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40 let moderní československé zoologie

akademik Bohumil Ryšavý

V letošním roce jsme oslavili čtyřicáté výročí osvobození naší vlasti z nacistické okupace a vítězství pokrokových sil celého světa nad německým fašismem, který vyvolal nejstrašnější válku v dějinách lidstva a který surově utlačoval národy ve velké části Evropy.

Při této příležitosti nelze nevpomenout slavnou sovětskou armádu, která nesla na svých bedrech nejtěžší břemeno druhé světové války a která rozhodujícím způsobem přispěla k tomu, že i oba naše národy mohly opět svobodně dýchat a nastoupit cestu nového poválečného rozvoje naší společnosti. Vítězství nad fašismem přineslo našim národům nejen osvobození, ale i reálnou naději na nové, spravedlivější uspořádání naší společnosti, na vyřešení dlouhotrvajících problémů sociálních a národnostních.

První léta po válce byla nejen léty horečného úsilí za odstranění krutých následků války, ale byla poznamenána i snahou rychle obnovit aktivitu vědeckých pracovišť za války buď okupanty uzavřených, nebo okleštěných tak, že nebylo možno na nich rozvíjet vědeckou práci v odpovídajících a potřebných směrech. Rozvoj vědecké práce u nás velmi těžce postihlo i uzavření vysokých škol v tehdejší Protektorátu Čechy a Morava a omezení jejich činnosti na Slovensku. Mnoho našich předních vědců našlo za okupace smrt ve fašistických koncentračních táborech, ve věznicích nebo při odbojové činnosti. Veliké ztráty pro naši vědu byly také způsobeny tím, že okupanti zničili nebo odvěkli mnoho zařízení a často unikátních materiálů.

Proto prvním poválečným úkolem bylo co nejrychleji obnovit činnost vědeckých pracovišť, výuku a vědeckou práci na vysokých školách. První poválečná léta byla i obdobím hledání a diskusí o nových koncepcích uspořádání naší vědy, aby se vytvořily podmínky pro její rychlý další vývoj. Již po osvobození bylo zřejmé, že v ČSSR bude nutno urychleně vybudovat novou strukturu vědeckých pracovišť, orientovanou na nové rodící se směry ve všech vědních oborech, tedy i v zoologii.

Naše poválečná zoologie díky velkému počtu obětavých pracovníků, zejména učitelů a pracovníků vysokých škol, se poměrně velmi rychle zkonsolidovala. Ještě v roce 1945 byla zahájena v plném rozsahu výuka na Přírodovědeckých fakultách v Praze, Brně a Bratislavě a na Vysokých školách zemědělských v Praze a v Brně. Svou činnost zahájily v oblasti zoologie i některé resortní výzkumné ústavy, zejména zemědělské, lesnické a veterinární.

Nejdůležitější ohniska pro příští rozvoj zoologie však byla pracoviště vysokých škol. Na nich se po válce začaly rozvíjet nejen tradiční zoologické obory jako entomologie, ornitologie, živočišná fyziologie, ale i obory nové jako hydrobiologie, parazitologie, theriologie, arachnologie, živočišná ekologie a další. Tyto nově se rozvíjející obory dříve buď se vůbec neprovozovaly, nebo se jimi zabývali pouze jednotlivci a to zpravidla ještě mimo práci v jiných oborech.

V letech 1948–50 vycházelo z našich Přírodovědeckých fakult značné množství absolventů — zoologů. Byl to důsledek pětiletého uzavření vysokých škol během okupace. Tito absolventi kromě odborného studia zoologie byli většinou i absolventi učitelského studia, zejména kombinací přírodopis—chemie a přírodopis—zeměpis. Učitelské studium absolvovali proto, že v tehdejších letech byla téměř jediná možnost uplatnění učitelská činnost na středních školách. Konečně i naprostá většina profesorů a docentů na Přírodovědeckých fakultách či zoologických ústavech tehdejších vysokých škol zemědělských se rekrutovala ze středoškolských učitelů.

Vítězný únor 1948 však otevřel nejen novou etapu rozvoje naší společnosti, ale také novou etapu rozvoje naší vědy a tedy i zoologie.

V dalším rozvoji naší zoologie se objevily dva zásadní nové momenty. Bylo to především zřízení vědecké aspirantury v červnu 1949 (mezi prvními 12 přijatými vědeckými aspiranty byli i 3 zoologové) a zejména pak rozhodnutí o zřízení Československé akademie věd. Současně se zřízením vědecké aspirantury byly jako přípravná fáze pro zřízení Čs. akademie věd zřízeny tzv. Ústřední ústavy, mezi nimi jako jeden z prvních i Ústřední ústav biologický, z něhož po založení Čs. akademie věd v roce 1952 vznikl Biologický ústav ČSAV. Tento ústav byl pracovištěm, v němž již od roku 1949 nalezlo uplatnění značné množství zoologů různého zaměření. Po založení ČSAV vznikla další pracoviště zoologické orientace, Protozoologická laboratoř ČSAV, Entomologická laboratoř ČSAV a Laboratoř pro výzkum obratlovců ČSAV v Brně. Tyto laboratoře spolu s odděleními Biologického ústavu ČSAV daly vznik řadě specializovaných pracovišť (Entomologický ústav ČSAV, Ústav pro výzkum obratlovců ČSAV, Parazitologický ústav ČSAV), po založení Slovenské akademie věd vznikly Ústav experimentální fytopatologie a entomologie SAV, Zoologická laboratoř SAV a Helminologický ústav SAV v Košicích. Při SAV vzniklo i Rybářské laboratorium, které bylo později převedeno do jiného resortu.

Kromě pracovišť ČSAV a SAV vznikla i celá řada zoologicky orientovaných pracovišť v resortních ústavech zemědělských, lesnických, veterinárních i zdravotnických. Začala se například úspěšně rozvíjet i lesnická zoologie, orientovaná jednak na ochranu lesů, jednak na výzkum lovné zvěře.

S pracovišti Vysokých škol, ČSAV, SAV a resortních ústavů vzniká tak poměrně rozsáhlá síť zoologických pracovišť pracujících v různých směrech a rovinách výzkumu. Činnost této rozsáhlé zoologické základny musela být však centrálně řízena a koordinována. Než vznikl systém státního plánu základního výzkumu, velkou práci na tomto poli vykonala Československá zoologická společnost, Československá entomologická společnost později Československá parazitologická společnost. Tyto společnosti mají velkou zásluhu na tom, že pomáhaly koordinovat výzkumné úkoly, vytvářet základnu pro společnou práci i informace svých členů a na svých konferencích vytýčovaly další orientaci zoologické práce.

Velkou zásluhu na rozvoji a moderní orientaci naší zoologie měla i zoologická komise ČSAV, vedená akademikem Kratochvílem, která po řadu let rovněž koordinovala práci zejména pracovišť ČSAV, ale byla i hlavním ideovým orgánem pro stanovení další orientace československé zoologie a vypracovala první projekty státního plánu základního výzkumu v zoologii.

Na počátku 60tých let, kdy československá zoologická základna byla již plně

vybudována, bylo jen v ČSAV a SAV 8 pracovišť buď zcela orientovaných na zoologický výzkum, nebo alespoň částečně některými svými odděleními.

Tento úspěšný rozvoj naší zoologie si ovšem nemůžeme představit bez našich vysokých škol, z nichž po válce přešel na zoologická pracoviště ČSAV, SAV a dalších resortů nejen velký počet absolventů, ale i velký počet pedagogických a odborných sil. To v některých případech vedlo i k dočasnému oslabení některých fakult.

Hovoříme-li o vývoji naší zoologie v uplynulých 40 letech je nutno hovořit i o významných úspěších naší zoologie.

Naše entomologie, která již před válkou měla velice dobrou pověst i v zahraničí, navázala na úspěšnou práci starší generace. Z velké části se orientovala na problematiku ochrany lesních a zemědělských kultur před škůdci. Tato orientace přispěla k vynikajícím výsledkům ve výzkumu ekologie, biologie a patologie hmyzu, které jsou uznávány a vysoce ceněny v celém světě. Ve výzkumu hmyzích hormonů má ČSSR stále ve světě přední pozici. Výsledky práce našich entomologů, které vycházejí z vynikající práce našich systematiků a taxonomů, se s úspěchem uplatňují nyní v naší zemědělské, lesnické a potravinářské praxi.

Významných výsledků dosáhli naši zoologové v hydrobiologickém výzkumu. Jejich práce, zásadně ekologicky orientované, pomáhají objasňovat samočisticí procesy ve vodě, koloběh látek ve vodě a energetickou bilanci našich vodních nádrží. Velký rozvoj doznala u nás i arachnologie, díky velké práci jejího zakladatele prof. Dr. F. Millera.

Významným úspěchem zoologie je půdní zoologie, která vznikla při Přírodovědecké fakultě UK v Praze a která se nyní úspěšně rozvíjí i na pracovištích ČSAV a SAV. Je možno hovořit o významných výsledcích naší parazitologie, ať se jedná o výzkum cizopasných prvoků, červů, hmyzu či kličat a dalších parazitických roztočů. Významné místo si vydobyl ve světě i výzkum obratlovců, který byl postaven na novou kvalitativní úroveň, je orientován důsledně ekologicky a stále více propojován se zemědělskou, rybářskou a lesnickou praxí.

Velkého uznání se v posledních letech dostalo i československým živočišným fyziologům, embryologům a cytologům, zejména také proto, že se orientují na moderní biochemické a fyziologické výzkumy na buněčné a membránové úrovni.

Odrážem vynikajících výsledků práce československých zoologů je i jejich publikační činnost. Jsou to především zoologicky orientované časopisy, kterých vychází v současné době u nás 6, dále to je ediční řada Fauna ČSSR, kde již vyšlo 24 svazků, kromě velkého množství monografických prací, příruček, určovacích klíčů, učebnic a jiných knižních publikací.

V tomto krátkém příspěvku nelze podrobně hodnotit všechny úspěchy práce našich zoologů, dosažené v uplynulých 40 letech. Nelze ani hovořit podrobně o problémech, s nimiž se naše zoologie musela na své cestě potýkat. Je však možno říci, že uplynulých 40 let bylo obřobí pro naši zoologii úspěšné, díky obětavé práci stovek pracovníků vysokých škol, pracovišť obou našich Akademií i resortních ústavů.

