Length of body 1220 μm, ratio of leg I length to body length: 1.20.

Length of chelicera 350 μm, breadth 140 μm, length of digitus mobilis 116 μm, length of proximal and distal cheliceral setae 49 μm, distance between bases of these setae 53 μm. Ratio of length to breadth: 2.50, length of digitus mobilis to that of chelicera: 0.33, length of digitus mobilis to breadth of chelicera: 0.83. Ratio of length of tarsus I to breadth: 4.30, ratio of length of terminal palpal segment to breadth: 2.30. Otherwise the same morphological data as in the holotype (cf. Zacharda, 1980).

**Material examined:** 1 ♀, Greenbrier Caverns (Organ Cave Section), 5 mi S of Ranceverte (Organ Cave System), Greenbrier Co., West Virginia, 22 Aug. 1964, J. R. Holsinger leg., coll. Acarology Laboratory, the Ohio State University.

**Discussion:** Originally this species was found at the Beaufort Sea shore, Tuktoyaktuk, Canada. If this species occurs in West Virginia and other parts of the U.S.A. (?) only in caves, then it may be troglophilic postglacial relic from the last Wisconsin glaciation (Munroe, 1968, Matthews, 1979).

3. *Foveacheles cf. holsingeri* Zacharda, 1980? (Fig. 4 — H, I)

*Foveacheles (Mediostella) holsingeri* Zacharda, 1980, Acta Univ. Carol. Biol., (1978) 5 - 6: 677 - 679.

**Description:** 1 ♀ examined. Length of body 924 μm, ratio of leg I length to body length: 1.64.

Epimeral formula of chaetotaxy 3-1-6-4, 5 pairs of progenital and 5 pairs of paragenital setae. Chelicerae resemble those in *F. holsingeri*. Length of chelicera 245 μm, breadth 80 μm, length of digitus mobilis 84 μm, length of proximal and distal cheliceral setae 28 and 63 μm, respectively. Distance between bases of these setae 21 μm. Ratio of length of chelicera to breadth: 3.06, length of digitus mobilis to that of chelicera: 0.34, length of digitus mobilis to breadth of chelicera: 1.05. Ratio of length of tarsus I to breadth: 6.0. Ratio of length of terminal palpal segment to breadth: 3.25. Rhagidial organ I consisting of 4 separated, oblique, long and slender rhagidial setae, stellate seta between 1st 2nd proximal rhagidial setae. Tibia I with 1 medioproximal dorsal solenidion, genu I with 1 distiventral solenidion. Dorsodistal rhagidial seta on tibia I very small, resembles small cryptical solenidion. The other legs torn off.

**Material examined:** 1 ♀, Dry Cave, Hardin Co., Kentucky, 30 Oct. 1965, T. Barr leg., coll. Acarology Laboratory, the Ohio State University.

**Discussion:** Unfortunately a single and badly damaged specimen has so far been available and its actual specific identity remains obscure. The chelicera is of the "*Foveacheles* — type", epimeral formula of chaetotaxy 3-1-6-4 resembles that in *F. holsingeri*. However, the rhagidial organ I resembles that in *Rhagidia varia*. The other legs have been torn off in the studied specimen. Only additional material from the locality mentioned above would elucidate the identity of this specimen. Maybe it is a new species of the genus *Foveacheles*.

Genus *Robustocheles* Zacharda, 1980

*Robustocheles* Zacharda, 1980, Acta Univ. Carol. Biol. (1978), 5 - 6: 527 - 528.

Subgenus *Lewia* Zacharda, 1980

*Lewia* Zacharda, 1980, Acta Univ. Carol. Biol. (1978), 5 - 6: 547.

1. *Robustocheles (Lewia) hilli* (Strandtmann, 1971)

*Rhagidia hilli* Strandtmann, 1971, Pacific Insects 13 (1): 113.

*Rhagidia grahami* Elliott, 1976, Occas. Pap. Mus. Tex. Tech. Univ. 43: 11 - 14.

*Robustocheles (Lewia) hilli*: Zacharda, 1980, Acta Univ. Carol. Biol. (1978), 5 - 6: 547 - 550.

Material examined: 9 ♀, 1 deutonymph, Reeves Cave, 3 mi. WSW Herndon, Christiansen Co., Kentucky, 12 Aug. 1965, J. R. Holsinger and T. Barr leg.; 6 ♀, Cue Cave, 9 mi. SE Columbia, Adair Co., Kentucky, 29 July 1964, T. Barr leg.; 1 ♀, Cave Hollow Cave, Cobhill Quadrangle, Lee Co., Kentucky, 31 July 1966, T. Barr leg.; 3 ♀, Devils Kitchen Cave, 2.7 mi. ESE Mingo, Randolph Co., West Virginia, 20 May 1973, J. R. Holsinger and D. Culver leg.; 4 ♀, Fletchers Cave, near Gap Mills, Monroe Co., West Virginia, 31 Aug. 1967, J. R. Holsinger and R. Baroody leg.; 2 ♀, Arbuckles Cave, 5 mi. N of Lewisburg near Maxwelton, Greenbrier Co., West Virginia, 2 Aug. 1964, J. R. Holsinger leg.; 1 ♀, 1 tritonymph, Greenbrier Caverns, 5 mi. S of Ranceverte Organ Cave System, Greenbrier Co., West Virginia, 22 Aug. 1964, J. R. Holsinger leg.; 1 ♀, Dyepot Cave, 5 mi NNE Bluefield, Mercer Co., West Virginia, 2 Aug. 1964, J. R. Holsinger leg.; 1 ♀, 1 tritonymph, Greenbrier Caverns, Zenith, Monroe Co., West Virginia, 31 August 1967, J. R. Holsinger leg.; 2 ♀, 1 ♂, 1 tritonymph, Pattons Cave near Gap Mills, Monroe Co., West Virginia, 11 May 1966, J. R. Holsinger leg.; 1 ♀, Beacon Cave, just outside of Bluefield, Mercer Co., West Virginia, 12 May 1966, J. R. Holsinger leg.; 3 ♀, Laurel Creek, Cave near Greenville, Monroe Co., West Virginia, J. R. Holsinger leg.; 1 ♀, Klimes Gap Cave, 7 mi NW Petersburg, Grant Co., West Virginia, 24 Aug. 1966, J. R. Holsinger leg.; 1 tritonymph, Endless Caverns commercial cave near New Market, Rockingham Co., Virginia, 31 Dec. 1965, J. R. Holsinger leg.; 1 ♀, Aqua Cave, 2 mi W Williamsville, Highland Co., Virginia, 8 July 1967, J. R. Holsinger and J. Cooper leg.; 2 ♀, Madison Saltpetre Cave near Grottoes, Augusta Co., Virginia, 24 Aug. 1964, J. R. Holsinger and R. Burnette leg.; 6 ♀, Goodwins Cave, 5 mi. E Elliston, Roanoke Co., Virginia, 26 Aug. 1967, J. R. Holsinger leg.; 1 ♀, 1 tritonymph, Clyde Cochranes Sinks Cave no. 1, 6 mi. SW Hillsboro, Pocahontas Co., West Virginia, 12 Aug. 1966, J. R. Holsinger leg.; 1 ♂, Poor Farm Cave, 1.5 mi E Williamsburg, Greenbrier Co., West Virginia, 27 Sept. 1969, J. R. Holsinger leg.; 1 ♀, Moccasin Valley Cave, 2.5 mi. E Gate City, Scott Co., Virginia, 25 Aug. 1969, J. R. Holsinger leg.; 1 ♀, Lane Cave, 5 mi. N Gate City near Copper Creek, Scott Co., Virginia, 7 October 1967, J. R. Holsinger and G. Titcomb leg.; 2 ♀, Repass Saltpetre Cave, 6 mi. SW Bland, Bland Co., Virginia, 10 May 1965, J. R. Holsinger leg.; 6 ♀, Rumbolds Cave, 1 mi. NE Callaghan, Alleghany Co., Virginia, 26 Aug. 1967, J. R. Holsinger leg.; 1 ♀, Fallen Rock Cave, Tazewell Co., Virginia, 10 Oct. 1970, L. M. Ferguson leg.; 1 ♀, Hamilton Cave, Bland Co., Virginia, 10 May 1971, J. R. Holsinger leg.; 1 ♀, Loney's Cave, Craig Co., Virginia, 11 April 1970, L. M. Ferguson leg.; 4 ♀, Goodwins Cave, Roanoke Co., Virginia, 17 Jan. 1971, L. M. Ferguson and D. Warrington leg.; 3 ♀, New River Cave, Giles Co., Virginia, 24 Oct. 1970, L. M. Ferguson leg.; 5 ♀, Banes Spring Cave, 3 mi. SW Mechanicsburg, Bland Co., Virginia, 5 Aug. 1973, J. R. Holsinger and D. Culver leg.; 1 ♀, Crocketts Cave, 2 mi. S Tazewell, Tazewell Co., Virginia, 10 April 1974, J. R. Holsinger and G. Dickson leg.; 6 ♀, Straleys Cave no. 1, 6.5 mi SE Pearisburg, Giles Co., Virginia, 29 June 1974, J. R. Holsinger and L. Ferguson leg.; 6 ♀, Gully Cave, 4 mi. SE Pounding Mill, Tazewell Co., Virginia, 28 July 1974, J. R. Holsinger and D. Culver leg.; 1 tritonymph, Kelly Cave, 3 mi. NE Big Stone Gap, Wise Co., Virginia, 30 Nov. 1974, J. R. Holsinger, J. Estes and G. Titcomb leg.; 1 ♀, Gillespie Water Cave, 4.5 mi. SSE Pounding Mill, Tazewell Co., Virginia, 23 July 1976, J. R. Holsinger and D. Culver leg.; 1 ♀, Sam Bells Cave, 0.8 mi. NNW Dublin, Pulaski Co., Virginia, 24 July 1979, J. R. Holsinger and V. Tipton leg.; 4 ♀, 1 tritonymph, Pearson Cave, 2 mi. SE Kyles Ford, Hawkins Co., Tennessee, 15 April 1967, J. R.