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**PHEROMONAL COMMUNICATION OF HOMOGAMIC AND HETEROGAMIC
POPULATIONS OF ARGAS (PERSICARGAS) PERSICUS (ACARINA:
ARGASIDAE)**

František DUSBÁBEK

Received February 12, 1985

Abstract. Responsiveness to assembly pheromone stimuli of *A. (P.) persicus* (Oken) populations from Czechoslovakia and Azerbaijan and their hybrids was studied using the multiple-choice method in Petri dishes. The number of males responding to assembly pheromone of both sexes was higher than that of the responding females. Aggregation score of fed males was mostly higher than that of the unfed ones. Differences in the efficacy of assembly pheromone of unfed and fed ticks were not demonstrated. Males of one population responded to male pheromone of other population in a similar manner as to the pheromone of their own. However, male responsiveness in population from Czechoslovakia (Cc) and Ca hybrids was markedly higher than that in population from Azerbaijan (Aa) and Ac hybrids. Aggregation score of F₁ generation hybrid males was more alike that of a homogamic population from which mother originated.

INTRODUCTION

Since the first reports on pheromonal communication of mites and ticks (Cone et al. 1971, Berger et al. 1971) numerous papers on different pheromones of these arthropods have been published. Most of them deal with pheromonal communication of hard ticks (Ixodidae), mainly with pre-attachment and attachment assembly and sexual pheromones. The first attempts have already been performed to apply the latter in the control of ticks of the genus *Amblyomma* (Gladney et al. 1974, Rechav and Whitehead 1978, 1981) and *Dermacentor* (Ziv et al. 1981). In soft ticks of the family Argasidae assembly pheromones were demonstrated in many species of the genus *Argas* and *Ornithodoros* (Leahy et al. 1973, 1975 a, b, Leahy 1979, George 1981, Gothe and Kraiss 1982a). They are soluble in water and saline, relatively thermostable (Leahy et al. 1973), of low species specificity (Leahy et al. 1975), detected by palpal organ (Leahy et al. 1975a), released mainly from anal pore (Gothé and Kraiss 1982b) and contained also in coxal fluid. The first experiments have been performed to search for the possibility of applying these pheromones in the control of soft ticks (Gothé et al. 1984).

Recently, female sexual pheromone released from genital pore have been reported in *Argas (P.) walkerae* Kaiser and Hoogstraal (Gothé and Kraiss 1982b) which may be analogous with identification sexual pheromones of ticks of the family Ixodidae. Schlein and Gunders (1981) reported on the

stimulating effect of female coxal fluid in three *Ornithodoros* species on the number of copulation trials exerted by *O. erraticus* (Lucas) males and assumed that a non-specific female sexual pheromone is excreted by the glandular part of coxal organ.

A decreased fecundity of fed females of several argasid species in which preoviposition period and egg laying occur in aggregations of conspecific adults, as demonstrated in *Argas (P.) arboreus* Kaiser, Hoogstraal nad Kohls (Khalil 1979, 1984) and *Ornithodoros (Pavlaskeyella) tholosani* (Laboulbene and Mégnin) and *O. (P.) papillipes* (Bir.) (Vasil'eva and Ershova 1980 a, b), may be due to a fecundity-reducing pheromone regulating the egg number in a batch (Khalil 1984). This pheromone released exclusively by fed adults of both sexes is likely to affect vitellogenin synthesis and its deposition in oocytes. Recently, the current state of knowledge of argasid pheromones has been reviewed (Sonenshine et al. 1982, Gothe 1983 a, b, Leonovich 1984) and the possibilities of applying them in the control of mites and ticks have been discussed (Sonenshine 1984).

Relatively little has hitherto been known on pheromone-induced behavior of different argasid populations and its affection by environmental factors. Some of these aspects are discussed in the present paper.

MATERIAL AND METHODS

Two different *Argas (Persicargas) persicus* (Oken) populations and their hybrids were used in the experiments. The population from Azerbaijan was collected in henhouses at Arad and Shlelyan, district of Yevlakh, Azerbaijan SSR, on October 16 and 22, 1979, and provided by courtesy of Dr. J. Řeháček, D.Sc. of the Institute of Virology, Slovak Academy of Sciences, Bratislava. The population from Czechoslovakia was collected in henhouses at Ipeľský Sokolec, district of Levice, on July 28, 1972. The ticks were kept in darkness at 27 °C (± 1 °C) and RH 75 % (± 5 %) maintained by saturated NaCl solution. Unfertilized females and males that had not mated before, aged 1–6 months after moulting (tests with unfed ticks), or 1–3 months after feeding on chickens (tests with fed ticks), i. e. specimens from laboratory-reared generations of the two populations kept for several years under constant laboratory conditions, and their F₁ generation hybrids were tested.

To test the responsiveness to assembly pheromone a method of discs of filter paper placed in Petri dishes (Leahy et al. 1973) was used. Petri dishes (150 mm) were radially divided into 8 equal sectors. The discs of Whatman No 1 filter paper (15 mm dia.), exposed to ticks from three weeks to several months, served as the source of pheromone. In each dish one impregnated disc was exposed, the remaining seven sectors contained unimpregnated ones which served as controls. The experiments, each repeated at least five times and each involving 10 ticks, were performed in closed dishes and in darkness. Aggregation of ticks in different sectors was evaluated under red light after 1, 2 and 6 hr exposure. The pheromone impregnated discs were used only once in each replication, the ticks were used for several times throughout the experiment. All experiments were performed at 27 °C (± 1 °C) and RH 75 % (± 5 %).

Significance of tick responsiveness to pheromone was evaluated by comparing the number of positively responding ticks with the critical value (x_{crit}) of binomical distribution (Likéš and Laga 1978), constituting at $n = 50$ $12 < x_{crit} < 13$ ($P = 0.01$) and $10 < x_{crit} < 11$ ($P = 0.05$). To compare significance of the response homogeneity within the groups tested and the differences between these groups χ^2 (chi-square) test was used.

The following abbreviations are used in the text and tables:

- Aa – progeny of ♀ from Azerbaijan and ♂ from Azerbaijan
- Ac – progeny of ♀ from Azerbaijan and ♂ from Czechoslovakia
- Cc – progeny of ♀ from Czechoslovakia and ♂ from Czechoslovakia
- Ca – progeny of ♀ from Czechoslovakia and ♂ from Azerbaijan

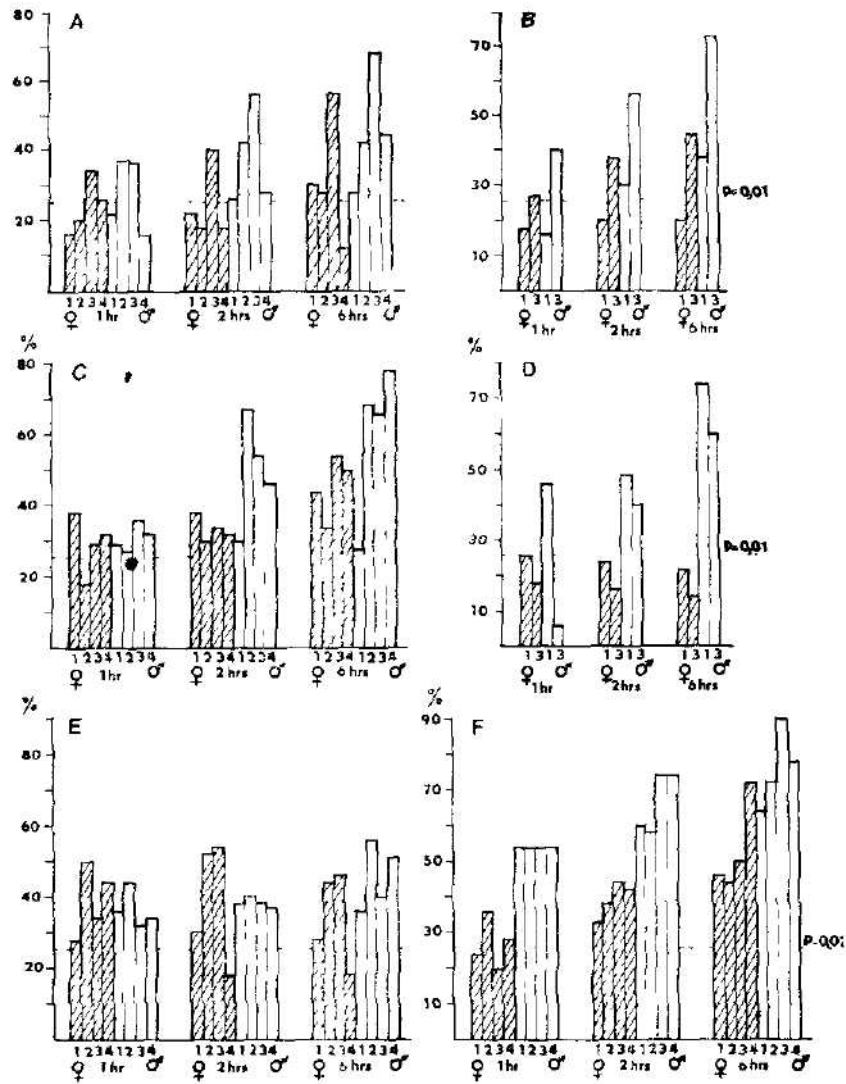


Fig. 1. Comparison of female and male responsiveness to assembly pheromone of their own population after 1, 2 and 6 hour exposition A — response of unfed imagoes to pheromone of unfed females. B — response of unfed imagoes to pheromone of fed females. C — response of fed imagoes to pheromone of fed females. D — response of fed imagoes to pheromone of unfed females. E — response of unfed imagoes to pheromone of unfed males. F — response of fed imagoes to pheromone of fed males 1 — homogamic population Aa, 2 — heterogamic population Ac, 3 — homogamic population Cc, 4 — heterogamic population Ca.

RESULTS

A. Comparison of male and female responsiveness to assembly pheromone of their own population

Response of both sexes to pheromone of females and males of their own population is shown in Figs. 1A-D and 1E-F, respectively. As indicated in the diagrams, male response to female pheromone is in most instances significant at $P < 0.01$, whereas females respond to their own pheromone more weakly, usually not reaching the above level of significance. The number of the responding males was mostly significantly higher ($P < 0.05$). Responsiveness of both sexes to male pheromone was usually significant ($P < 0.01$). In general, in unfed ticks (Fig. 1E) significant differences between female and male responsiveness were not recorded, however, in fed ticks the responsiveness in males was significantly higher than in females ($P < 0.05$) (Fig. 1F). Significant differences between the numbers of unfed males and females responding to pheromone of unfed ticks of both sexes were not detected. Higher numbers of fed males responded probably significantly more to male pheromone ($P < 0.05$) than to female pheromone, however, these differences were not demonstrated by female response. In addition, the diagrams show a marked increase in the numbers of the positively responding ticks with the increasing length of exposure, and differences in the responsiveness of ticks of different populations and their hybrids, which is discussed in detail below.