Holsinger leg.; 2 ♀, Wildmann Cave near Colham, Grundy Co., Tennessee, 8 June 1958. T. Barr leg.; 1 ♀, Carter Saltpetre Cave near Johnson City, Carter Co., Tennessee, 2 Oct. 1966. J. R. Holsinger leg.; 1 ♀, 1 tritonymph, Byers Cave, 1.5 mi. SW Rising Fawn, Dade Co., Georgia, 18 June 1967. J. R. Holsinger, S. Peck, A. Fiske and R. Baroody leg.; 1 ♀, Donaldsen Cave, Spring Mill State Park, Lawrence Co., Indiana, 13 Nov. 1965. T. Barr leg.; 2 ♀, Deadhorse Cave, Skamania Co., Washington, 23 Oct. 1976. C. M. Senger leg., coll. W. R. Elliott; 1 ♀, Redman Cave, elev. 1980 m., Gila Co., Arizona, R. C. Graham leg., coll. Zacharda. Otherwise the material mentioned above has been deposited in the Acarology Laboratory, the Ohio State University.

Discussion: *Robustocheles hilli* seems to be the most abundant and frequently collected species of the Rhagidiidae in the North American caves. As in *Foveacheles tuktoyaktukensis*, *R. hilli* was found originally in lichens in Alaska (Strandtmann, 1971) and later it was described also from tundra of the Canadian Arctic Archipelago (Zacharda, 1980). But in the U.S.A. it has so far been found only in various caves. This species has no troglomorphisms (Zacharda, 1979, 1980) and therefore it should be considered only a troglophilic species. Maybe in the U.S.A. it is a postglacial relic surviving in caves during the present post-Wisconsin time (Munroe, 1968, Matthews, 1979).

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*Anděra M.*: Geographical distribution of the colour phases of the red squirrel in Bohemia and Moravia