B. Comparison of male responsiveness to assembly pheromone of different population

Based on the results of our previous experiments, male responsiveness to pheromone of different populations was evaluated by the response of fed males to pheromone of fed males after 6 hr exposure when the response reached the maximum in all populations studied. The results obtained are shown in Tab. 1 and indicate that the response of males from one population is mostly homogenic and males respond to pheromone of all populations studied at the same intensity.

Table 1. Fed males of *A. (P.) persicus* responsiveness to assembly pheromone of fed males of different populations after six hour exposition

| Donors of pheromone | % Males in test sector | | | |
|------------------------------|------------------------|-------|----|------|
| | Aa | Ac | Cc | Ca |
| Aa | 64 | 60 | 86 | 74 |
| Ac | 48 | 55 | 94 | 70 |
| Cc | 56 | 50 | 90 | 92 |
| Ca | 46 | 42 | 78 | 78 |
| Total % males in test sector | 53.5 | 51.75 | 87 | 78.5 |

This response homogeneity was significant in Aa progeny and Ac hybrids at $P > 0.01$, in Cc progeny and Ca hybrids at $P > 0.05$. Due to this response homogeneity in the populations tested the differences in the intensity of the

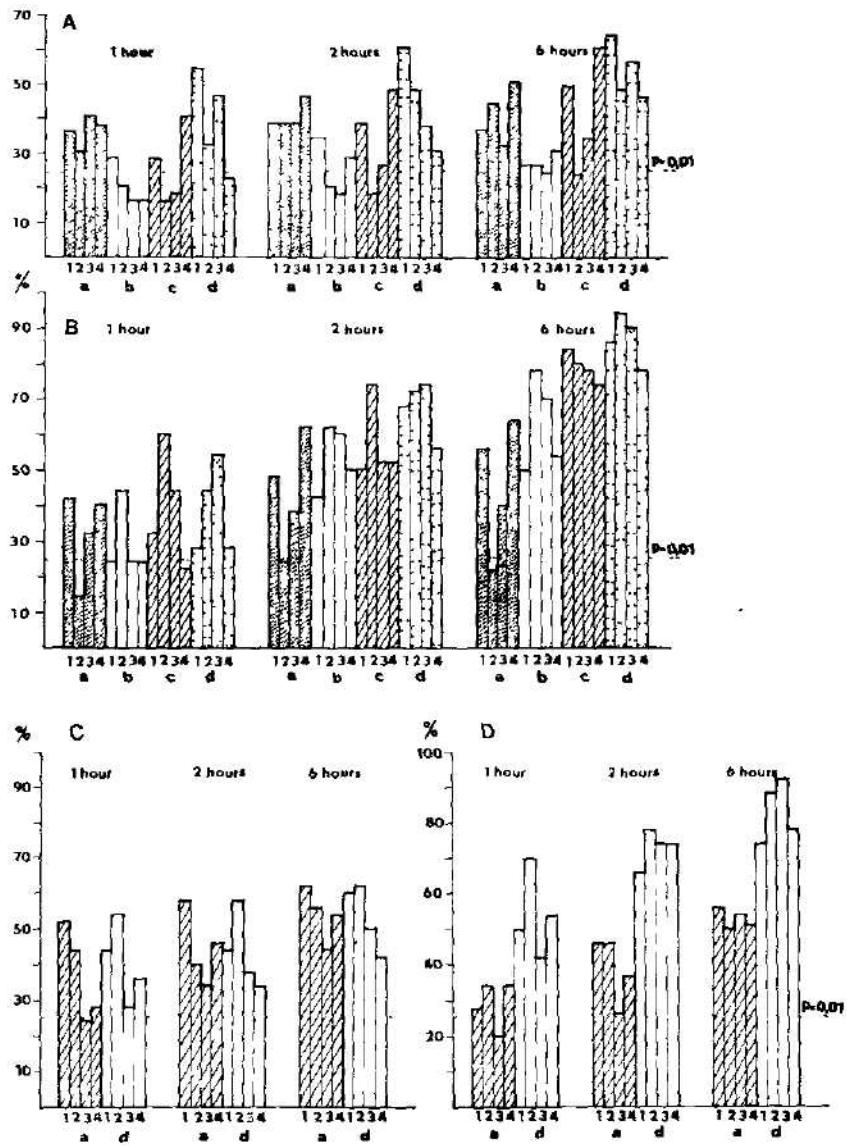


Fig. 2. Comparison of the males physiological state influence on their responsiveness to assembly pheromone after 1, 2 and 6 hour exposition in A – homogamic population Aa, B – homogamic population Cc, C – heterogamic population Ac, D – heterogamic population Ca.

1 – pheromone of homogamic population Aa, 2 – pheromone of heterogamic population Ac, 3 – pheromone of homogamic population Cc, 4 – pheromone of heterogamic population Ca.

a – responsiveness of unfed males to pheromone of unfed males

b – responsiveness of unfed males to pheromone of fed males

c – responsiveness of fed males to pheromone of unfed males

d – responsiveness of fed males to pheromone of fed males.

response of individual populations are conspicuous. The highest aggregation score was recorded in males of Cc progeny and Ca hybrids, differing one from another only at $P < 0.05$. A significantly lower score ($P < 0.01$) was recorded in Aa progeny and Ac hybrids that did not significantly differ from one another (Tab. 1).

C. Comparison of the effect of the physiological state of ticks on assembly pheromone release and on the responsiveness to pheromone

Effect of physiological state of argasids on their responsiveness was studied comparing the response of unfed and fed males to male pheromone of two different populations and their hybrids. Fig. 2 shows that the responsiveness of engorged males of Cc progeny and Ca hybrids (Figs. 2B, D) to both pheromone of unfed and fed males is significantly higher than that in unfed ticks ($P < 0.05$). This difference is less expressed in males of Aa progeny and not significant in Ac hybrids at all (Figs. 2A, C). In homogamic Cc progeny (Fig. 2B) there is an indication of lower effect (or lower release) of assembly pheromone of unfed males when compared with that of fed males, however, these differences are not statistically significant. Figs. 1A-D show the responsiveness of fed and unfed ticks to female pheromone of their own populations. No significant differences in male responsiveness were observed and the numbers of the responding males were always significant ($P < 0.01$). In most instances, female responsiveness was insignificant or at the level of significance, and only engorged females responded to pheromones of engorged females significantly (Fig. 1C). Also in this instance, there was an indication of lower effect of pheromone released by unfed females, although those differences were not statistically significant.

DISCUSSION

Studies on female and male responsiveness to assembly pheromone of their own population demonstrated that the number of males responding to pheromone of both sexes was higher than that of the responding females. That coincides well with the results of Leahy et al. (1973) who studied the responsiveness of the same argasid species. Similar results were recorded in *Argas (P.) walkerae* Kaiser and Hoogstraal (Gothe and Kraiss 1982a). In this species, the above authors noted the same effect of female and male assembly pheromone as recorded in our experiments. In the studies of physiological state of ticks and its effect on the responsiveness to assembly pheromones better aggregation score was noted in fed males than in the unfed ones. This finding corresponds well with the results of Gothe and Kraiss (1982a) who reported on a high (90–100%) aggregation of engorged *A. (P.) walkerae* males after 6 hr exposure. Leahy (1979) summarized the results of studies on fed and unfed *A. (P.) persicus* of both sexes using fed and unfed females as the source of assembly pheromone. She revealed that unfed females and males responded more intensively than the fed ticks and that the pheromone of engorged females induced higher aggregation than the pheromone of unfed females. Nevertheless, these findings have not been confirmed in our experiments which indicated that the responsiveness was higher in fed specimens than in the unfed ones. The different conclusions may be due to the fact

that Leahy's experiments (1979) were evaluated after 1 hr exposure, when the response to pheromone is usually not very much marked, whereas our results were obtained during 6 hr exposure providing a better survey of the response dynamics. In addition, engorged males and females were tested 1-3 months after feeding in our experiments, i. e. when a certain degree of digestion of blood meal had been reached. Some role is certainly played by different responsiveness of individual argasid populations as shown by different scores of populations from Czechoslovakia and Azerbaijan. We failed in demonstrating some differences in the effect of assembly pheromone released by fed and unfed ticks. In several instances, higher aggregation was induced by pheromone of engorged specimens, however, these differences were not statistically significant and remained unconfirmed by other results.

Some interesting findings have been obtained by comparing the responsiveness of males from different populations and their hybrids. Males of each homogamic and heterogamic population were found to respond to pheromone of their own population at the same intensity as to those of other population and the responsiveness was therefore homogenic. This indicates that males of all groups tested appear to release pheromone of the same efficacy and at about the same rate. Therefore, a further finding that males of population from Czechoslovakia respond more intensively and rapidly than males from Azerbaijan population may be due to the differences in the process of pheromonal perception and processing and not due to different ability of pheromonal release.

Remarkable is the finding that the responsiveness of F_1 generation hybrid males is more similar to that of a homogamic population from which mother originated. This matroclinity feature in F_1 generation of hybrids was observed also in comparing the characteristic features of the life cycles of homogamic and heterogamic populations of this and other argasid and tick species (Dusbek 1985a, b, Hunt and Drummond 1983 etc.). It has been ascertained that in the ticks *Amblyomma americanum* (L.), *Argas (P.) persicus* (Oken) and *A. (A.) polonicus* Siuda, Hoogstraal, Clifford and Wassef the characteristic features of the life cycle of F_1 reciprocal crosses of two populations are similar to the characteristic features of a homogamic population from which mother originates. Dominant maternal characteristic features were found also in the nymphs of *Ornithodoros (Alectorobus) coniceps* (Canestrini) and *O. (A.) capensis* Neumann hybrids (Panova 1967), demonstrating matroclinity of some characteristic hereditary features of F_1 generation. Nevertheless, further detailed studies on this question, primarily those on the diminution of features inherited in this way in further filial generations, are needed.