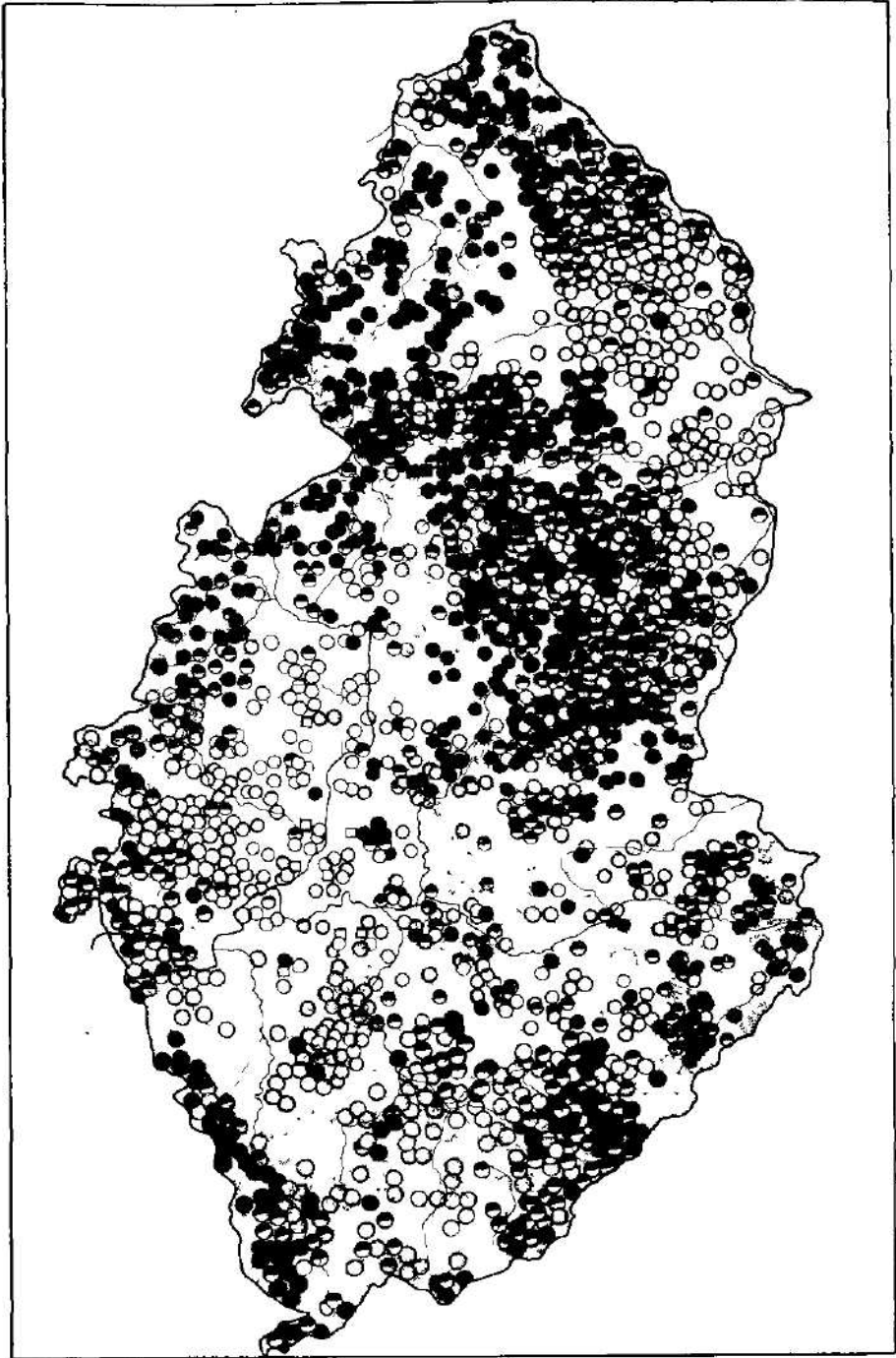


Fig. 1 Map showing the distribution and character of the occurrence of the two

*Andèra M.: Geographical distribution of the colour phases of the red squirrel in Bohemia and Moravia.*