CONCLUSIONS

The following results have been obtained by comparing male and female response in *Argas (P.) persicus* populations from Czechoslovakia and Azerbaijan and their hybrids to assembly pheromone of their own population:

- Aggregation induced by males and females released assembly pheromone was demonstrated to be nearly identical — hence the assembly pheromone of both sexes is of the same efficacy.
- The number of males responding to male and female assembly pheromone

is markedly higher than that of the responding females, i. e., males tend to be more sensitive to pheromone.

The results of comparison of the response in fed males to assembly pheromone of different populations are summarized as follows:

— Males in homogamic populations from Czechoslovakia (Cc) and Azerbaijan (Aa) differed in their response to assembly pheromone of engorged males in that the aggregation score of Cc males was significantly higher than the score of Aa males.

— F₁ generation males of heterogamic Ca and Ac crosses responded in a similar manner as males from a homogamic population from which mother of heterogamic hybrids originated. In that way, Ca cross-bred males responded similarly as males of homogamic Cc population; Ac heterogamic males responded similarly as Aa homogamic males.

— Engorged males of each heterogamic and homogamic population responded to assembly pheromone of other populations at about the same level as to pheromone of their own population.

From the results of studies on the effect of physiological state of argasids on the release of assembly pheromone and the responsiveness to them the following conclusions have been reached:

— When responding to male pheromone, the score of engorged males in both Cc homogamic and Ca heterogamic populations was higher than that of unengorged males. These differences were less pronounced in Aa homogamic males and Ac hybrids and the responsiveness of unfed males attained nearly the same response intensity as exhibited by the fed males.

— Differences in the release and efficacy of assembly pheromone produced by fed and unfed argasids were not demonstrated. In several instances, higher aggregation was induced by pheromone released by engorged specimens (Figs. 1A-D, 2B), however, these differences were not statistically significant.

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ACCUMULATION OF NATURAL RADIONUCLIDES AND GROWTH OF SELECTED FISH SPECIES IN CONTAMINATED WATERS

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Abstract. In the years 1974–1980, the authors dealt with the accumulation of natural radionuclides in tissues of selected fish species and their growth in Northern Bohemia. On the whole, 94 radiochemical analyses of 669 fish belonging to 8 species were carried out. All the species studied appeared to have their growth affected mainly by the reservoir trophic base. The increased accumulation of natural radionuclides was found only in extremely quickly growing roach and in rather benthofagous species (carp, tench, crucian carp). The radium content is generally above the level of the natural background (i. e. more than $0.012 \text{ Bq} \cdot \text{g}^{-1}$ fish dry weight), the uranium content is maximally on the level of the natural background (i. e. values of $1 \mu\text{g} \cdot \text{g}^{-1}$ dry weight or lower).

MATERIAL AND METHODS

Ichthyological research began in the spring of 1974 and fish samples were obtained from the ponds "Pustý rybník", "Ještědský rybník", "Hamerský rybník" and the water reservoir "Horecká nádrž" or "Horka" in northern Bohemia. The work continued till 1980. The surfaces and water volumes of these reservoirs are as follow: "Pustý rybník"; land register area 4.0 ha, water surface 3.4 ha, when it belonged to the State Fishery at Doksy; later the pond was rebuilt into a sediment pond and its water surface varies (max. up to 5.0 ha, water volume 40,000 cbm, during our experiments the cubature was about 30,000 cbm). "Ještědský rybník": land register area 2.35 ha, water volume 39,500 cbm. "Hamerský rybník": land register area 55.32 ha, water surface cca 48 ha. "Horecká nádrž" or "Horka"; land register 47.90 ha, water surface area 40–45 ha, water volume 455,000 cbm.

Fishes were collected by means of hoop-nets and small seine nets in outflow parts of the reservoir "Horecká nádrž" and of the pond "Hamerský rybník", or directly in the pond ("Pustý rybník"), but the majority of the material studied was obtained during outfishing operations of all ponds, with the exception of "Pustý rybník", which has not been used for fishery management after its reconstruction for sedimentation purposes. The growth of fishes was determined by means of scales. Concerning carp the methods were used as described by Oliva (1955), for the crucian carp following Oliva and Hruška (1954), Čihař (1957), Libosvářský (1963), for the tench after Černý (1968), Lohniský (1966), for the pike following Tandon and Oliva (1978), for the roach and the perch after Pivnička (1974) and Švátora (1974), for the whitefish (*Coregonus lavaretus maraena*) after Gasowka (1953) and Vostradovská (1966), for the brown trout (*Salmo trutta m. fario*) after Frank (1959, 1962).

As regards radiochemical analyses, our work coincided with the following authors: Cejtlín and Bykov (1961), Justýn (1973), Justýn (1980), Justýn and Lusk (1976), Justýn – Marvan – Rosol (1979), Nesmějanov and Prislekov (1959), Pečkurenkov (1981).

²²⁶Ra determination. The fish tested were dried to constant weight at 100–105 °C, then burnt to ashes in a muffle oven at 550 °C, the ash was ground in an agate mortar and the necessary amount was put into solution and measured emanometrically (Cejtin 1961, Nesmějanov 1959, Vermířovský 1963, Justyn 1973). With the method used, the determination error represents 5–20 % depending on ²²⁶Ra concentration.

For uranium determination in fish the method based on the determination of U^{IV} (after reduction with zinc and ascorbic acid) with Arsenazo III was applied. The resulting bluegreen complex was measured photometrically at 665 nm (red filter). When using suitable measuring cells (width 5 cm), the lower sensitivity limit of the method was 1 µg absolute uranium in samples. The error of determination was 5–10 % (H a n u š o v á 1974).

Table 1. Growth of the roach in the pond "Hamerský rybník" in 1975–1979

| Age group | n*) | lc | w | l ₁ | l ₂ | l ₃ | l ₄ | l ₅ |
|-----------|-----|-----|-----|----------------|----------------|----------------|----------------|----------------|
| 1+ | 11 | 124 | 38 | 63 | — | — | — | — |
| 2- | 12 | 209 | 207 | 67 | 141 | — | — | — |
| 3+ | 1 | 245 | 347 | 58 | 135 | 183 | — | — |
| 4+ | 45 | 280 | 536 | 59 | 135 | 203 | — | — |
| 5+ | 2 | 285 | 568 | 60 | 127 | 188 | 233 | 281 |
| | 70 | — | — | 62 | 134 | 196 | 241 | 281 |

*) n = number of specimens, L = body (standard) length, W = weight in grams, l₁, l₂ etc = back calculated body lengths.

FISH GROWTH

Simultaneously with the accumulation of natural radionuclides, the growth analyses of tested fishes were performed. The reason for this was the presumption of quicker accumulation of natural radionuclides in faster growing, and therefore more metabolic, active individuals, which represent the samples of faster or slower growing populations. In this way it was possible to enclose the tested species into the whole context of growth values obtained in previous studies and to eliminate the possibility of radiochemical evaluation of these

Table 2. Growth of the roach in the reservoir "Horka" in 1975–1979

| Age group | n | lc | w | l ₁ | l ₂ | l ₃ |
|-----------|----|-----|-----|----------------|----------------|----------------|
| 1 | 2 | 68 | 6.4 | 68 | — | — |
| 1+ | 1 | 150 | 80 | 63 | — | — |
| 2 | 18 | 130 | 51 | 66 | 130 | — |
| 2+ | 33 | 204 | 214 | 65 | 137 | — |
| 3 | 6 | 196 | 188 | 66 | 133 | 196 |
| 3- | 8 | 240 | 359 | 61 | 151 | 206 |
| | 68 | — | — | 65 | 138 | 201 |

fishes which show apparent deviations from values of the expected average growth. Last but not least it was necessary to differentiate tested specimens by ageing and thus to hinder the possibility of comparison of younger year

Table 3 Growth of the roach burnt to ashes for the radiochemical analysis from the pond "Hamerský rybník" in 1977—1978

| Age group | n | lc | w | l ₁ | l ₂ | l ₃ | l ₄ | l ₅ |
|-----------|----|-----|-----|----------------|----------------|----------------|----------------|----------------|
| 1+ | 57 | 124 | 38 | 63 | — | — | — | — |
| 4+ | 4 | 280 | 518 | 63 | 149 | 200 | 249 | — |
| 5+ | 2 | 285 | 615 | 65 | 130 | 193 | 236 | 262 |

classes (in general more active metabolically) with the older, mature ones, in which the somatic increments are substantially lower

Roach (*Rutilus rutilus*) growth was studied in the pond "Hamerský" in 70 specimens of 5 age classes and it was evaluated jointly for years 1975—1979 (Tab. 1,3). Within the same period the growth from the reservoir "Horecká nádrž" (68 specimens in 3 age classes) was also evaluated (Tab. 2). When evaluating the weight growth of the roach from the pond "Hamerský" (4—6 age class), the sum of the weight increments during one year is 400 g, which represents the largest value ascertained in our conditions up to the present. For comparison it should be pointed out that the growth of the roach evaluated by means of the same method closely after the water filling of the valley water reservoir Švihov reached the value of 399 g, in the Lipno water reservoir 317 g, but, on the contrary, in the Labe backwater called "Poltruba" only 38 g.

In the water reservoir "Kličava", where the growth of the roach has been studied since 1964, the weight value of increments of the above cited age classes ranged between 80—90 g (Pivnička 1974). The growth of the roach from the reservoir "Horecká nádrž" cannot be evaluated in a similar way, because the oldest roach obtained reached only 3 years of age.

When we compare the values at our disposal with the same values ascertained in roach from the pond "Hamerský", agreement can be found in the growth tempo in both the reservoirs. This apparently fast growth is most probably related with the lowered number of stocked carp which is kept here with regard to the use of the reservoir for recreational purposes. The

Table 4. Growth of the perch in the pond "Hamerský rybník" in 1975—1978

| Age group | n | Lo | w | l ₁ | l ₂ | l ₃ | l ₄ | l ₅ | l ₆ | l ₇ | l ₈ | l ₉ |
|-----------|-----|-----|-----|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|
| 1+ | 4 | 90 | 17 | 64 | — | — | — | — | — | — | — | — |
| 2+ | 20 | 110 | 30 | 61 | 93 | — | — | — | — | — | — | — |
| 3+ | 36 | 128 | 45 | 55 | 86 | — | — | — | — | — | — | — |
| 4+ | 17 | 150 | 80 | 56 | 87 | 111 | 130 | — | — | — | — | — |
| 5+ | 22 | 176 | 118 | 58 | 90 | 116 | 136 | 160 | — | — | — | — |
| 6+ | 12 | 205 | 172 | 57 | 93 | 117 | 138 | 164 | 184 | — | — | — |
| 7+ | 17 | 234 | 314 | 59 | 93 | 122 | 148 | 173 | 197 | 217 | — | — |
| 8+ | 17 | 234 | 307 | 58 | 90 | 115 | 138 | 164 | 196 | 207 | 226 | — |
| | 145 | — | — | 59 | 90 | 115 | 138 | 165 | 192 | 210 | 226 | 243 |

growth of the ash-tested roach is identical with the growth ascertained in the evaluated sample of the roach. As "identical" we denote the growth whose coefficient of variation in the single values does not exceed 3 percent.

In connection with the fast growth tempo found in the roach also the accumulation of ^{226}Ra was about twice larger in this fish species than in perch and pike. Larger values were found only in the crucian carp. A similar situation appeared also with natural uranium, where in the crucian carp again larger values were found.

Table 5. Growth of the perch in the reservoir "Horka" in 1975—1979

| Age group | n | Lc | W | l ₁ | l ₂ | l ₃ | l ₄ | l ₅ | l ₆ | l ₇ |
|-----------|-----|-----|-----|----------------|----------------|----------------|----------------|----------------|----------------|----------------|
| 1 | 11 | 75 | 11 | 75 | — | — | — | — | — | — |
| 1+ | 17 | 100 | 20 | 65 | — | — | — | — | — | — |
| 2 | 78 | 103 | 25 | 64 | 102 | — | — | — | — | — |
| 2+ | 24 | 115 | 31 | 58 | 93 | — | — | — | — | — |
| 3 | 63 | 120 | 42 | 59 | 94 | 120 | — | — | — | — |
| 3+ | 15 | 156 | 98 | 60 | 98 | 134 | — | — | — | — |
| 4 | 10 | 149 | 82 | 65 | 96 | 126 | 149 | — | — | — |
| 4+ | 21 | 182 | 137 | 66 | 107 | 135 | 162 | — | — | — |
| 5 | 15 | 204 | 159 | 63 | 100 | 131 | 193 | 204 | — | — |
| 5+ | 2 | 200 | 190 | 57 | 89 | 112 | 147 | 166 | — | — |
| 6 | 8 | 200 | 188 | 61 | 91 | 123 | 150 | 173 | 200 | — |
| 7 | 15 | 213 | 199 | 58 | 93 | 122 | 148 | 172 | 189 | 213 |
| | 279 | — | — | 63 | 96 | 125 | 155 | 179 | 195 | 213 |

Perch (*Perca fluviatilis*) growth was studied during 1975—1979 in the pond "Hamerský" using 145 specimens in 8 age classes, in the reservoir "Horecká nádrž" (279 specimens in 7 age classes) and in 4 specimens originating from the pond "Pustý rybník" in 2—5 age classes (Tab. 4—8). The weight

Table 6. Growth of the perch burnt to ashes for radiochemical analyses from the pond "Pustý"

| Age group | n | Lc | W | l ₁ | l ₂ | l ₃ | l ₄ | l ₅ | l ₆ |
|-------------|---|-----|-----|----------------|----------------|----------------|----------------|----------------|----------------|
| 13. 6. 1974 | | | | | | | | | |
| 2 | 1 | 101 | — | 57 | 97 | — | — | — | — |
| 28. 3. 1978 | | | | | | | | | |
| 3 | 1 | 125 | 41 | 67 | 102 | 125 | — | — | — |
| 4 | 1 | 125 | 39 | 60 | 92 | 108 | 125 | — | — |
| 5 | 1 | 190 | 135 | 60 | 85 | 139 | 164 | 185 | 190 |
| | 3 | — | — | 62 | 93 | 124 | 145 | 185 | 190 |

growth was evaluated again by summarizing the weight increments of 2—6 age classes and reached the following values: pond "Hamerský" 145 g, reservoir "Horecká nádrž" 141 g, pond "Pustý" cca 140 g (small number of specim-

Table 7. Growth of the perch burnt to ashes for radiochemical analysis from the pond "Hamerský rybník" in 1974—1978

| Age group | n | lc | w | l ₁ | l ₂ | l ₃ | l ₄ | l ₅ | l ₆ | l ₇ | l ₈ |
|-------------|-----|-----|-----|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|
| 0+ | 191 | 61 | — | — | — | — | — | — | — | — | — |
| 1+ | 100 | 88 | 14 | 51 | — | — | — | — | — | — | — |
| 4+ | 2 | 185 | — | 57 | 104 | 140 | 163 | — | — | — | — |
| 5+ | 1 | 217 | — | 93 | 128 | 160 | 180 | 201 | — | — | — |
| 6+ | 2 | 229 | — | 55 | 96 | 123 | 149 | 179 | 203 | — | — |
| 8+ | 2 | 253 | 346 | 54 | 88 | 113 | 138 | 166 | 187 | 210 | 234 |
| 2+ up to 6+ | 10 | — | — | 57 | 100 | 134 | 156 | 185 | 203 | — | — |

ens). In the perch from other localities the growth evaluated by means of the same method was as follows: valley water reservoir "Kličava", average from years 1963—1972; 94 g, riverine lake Lipno, average 1965—1968; 55 g, pond "Máchovo jezero": 175 g, pond "Velký Tisý": 204 g, riverine lake "Oravská nádrž", 3 years after water filling: 174 g, pond "Vyžlovský", near Jevany, central Bohemia: 167 g, reservoir "Mšeno": 45 g (Švátora 1974 and further not yet published data).

Table 8. Growth of the perch burnt to ashes for radiochemical analysis from the reservoir "Horka" in 1975—1980

| Age group | n | lc | w | l ₁ | l ₂ | l ₃ | l ₄ | l ₅ | l ₆ |
|-------------|----|-----|-----|----------------|----------------|----------------|----------------|----------------|----------------|
| 3 | 34 | 110 | 30 | 54 | 92 | 110 | — | — | — |
| 4 | 4 | 185 | 160 | 61 | 101 | 137 | 164 | — | — |
| 6 | 6 | 209 | 225 | 60 | 104 | 132 | 164 | 192 | 211 |
| 6+ | 2 | 215 | — | 85 | 115 | 136 | 161 | 183 | 201 |
| 1+ up to 3+ | 60 | — | — | 63 | 90 | 109 | — | — | — |
| 1+ up to 4+ | 41 | — | — | 58 | 87 | 111 | 141*) | — | — |
| 1+ up to 4+ | 21 | — | — | 71 | 116 | 150 | 180**) | — | — |

*) Growth was gradually faster with regard to the decrease of carp stock, date Nov. 3, 1976
 **) date Nov. 7, 1979

From comparing the above cited localities it can be concluded that the growth of the perch in the reservoirs "Hamerský", "Horka" and "Pustý"

Table 9. Growth of the carp in the pond "Hamerský rybník" in 1977—1978

| Age group | n | lc | w | l ₁ | l ₂ | l ₃ |
|-----------|----|----|---|----------------|----------------|----------------|
| 2+ | 38 | — | — | 76 | 210 | — |
| 3+ | 4 | — | — | 71 | 195 | 375 |
| | 42 | — | — | 75 | 209 | 375 |

Table 10. Growth of the carp burnt to ashes for radiochemical analysis from the reservoir "Horka" in years 1975—1979

| Age group | n | lc | w | l ₁ | l ₂ |
|-----------|----|-----|-----|----------------|----------------|
| 1+ | 3 | 268 | 810 | 79 | — |
| 2 | 6 | 208 | 363 | 61 | 208 |
| 2+ | 6 | 272 | 953 | 80 | 141 |
| | 15 | — | — | 73 | 174 |

is very good and similar to the growth tempo found in the ponds, but does not reach the maximum values found in this fish species. The values of accumulated ²²⁶Ra, U nat. and the total beta activity are only average. After six months exposition of the perch kept in cages in the pond "Pustý", a 1,000-fold increase of ²²⁶Ra concentration, a 50-fold increase of uranium and about a 100-fold increase of the total beta activity were reported. However, these were dead individuals (skeletons) and the values presented were on the level of the concentration of natural radionuclides in bottom sediments.

Table 11. Growth of the pike burnt to ashes for radiochemical analysis from the pond "Hamerský rybník" in 1977—1978

| Age group | n | lc | w | l ₁ | l ₂ |
|-----------|---|-----|-----|----------------|----------------|
| 0+ | 2 | 195 | 80 | — | — |
| 1+ | 2 | 368 | 511 | 225 | — |
| 2+ | 2 | 325 | 365 | 185 | 208 |
| | 6 | — | — | 205 | 208 |

Carp (*Cyprinus carpio*) growth is important, because the carp is the main fish species of both large reservoirs. Its growth tempo was close to the values found in the backwaters of the inundation area of the Labe in central Bohemia, or in the "Slapy" riverine lake (Oliva 1955, Čihař 1961). In subsequent years no radical differences were found. The growth of the first age group

Table 12. Growth of the pike burnt to ashes for radiochemical analysis from the reservoir "Horka" in 1975—1979

| Age group | n | lc | w | l ₁ | l ₂ |
|-----------|---|-----|-----|----------------|----------------|
| 0+ | 2 | 205 | 95 | — | — |
| 1+ | 2 | 435 | 750 | 219 | — |
| 2+ | 2 | 330 | 343 | 185 | 290 |
| | 6 | — | — | 202 | 290 |

Table 13. Growth of the tench in the pond "Hamerský rybník" in 1977—1978

| Age group | n | lc | w | l ₁ | l ₂ | l ₃ | l ₄ | l ₅ |
|-----------|----|-----|-----|----------------|----------------|----------------|----------------|----------------|
| 1+ | 1 | 110 | -- | 72 | — | — | — | — |
| 2+ | 8 | 161 | — | 68 | 110 | — | — | — |
| 3+ | 9 | 205 | — | 76 | 108 | 149 | — | — |
| 4+ | 5 | 219 | — | 76 | 118 | 156 | 191 | — |
| 5+ | 1 | 215 | 270 | 68 | 90 | 127 | 141 | 192 |
| | 24 | — | — | 72 | 107 | 144 | 166 | 192 |

is probably influenced by the origin of stocked fish. The growth of the carp in the pond "Hamerský" is very similar to the growth found in the reservoir "Horecká nádrž", and also in subsequent years the carp here did not, apparently, accelerate its growth (Tab. 9, 10). This resembles the carp growth in open waters and not in artificial pond. The slow growth tempo of the carp in both large reservoirs is in contrast with the very fast growth tempo found in the roach and in the perch, and can be explained only by the slowly growing stock of the carp. Carp was also kept in wire cages in the pond "Ještědský"