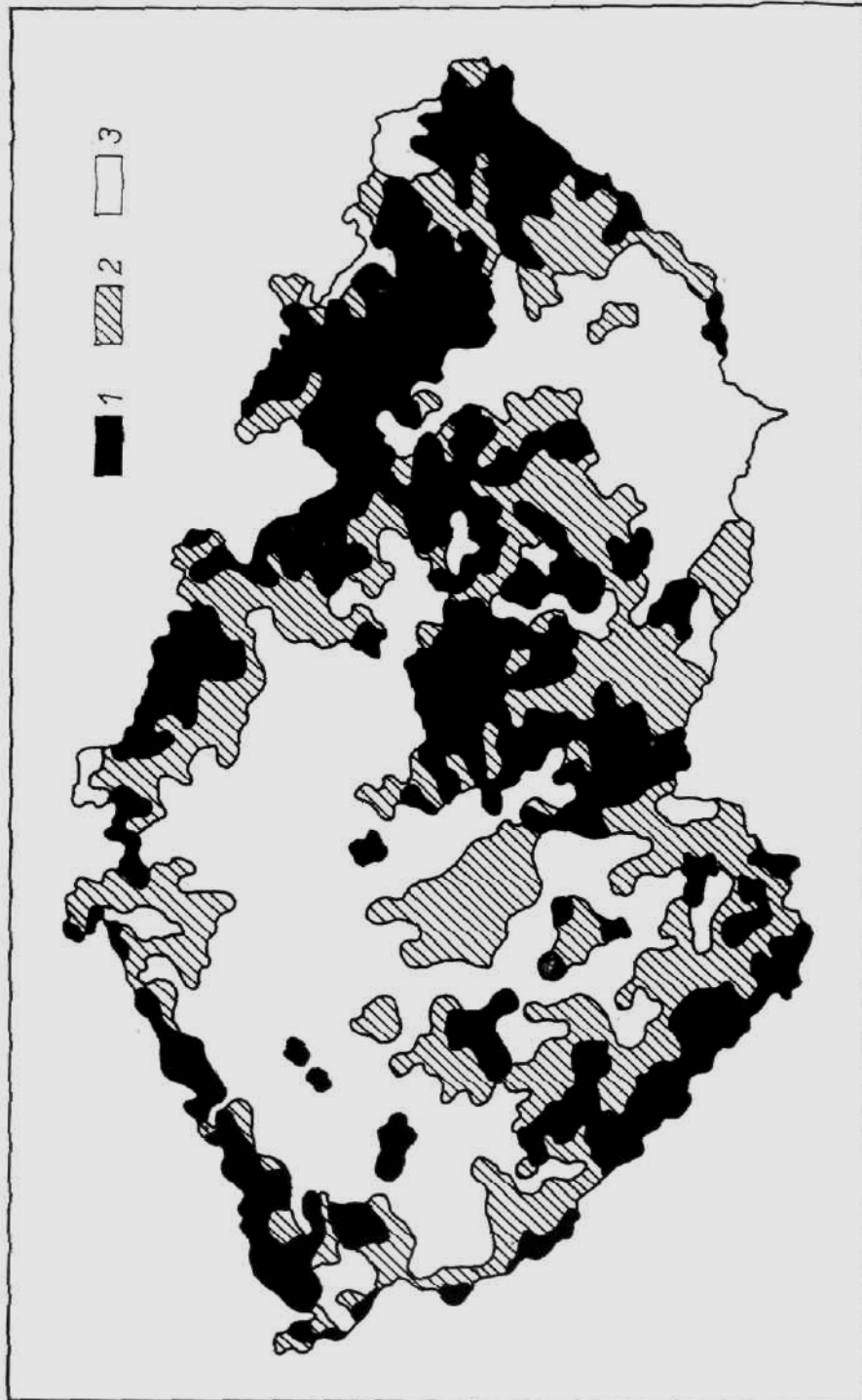


Fig. 2. Map showing a summarized survey of the data on the relative frequencies of the color phases of the red squirrel in the territory of Bohemia and Moravia. (Designations 1 — dark phase occurs only or predominates, 2 — both colour phases are approximately balanced, 3 — red phase occurs only or predominates).

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Fig. 2. The edge of the mixed forest and the small quarry at the locality No. 1 (the occurrence of *Pitymys* cf. *tatricus*).  
Fig. 3. View of the lower part of the locality No. 3 (the occurrence of *Microtus arvalis*).

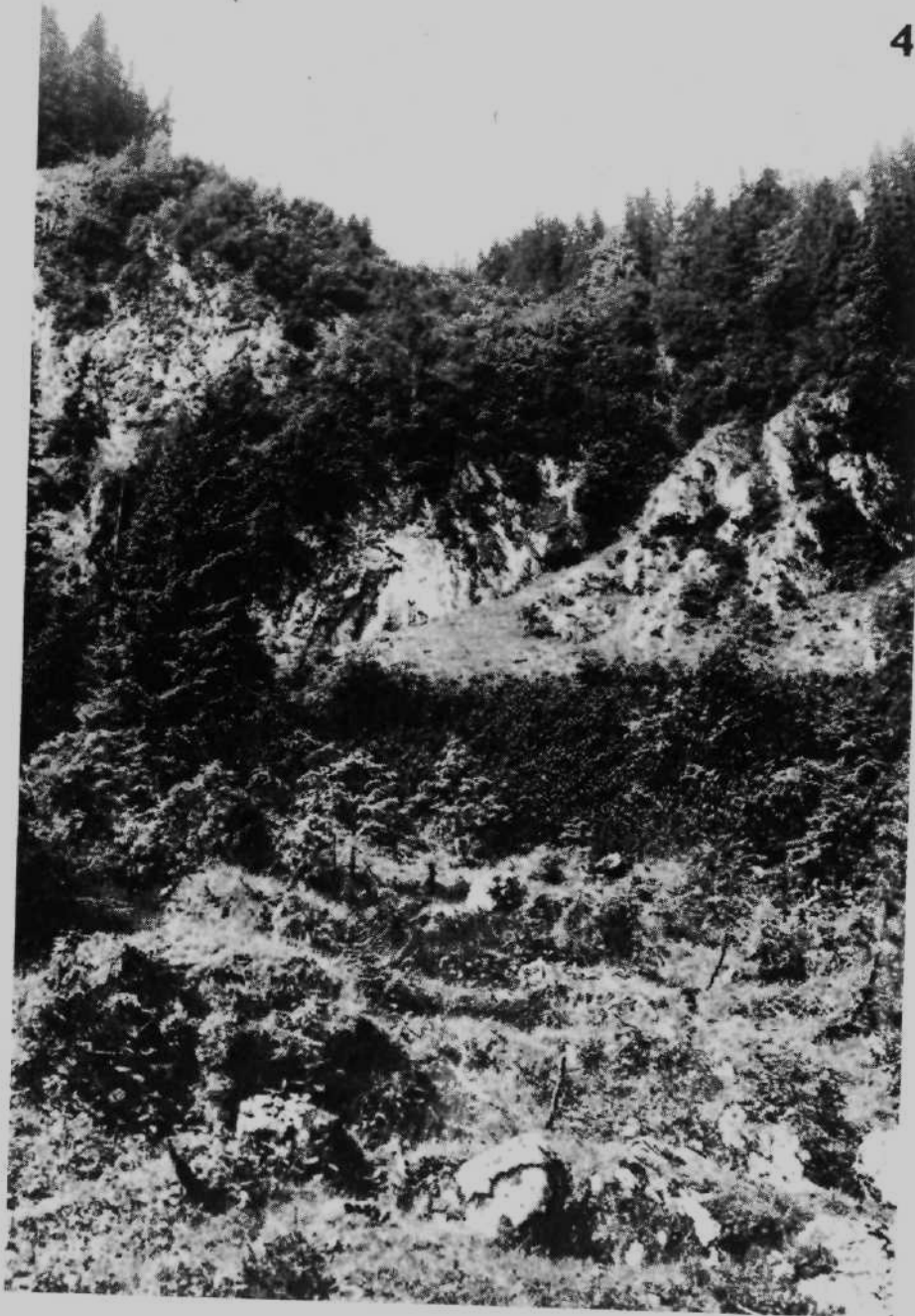


Fig. 4. View of the upper part of the locality No. 3 (the occurrence of *Pitymys cf. taticus*). Photos J. Flousek.