Table 14. Growth of the tench burnt to ashes for radiochemical analysis from the pond "Hamerský rybník" in 1977—1978

| Age group | n | lc | w | l ₁ | l ₂ | l ₃ | l ₄ | l ₅ | l ₆ |
|-----------|---|-----|------|----------------|----------------|----------------|----------------|----------------|----------------|
| 3+ | 1 | 280 | 710 | 56 | 125 | 205 | — | — | — |
| 5+ | 3 | 250 | 1349 | 64 | 101 | 174 | 200 | 233 | — |
| 6+ | 1 | 280 | — | 68 | 135 | 175 | 221 | 259 | 267 |
| | 5 | — | — | 63 | 120 | 185 | 210 | 246 | 267 |

(first and second age classes) within the period of 6 and 12 months. According to our presumption the faster growth (1st age group, $G = 1.25$) is shown by the ten times larger concentration of ^{226}Ra and the total beta activity and the four times larger elevation of natural uranium, the slower growth tempo (second age class, $G = 0.33$) by the only six times larger concentration of

Table 15. Growth of the tench burnt to ashes for radiochemical analysis from the reservoir "Horka" in 1978

| Age group | n | lc | w | l ₁ | l ₂ | l ₃ | l ₄ | l ₅ |
|-----------|---|-----|-----|----------------|----------------|----------------|----------------|----------------|
| 4+ | 1 | 230 | 350 | 59 | 103 | 148 | 198 | — |
| 5+ | 2 | 238 | 375 | 55 | 91 | 143 | 173 | 216 |
| | 3 | — | — | 57 | 97 | 145 | 185 | 216 |

Table 16. Radiochemical analyses of the main fish species from the reservoir "Horka" and the pond "Hamerský rybník" in 1974—1980

| Species Locality | ^{226}Ra | | Uran. nat. | | Total beta activity corr. to ^{40}K | |
|---|---------------------------------------|--------|---------------------------------------|--------|---|--------|
| | Bq · g ⁻¹ dry subst. | ash. | μg · g ⁻¹ dry subst. | ash. | Bq · g ⁻¹ dry subst. | ash. |
| roach Horka | 0.043 | 0.16 | 0.97 | 2.47 | 0.30 | 1.11 |
| | ± 0.017 | ± 0.06 | ± 0.45 | ± 1.25 | ± 0.15 | ± 0.28 |
| roach Hamerský rybník | 0.024 | 0.12 | 0.54 | 4.20 | 0.15 | 1.71 |
| perch Horka | 0.025 | 0.08 | 0.96 | 4.21 | 0.32 | 1.21 |
| | ± 0.024 | ± 0.07 | ± 0.20 | ± 2.06 | ± 0.11 | ± 0.23 |
| perch Hamerský rybník | 0.026 | 0.15 | 0.92 | 4.80 | 0.12 | 0.65 |
| pike Horka | 0.020 | 0.09 | 0.61 | 4.30 | 0.21 | 1.72 |
| pike Hamerský rybník | 0.005 | 0.03 | 0.08 | 0.30 | 0.35 | 1.74 |
| carp Horka | 0.035 | 0.29 | 0.83 | 8.20 | 0.15 | 1.28 |
| carp Hamerský rybník | 0.020 | 0.11 | 0.55 | 3.00 | 0.13 | 1.10 |
| tench Horka | 0.047 | 0.40 | 0.63 | 5.12 | 0.36 | 1.66 |
| tench Hamerský rybník | 0.010 | 0.06 | 0.86 | 5.39 | 0.21 | 1.73 |
| grand average Horka | 0.034 | 0.20 | 0.80 | 4.86 | 0.27 | 1.39 |
| grand average Hamerský rybník | 0.017 | 0.09 | 0.59 | 3.54 | 0.19 | 1.39 |
| whitefish Horka | 0.005 | 0.04 | 0.14 | 1.00 | 0.13 | 0.93 |
| crucian carp Horka | 0.070 | 0.20 | 1.10 | 3.00 | 0.52 | 1.42 |
| brown trout | 0.020 | 0.23 | 2.40 | 31.10 | 0.31 | 3.96 |
| Radiochemical analyses of eggs — grand ave — roach, pike, perch, carp | | | | | | |
| Horka | 0.027 | 0.35 | 0.81 | 9.30 | 0.15 | 1.31 |
| | ± 0.014 | ± 0.22 | ± 0.41 | ± 4.50 | ± 0.12 | ± 0.33 |
| Hamerský rybník | 0.008 | 0.09 | 0.28 | 3.90 | 0.16 | 1.22 |
| Radiochemical analyses of the muscles — carp, tench | | | | | | |
| Horka | 0.046 | 0.61 | 0.88 | 12.00 | 0.18 | 2.49 |
| Hamerský rybník | 0.004 | 0.06 | 0.17 | 2.37 | 0.17 | 2.06 |
| Radiochemical analyses of the bowels | | | | | | |
| Horka | | | | | | |
| pike | 0.005 | 0.08 | 0.57 | 8.50 | 0.18 | 2.96 |
| tench | 0.007 | 0.36 | 0.90 | 5.80 | 0.14 | 2.10 |
| carp | 0.016 | 0.03 | 0.71 | 10.00 | 0.09 | 1.44 |
| Hamerský rybník | | | | | | |
| pike | 0.004 | 0.06 | 0.02 | 0.20 | 0.14 | 2.30 |
| carp | 0.013 | 0.15 | 0.38 | 5.44 | 0.14 | 1.71 |

^{226}Ra and the total beta activity and the four times larger elevation of natural uranium concentration.

Pike (*Esox lucius*) growth shows great ranges in its tempo, because the pike is a typical stationary fish species, waiting for its prey (Tab. 11, 12). Therefore even pikes from the same reservoirs show very conspicuous differences (up to 100 percent) in their length growth. The growth of the pike in the first year of life is close to that in the valley water reservoir "Kličava" (Holčík 1970). For the second year only limited data were obtained. Pikes were gathered in autumn, and in this species also during winter months it is necessary to calculate with some increments. The growth values from the 2nd year of the life resemble the life condition of the pike in the lower part of the river Berounka (Tandon and Oliva 1978) or in the back waters of the river Labe near Čelákovice, central Bohemia (Oliva 1956).

The tench (*Tinca tinca*) growth, similarly as in the carp, shows large ranges (Tab. 13–15). It resembles the growth of the tench in the valley water reservoir "Klíčava" (Holčík 1970), but it is worse than the growth of the tench in the riverine lake "Lipno" (V ostrádovský 1965).

Table 17. Radiochemical analyses of the main fish species from the pond "Ještědský rybník"

| Species Locality | ^{226}Ra | | Uran nat. | | Total beta activity corr. to ^{40}K | |
|--|---------------------------------------|------|---------------------------------------|------|---|------|
| | Bq · g ⁻¹ dry subst. | ash. | μg · g ⁻¹ dry subst. | ash. | Bq · g ⁻¹ dry subst. | ash. |
| Sept. 12, 1979, start, carp, 2 sp., 330 g, from Doksy | 0.011 | 0.36 | 0.1 | 3.24 | 0.09 | 2.92 |
| after 12 months exposition, pond Ještědský, 230 g, Oct. 6, 1980 | 0.07 | 0.42 | 0.4 | 2.40 | 0.55 | 3.29 |
| Apr. 30, 1980, start, carp 30 sp., 430 g, from Doksy | 0.009 | 0.31 | 0.1 | 3.47 | 0.06 | 2.08 |
| after 6 months exposition carp, 5 sp., 250 g, pond Ještědský, Oct. 6, 1980 | 0.1 | 0.64 | 0.4 | 2.57 | 0.62 | 4.01 |

Growth of the crucian carp (*Carassius carassius*), 4 specimens, reservoir "Horecká nádrž", Oct. 27, 1978 ($l_1 = 46$, $l_2 = 93$, $l_3 = 116$, $l_4 = 136$ mm, average values) is, according to our presumption, substantially faster as compared with the growth in stagnant natural ponds in eastern Slovakia or in similar localities near Čelákovice, central Bohemia (Čihař 1957, Oliva and Hruška 1955). Similarly as in the reservoir "Horecká nádrž" the crucian carp grows in the so-called "ping" Modlany near the town of Teplice in northern Bohemia (depression filled secondarily by water after closing up surface mining), see Oliva et al. (1979), or in the pond "Jaroměřický" (Libosvářský 1963).

The growth of the whitefish (*Coregonus lavaretus maraena*), captured Oct. 2, 1975, in the reservoir "Horecká nádrž", showed the following values: $l_1 = 98$ mm, at the end of the second growing season 243 mm. Unfortunately only 2 specimens were at our disposal. Their growth was similar to the growth of this species in Lake Wzdzydze (Zawisza 1961), but it was remarkably slower than in the riverine lake "Jesenická nádrž" (V ostrádovská 1966) or in the Polish natural lake Goldopiwo (Gasowska 1953). The concentration of ^{226}Ra , uranium and the total beta activity, under the assumption that this species is planktonophagous, was the lowest of all the species studied.

Besides the above mentioned species, some other species were found on the territory under research, mainly the brook lamprey (*Lampetra planeri*) and the gudgeon (*Gobio gobio*), which were not used for radiochemical analyses due to their low number, and the brown trout (*Salmo trutta m. fario*), which was burnt to ashes.

The growth of 3 trouts from the effluent of the reservoir "Horecká nádrž", average length 200 mm, 2nd age class, weight unknown, was as follows: $l_1 =$

= 85, $l_2 = 169$ mm. It resembles the growth in the brook "Kličava" or in the brook "Lánský", but it was worse than in the riverine lake "Kličava" (Frank 1959, Holčík 1970) and faster than in the river Morávka (Frank 1962).

Table 18. Radiochemical analyses of the perch from the pond "Pustý"

| Species Locality | ^{226}Ra | | Uran nat. | | ^{40}K | | Total beta ac- tivity corr. to ^{40}K | |
|--|--|-------|--|------|--|------|--|-------|
| | $\text{Bq} \cdot \text{g}^{-1}$ dry subst. | ash. | $\mu\text{g} \cdot \text{g}^{-1}$ dry subst. | ash. | $\text{Bq} \cdot \text{g}^{-1}$ dry subst. | ash. | $\text{Bq} \cdot \text{g}^{-1}$ dry subst. | ash. |
| June 13, 1974 perch | 0.09 | 0.59 | 1.36 | 10.0 | 0.22 | 1.59 | 0.34 | 2.48 |
| March 28, 1978 perch 215 g | 0.32 | 0.82 | 21.0 | 8.2 | 0.32 | 0.82 | 1.51 | 1.88 |
| Oct. 6, 1980 Rests of the perch and the carp, after half a year exposition 120 g | 136.0 | 186.0 | 44.0 | 60.0 | — | — | 373.0 | 505.0 |

DISCUSSION

It was shown that the growth tempo of all fish species, was influenced mainly by the type of water body, i. e. by its trophic base, which again depends considerably on the quantity of the fish stock and the length of the vegetation period. No influence of the increased content of radionuclides and other chemicals present in discharged purified sewage effluents from the mining of uranium ore was ascertained. Very interesting are anglers' records for the river Ploučnice (rod angling) in the angling district of Stráž pod Ralskem, where the decrease in number and biomass of fishes captured before and after the beginning of mining is remarkable. In 1959, 1,456 specimens weighing 866 kg were angled, but in the years 1976 and 1977, in the same part of the river, only 815 and 565 specimens, respectively, weighing 404 and 219 kg, were captured. A similar decrease of the abundance and biomass was ascertained using electrofishing in the brook "Ještědský potok" in 1970 and 1974 (Lusk and Justýn 1976, Justýn 1980). During 1970, about 2,956 specimens of fishes of 8 species weighing $226.9 \text{ kg} \cdot \text{ha}^{-1}$ were found, but 4 years later only 1,248 fishes of 6 species, weighing $88 \text{ kg} \cdot \text{ha}^{-1}$. Thus it can be said that both streams, having a small flow and influenced by pollutants, are more contaminated than the pond "Hamerský", which is situated outside the mining area, or the reservoir "Horecká nádrž", where a diversion ditch for the purified pollutants has been constructed. Generally, it can be stated that the fish living in the same locality at the bottom (tench, carp, crucian carp) accumulate up to ten times more natural radionuclides examined than the species living in the water column (whitefish). Similarly, in the fish species in which the extraordinarily fast growth rate (roach) was found in the same locality,

the tendency leading to the increased accumulation of natural radionuclides becomes evident.

In rapidly growing fish, it must be taken into account that the concentration of natural radionuclides could increase in certain localities as compared with the localities with the same concentration of natural radionuclides, but with more slowly growing fish populations. A dependence between the rapidity of the growth and metabolic intensity is presumed (Pečkurenkov 1981). The evident increase of concentration of radionuclides in relation to the growth tempo was found in carp kept in cages (see above).

When examining the accumulation, we devoted attention primarily to ^{226}Ra and natural uranium, which are the most significant contaminants of the river Ploučnice watershed. Justýn et al. (1979) give the values of the ^{226}Ra concentration in fish from 0.004 to 0.012 $\text{Bq} \cdot \text{g}^{-1}$ dry weight in 1966, i. e., before launching the uranium industry in the area studied.

According to the paper quoted the total content of uranium in fish from the river Ploučnice in 1966, prior to concentration, was $0.04 - 1 \cdot \mu\text{g} \cdot \text{U} \cdot \text{g}^{-1}$ of dry weight. Analogous concentration of radium and uranium were found also in the years 1970–1975 in fish caught in the river Ploučnice near the village of Osečná above the discharge of the uranium ore mining.

According to our findings in 1974–1980 the radium content in fish from the "Hamerský" pond was moving on the average above the values of the given natural background (Tab. 16), the values of the radium concentration under the level of the natural background were found in the pike and the tench. As regards uranium, the values measured were again on the level of the natural background in all cases.

According to the data for the Czechoslovak Uranium Industry, the "Hamerský" pond is not directly contaminated by the uranium ore mining effluents, nevertheless slighter contamination of the reservoir cannot be completely excluded.

In the years 1974–1980, the radium concentration in fish in the "Horka" reservoir was above the level of the natural background in most cases and was expressed in hundredths $\text{Bq} \cdot \text{g}^{-1}$ dry weight (two- or threefold values of the natural background on the average). The values of the uranium concentration in the "Horka" reservoir were generally on the level of the natural background. However, these values must be considered from the point of view of their high variability ($\text{CV} = 50 - 100\%$). The above mentioned increase of the ^{226}Ra content that was observed in fish from the "Horka" reservoir is the natural consequence of the leakage of the cenoman rock uranium mining effluents with the increased content mainly of this radionuclide into the reservoir during the breakdowns in the years 1969–1972.

In the reservoir "Horecká nádrž" radium is concentrated chiefly in bottom sediments. Its contents decreases continually and in the future a gradual decrease practically to the level of natural background can be expected. In some fishes (pike, roach, perch, carp) eggs were burnt to ashes separately.

The overall average concentration of natural radionuclides in the "Horka" reservoir was above the level of the natural background (^{226}Ra), that of uranium under the level of the natural background. In the pond "Hamerský" both values were under the level of the natural background. The highest ascertained average concentration of natural radionuclides was found in the muscula-

ture of the carp and the tench from the "Horka" reservoir (^{226}Ra 0,046), the uranium concentration was closely under the level of the natural background.

The level of the concentration of natural radionuclides in bowels (pike, carp, tench) was moving under the level of the natural background in all cases.

In a further study we concentrated on the cage culture of fish. Selected uncontaminated carps and perches were kept for a certain time in cages in the "Pustý" sedimentation pond and in the mine-waters pond near the Ještědský brook, which serve as provisional final treatment units of uranium ore mining effluents.

As it is evident from the Table 17, in carps kept in the pond "Ještědský" we noted, after 6–12 months, up to 10 times larger increment of concentration of ^{226}Ra (from 0.009 up to 0.1 $\text{Bq} \cdot \text{g}^{-1}$ in the first, and from 0.011 up to 0.07 in the second case). In our experiments the uranium content in fishes ranged below the level of the natural background. This was a coincidence with the uranium content in the water of this pond. On the contrary, in the fishes of the pond "Pustý rybník" we have measured, in 1980, relative by high concentrations of ^{226}Ra (136 $\text{Bq} \cdot \text{g}^{-1}$ dry weight) and uranium (44 $\mu\text{g} \cdot \text{g}^{-1}$ dry weight). In fishes caught in the pond "Pustý rybník" in the years 1974 and 1978 we noted the uranium and radium concentration above the level of the natural background (^{226}Ra , 0.32 $\text{Bq} \cdot \text{g}^{-1}$ in dry substance, uranium 21 $\mu\text{g} \cdot \text{g}^{-1}$ of the dried fish). During the cage experiments in the year 1980 we were able to analyse only dead fishes, which died during our experiments. On their bodies sediments were found. In their bodies radium and uranium corresponded approximately to concentrations of both in surrounding bottom sediments (^{226}Ra 136 $\text{Bq} \cdot \text{g}^{-1}$ dried weight and uranium 44.0 $\mu\text{g} \cdot \text{g}^{-1}$ dried weight, Tab. 18).

Generally it can be said that fishes accumulate radionuclides (radium and uranium) more slowly than other aquatic organisms (e. g. water plants) and also less intensively. In higher plants, radium in the rank of tenths of Bq, and uranium in units of μg are present, which represents values 10 times higher than in fishes.

Our results show that fish can be used as bioindicators of the natural radioactive contamination, though they are less suitable than, e. g., plants. In comparison with plants the migration of fish appears to be a disadvantage (individual different habitat, changes of habitat even during seasons, etc.).

SUMMARY

In radiochemical analyses of fish carried out since 1974 in the localities of the "Hamerský" pond, reservoir "Horka", "Pustý" pond, "Ještědský" pond and the river Ploučnice under the village Osečná, 669 fish were burnt to ashes (480 specimens of the perch, 109 roach, 8 tench, 2 whitefish, 4 crucian carp, 12 pike, 53 carp and 1 trout) in the total number of 94 analyses. The values of ^{226}Ra and uranium concentrations in the "Hamerský" pond coincided with rare exceptions, with the level of the natural background. In the "Horka" reservoir the uranium concentration in fish was also practically on the level of the natural background, but the radium content was generally above the level of the natural background. This is the consequence of the leakage of the cenoman rock uranium mining radioactive effluents into the reservoir in past years. The evaluation is complicated by high values of the variability

coefficient moving in the range of 50–100%. However, in controlled breeding of selected carp and perch in provisional final treatment units of uranium ore mining effluents we found 4–10 fold increase of the radium and uranium concentration in fish after 6–12 months as compared with the initial values found in fish at the beginning of the experiment. It has appeared that in all species of the fish studied the level of contamination is connected with the feeding biology (higher concentration in benthofages than in planktonphages) and with the growth rate. Generally, it can be said that when compared with e. g., plants, fish accumulate the natural radionuclides studied about ten times slower, hence they are less applicable as bioindicators of radioactive contamination. It can be concluded from our results and literature data (Justýn and Lusk 1976) that at present time there is no danger on the territory of our republic of the values of radium ingestion exceeding the limit harmful for man. However, the amount of ^{226}Ra and uranium that a man may absorb in consuming contaminated fish from the Ploučnice watershed is — in spite of a small share of fish in man's overall nutrition — principally determinable.

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**TAXONOMIC
NOTE ON AFRICAN KNIFEFISH, *XENOMYSTUS NIGRI* (PISCES:NOTOPTERIDAE)**

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Abstract. Boulenger's original description of the African Knife Fish, *Xenomystus nigri* are enhanced by the examination of selected characters for two specimens obtained from aquarists.

Several years ago also the Czech aquarium hobbyists got familiar with the African knifefish, *Xenomystus nigri* (Günther, 1868). Later they supplied the Department of Systematic Zoology with 2 specimens, which died in their tanks. Due to the scarcity of this fish here I believe it could be useful to present a short description of both specimens. Unfortunately, there is a total lack of published informations concerning observations on living specimens in aquaria. Walker 1965 recommended the fish as the most suitable representative of Notopteridae for home aquaria, because it is not aggressive and can be even kept with fishes smaller than itself, is easily fed and lives long (see also Sterba 1959, who registered the first import into Europe in 1909, but the fish disappeared again). There are also no reports about the spawning in captivity.