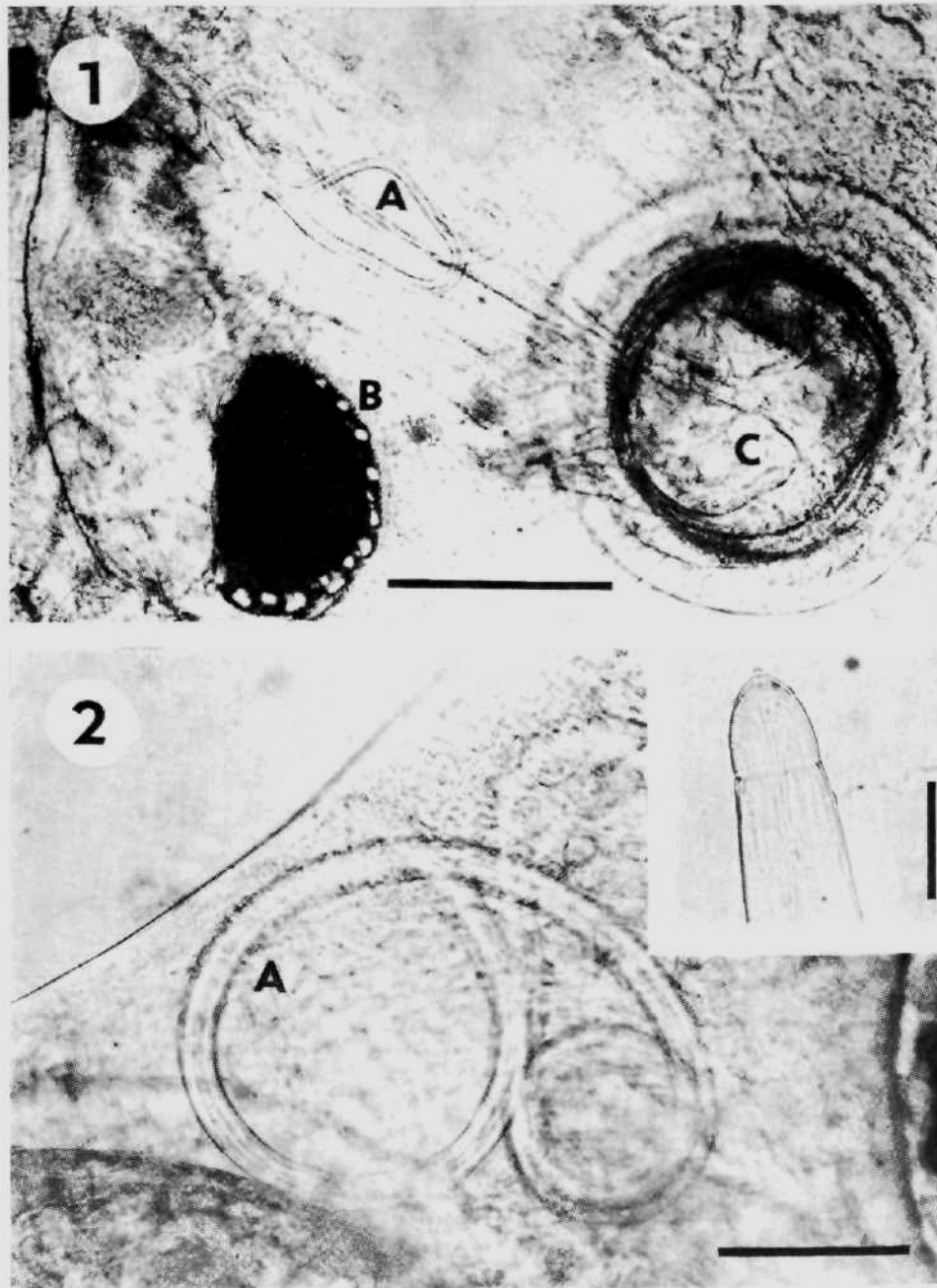


Plate I. Fig. 1. Infective larva of the nematode *Skrjabillanus tincae* (A) in the body cavity of the branchiurid intermediate host, *Argulus foliaceus*; note branchiurid's eye (B) and sucker (C). (Scale = 0.3 mm).  
Fig. 2. Same. (Scale = 0.1 mm) Inset: head end of *S. tincae* infective larva (Scale = 0.02 mm).



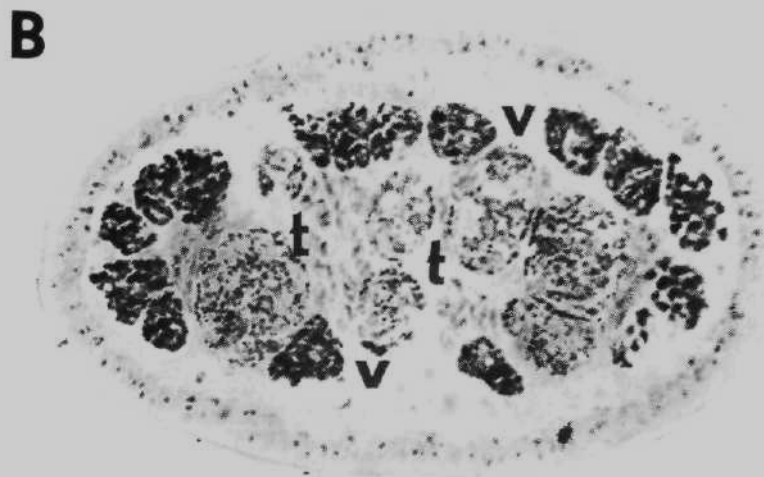
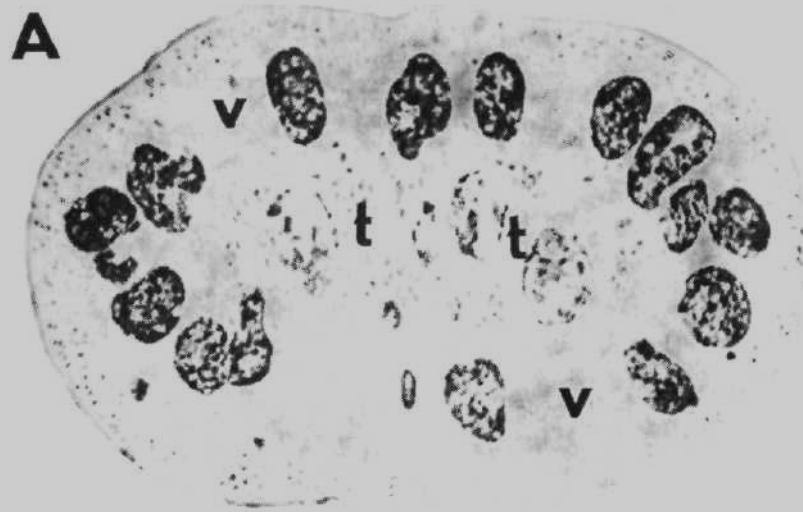


Plate II. Comparison of the distribution of vitellaria (v) and testes (t) in caryophyllid cestodes *Khawia baltica* from tench (A) and *Caryophyllaeus laticeps* from bream (B). Cross sections. Hematoxylin - eosin ( $\times 70$ ).

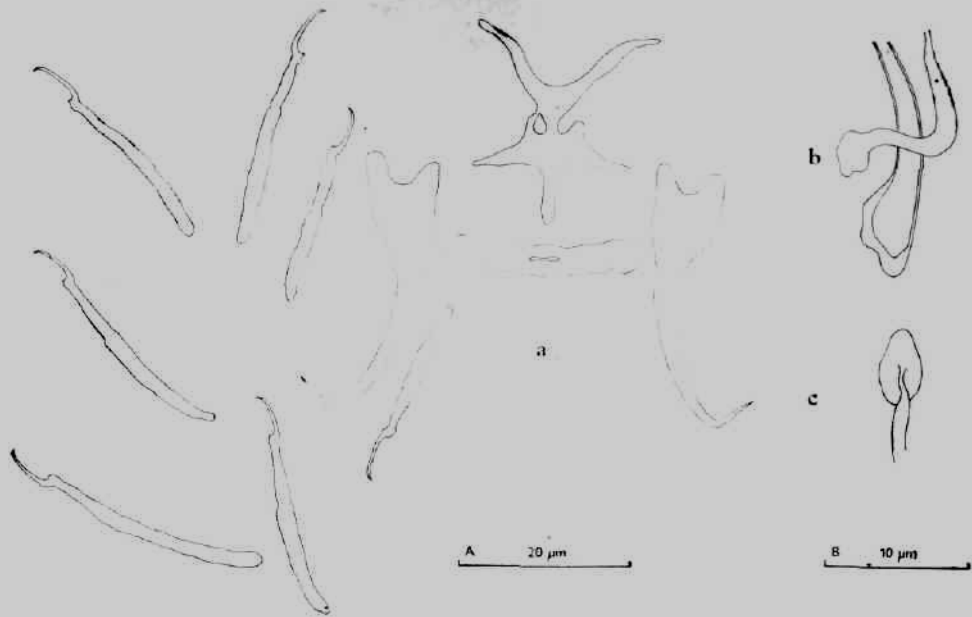


Fig. 1. Hard parts of opisthaptor (a), copulation apparatus (b), vaginal fortification (c) of *Dactylogyrus volfi* Lucký, 1970.  
Scale A = hard parts of opisthaptor; B = copulation apparatus and vaginal fortification.

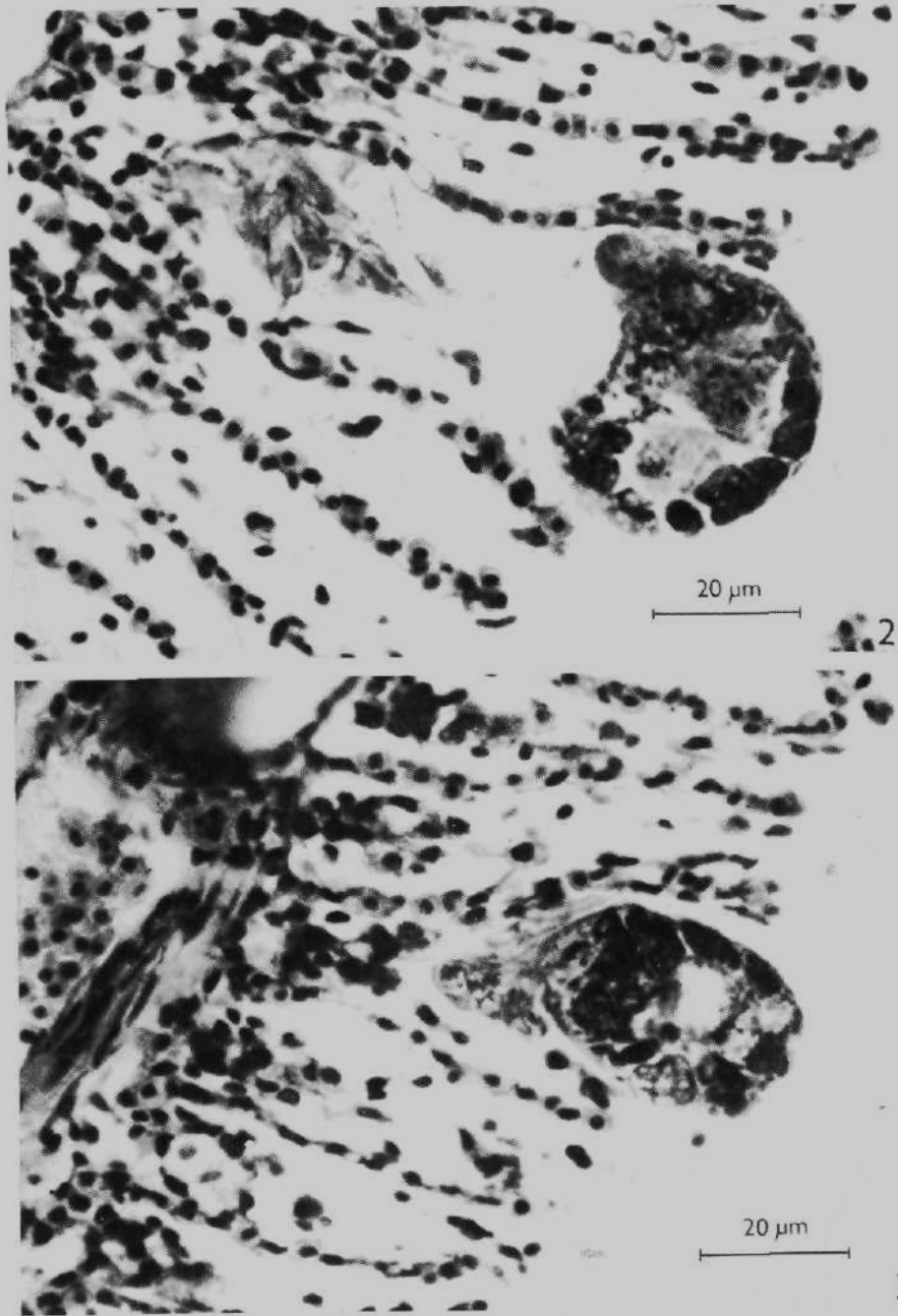


Fig. 2 and 3. *Dactylogyrus volfi* Lucký, 1970, on gills of *Capoeta tetrazona*; no inflammatory response at the sites of parasites.

## POKYNY PRO AUTORY

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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 stránkovan.

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

V rukopisu nepředpisujte zásadně žádné typy písma, označte pouze tužkou po straně části, které mají být vysazeny peřitem.

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