In two examined specimens total length was 123 and 133 mm, body length 119 and 129 mm. In % of total length: head length 15 (13–16, summarized Boulenger's data 1901, 1909), body depth 20–21 (20–23), eye diameter 27 (27–33 according to Boulenger, l. c.) of the head length. The length of the snout is 75–87 % of the eye diameter, the diameter of the eye represents 81–93 % of the interorbital distance. Boulenger, 1901 found both distances to be the same. Apparently due to the shrinkage in formalin solution the nasal tentacles are shorter, measuring about one third of the eye diameter or less, Boulenger 1901 reported larger values (60–76 % of the eye diameter). In % of the head length: the postorbital distance 52–56, head depth 85–88, head width 56–57; in % of the total length: preanal distance 38–42, P–A distance 10–12, length of anal 80–84. The P length is equal to 62–75 % of the head length and pectorals were found clearly shorter than the head, and not shorter or longer as stated Boulenger 1909. Ventrals are rudimentary, there are 29–30 serrated spines along the median line of the belly (Boulenger 26–30). 112 and 123 rays were found in the anal fin. The number of minute scales could not be ascertained precisely, according to Boulenger 1901, 120–140 scales along the lateral line can be found.

The fish has broad distribution throughout Africa north of the equator. Some localities are enumerated by Boulenger 1901 and 1909.

The author wishes to thank Dr O. Oliva for suggesting him study this fish species.

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**DIE ERFORSCHUNG DES ZOOBENTHOS AUF DEM BEISPIEL EINES
KLEINEN BACHES**

Zdeněk KONEČNÝ, Otakar ŠTÉRBA

Eingegangen am 4. Februar 1985

Abstract. The macrozoobenthos of a little brook with a varied character of its bed (stones, gravel, sand, detritus, moss, leaves) was investigated. Affinity between benthos and the respective microbiotopes was found. The relative occurrence of the microbiotopes in a 300-metre stretch of the brook was recorded. According to the occurrence figures and to the affinity of benthos to the bed the abundance and biomass of macrozoobenthos in the investigated stretch of the brook was calculated. The results of the calculation differ considerably from the values found in benthos samples.

EINLEITUNG

Im Jahre 1981 und 1982 haben wir eine detaillierte Erforschung des Makrozoobenthos eines kleinen Untergebirgsbaches, dessen Grund aus buntem Material besteht. Wir haben dabei die Abhängigkeit des Benthos an einzelnen Mikrobiotopen verfolgt, die den Organismen verschiedene Möglichkeiten für ihre Fixation zum Substrat anbieten sowie ein unterschiedliches Nahrungsangebot bedeuten.

DIE CHARAKTERISTIK DES BACHES

Der verfolgte Bach fließt von dem Rychleby-Gebirge im Norden von Mähren. Er entspringt in den Nadelwäldern in der Seehöhe um 650 m, durchfließt die Areale des gemischten Waldes und im Abschnitt, wo die verfolgten Lokalitäten waren (Seehöhe 310 m), fließt er in die Bodenkulturlandschaft (7 km nördlich vom Städtchen Javorník). Die Breite des Baches ist von 80 bis 200 cm, den Durchschnittsdurchfluss schätzen wir auf 40 l. Sec.⁻¹, in den Trockenperioden ist sein Durchfluss minimal. Im Bach leben kleine Forellen (*Salmo trutta m. fario*), andere Fischarten wurden nicht beobachtet. Das Flussbett ist natürlich, an den Ufern wachsen Laubbäume, überwiegend Erlen. Am Bach ist keine Verunreinigungsquelle. Im Bach haben wir 6 verschiedene Typen des Grundes unterschieden, die wir als Mikrobiotope bezeichnen: 1) „Steine“ — alle Steine grösser als 50 mm, 2) „Geröll“ — Körner von 50 bis 2 mm, 3) „Sand“ — Körner unter 2 mm, 4) „Detritus“, 5) „Laub“ — Anhäufungen von abgefallenen Blättern und kleinen Ästen, 6) „Moos“ — Anwachsungen von Moos an grösseren Steinen (diese Fläche ist ausser der gesamten Fläche des Grundes, der aus den Teilflächen ad 1–5 besteht, gezählt).

DIE METHODIK DER ENTNAHME DES BENTHOS

Auf dem verfolgten Abschnitt des Baches wurde immer eine Stelle ausgesucht, wo die Breite des Baches ungefähr 100 cm erreicht. Diese Stelle haben wir mit 5 Brettern (deren Unterkante mit Blech beschlagen ist), abgegrenzt. Zwei untere Bretter (in Stromrichtung) waren in den Grund komisch eingesetzt und zwischen ihnen war eine Spalte, durch die das Wasser durchfliesst. In diese Lücke wurde das Netz eingesetzt, das die mitgerissenen Organismen einfängt, die sich bei der weiteren Arbeit auslösen. Den grossten Teil des Wassers im Bach versuchten wir entlang einer Abgrenzung aus Brettern, deren Fläche ungefähr 1 m² zählte, abzuführen. Diese abgegrenzte Fläche haben wir genau aufgezeichnet, indem wir auf den Millimeterpapier die einzelnen Mikrobiotope übertragen haben und aus der Zeichnung später ihre Flächen festgestellt haben. Dann haben wir angefangen den Benthos in der Reihenfolge Laub, Moos, Detritus, Sand, Geröll, Steine abzunehmen. Am Ende haben wir mit einem groben Besen die Organismen, die noch im abgegrenzten Raum blieben, zusammengehauft, zusammen mit den Organismen, die im Netz an der Unterseite der Wand eingefangen wurden; so entstand die Letzte Probe, die als "Rest" bezeichnet war.

Taf. I. Zahl der Organismen auf 1 m², \varnothing aus 11 entnommenen Proben

| Mikrobiotop Fläche in % | Steine 58,1 | Geröll 27,2 | Sand 7,0 | Detritus 6,0 | Moos 3,9 | Laub 1,7 | „Rest“ — | Gesamtzahl 100,0 |
|----------------------------|----------------|----------------|-------------|-----------------|-------------|-------------|-------------|---------------------|
| „Vermes“ | 31,5 | 22,1 | 12,7 | 7,8 | 21,9 | 10,0 | 14,3 | 120,4 |
| | 1,5 | 1,1 | 0,6 | 0,4 | 1,0 | 0,4 | 0,7 | 5,8 |
| Crustacea | 71,4 | 45,6 | 29,1 | 35,6 | 46,7 | 9,8 | 35,0 | 273,1 |
| % | 3,4 | 2,2 | 1,4 | 1,7 | 2,2 | 0,5 | 1,7 | 13,0 |
| Ephemeroptera | 91,1 | 78,4 | 26,8 | 23,0 | 10,1 | 9,1 | 30,5 | 269,1 |
| % | 4,4 | 3,7 | 1,3 | 1,1 | 0,5 | 0,4 | 1,5 | 12,9 |
| Plecoptera | 83,5 | 68,9 | 43,2 | 22,1 | 38,7 | 43,7 | 31,8 | 331,9 |
| % | 4,0 | 3,3 | 2,1 | 1,1 | 1,8 | 2,1 | 1,5 | 15,6 |
| Coleoptera | 17,5 | 18,7 | 10,3 | 2,9 | 6,6 | 5,2 | 7,6 | 68,9 |
| % | 0,8 | 0,9 | 0,5 | 0,1 | 0,3 | 0,2 | 0,4 | 3,3 |
| Trichoptera | 59,1 | 33,3 | 20,7 | 20,4 | 13,5 | 13,9 | 7,6 | 168,6 |
| % | 2,8 | 1,6 | 1,0 | 1,0 | 0,6 | 0,7 | 0,4 | 8,1 |
| Diptera | 196,9 | 82,5 | 54,1 | 137,0 | 146,1 | 75,6 | 42,2 | 734,2 |
| % | 9,4 | 3,9 | 2,6 | 6,5 | 7,0 | 3,6 | 2,0 | 35,1 |
| Übrigen | 57,7 | 29,3 | 12,2 | 8,9 | 4,6 | 2,7 | 11,9 | 127,3 |
| % | 2,7 | 1,4 | 0,6 | 0,4 | 0,2 | 0,1 | 0,6 | 6,1 |
| Gesamtzahl | 608,7 | 378,9 | 209,1 | 257,7 | 288,2 | 170,0 | 180,9 | 2093,5 |
| % | 29,1 | 18,1 | 10,0 | 12,3 | 13,8 | 8,1 | 8,6 | 100,0 |

Vertreter des Benthos, die wir in ein grosses Planktonnetz einfingen, übertrugen wir quantitativ in Literflaschen und fixierten sie mit 4%-igen Formaldehyd. Die Organismen haben wir unter einer Binokularlupe im Laboratorium herausgenommen, sodass wir auch kleine Formen (Copepoda, Naididae ua.) erfasst haben.

Insgesamt wurden 11 Proben entnommen, deren Gesamtfläche 13,36 m² einnahm. Die Proben haben wir in diesen Tagen entnommen: 1981: 23., 26., 28. IV., 14., 15., 16. VII., 3., 21. X., 1982: 27. II., 11. IV., 5. VIII.

DIE VERTEILUNG DES BENTHOS

In dem erfassten Benthos wurden 26 403 Individuen festgestellt, die zu den 141 Taxonen gehören. Nach der Ermittlung der Durchschnittszahlen der Organismen und ihrer Biomasse haben wir alle 11 Proben auf 1 m² Fläche des Grundes umgerechnet (Taf. 1 und 2). Die Biomasse der gefundenen Organismen

Taf. 2. Biomasse der Organismen in mg auf 1 m², \varnothing aus 11 entnommenen Proben

| Mikrobiotop Fläche in % | Steine 58,1 | Geröll 27,2 | Sand 7,0 | Detritus 6,0 | Moos 3,9 | Laub 1,7 | „Rest“ — | Ges.-Gewicht 100,0 |
|----------------------------|----------------|----------------|-------------|-----------------|-------------|-------------|-------------|-----------------------|
| „Vermes“ % | 141 3,8 | 65 1,8 | 51 1,4 | 16 0,4 | 64 1,7 | 25 0,7 | 28 0,8 | 390 10,6 |
| Crustacea % | — | — | — | — | — | — | — | — |
| Ephemeroptera % | 116 3,2 | 63 1,7 | 27 0,7 | 20 0,5 | 7 0,2 | 17 0,5 | 34 0,9 | 284 7,7 |
| Plecoptera % | 154 4,2 | 122 3,3 | 46 1,3 | 36 1,0 | 42 1,1 | 75 2,0 | 45 1,2 | 520 14,2 |
| Coleoptera % | 21 0,6 | 17 0,5 | 10 0,3 | 4 0,1 | 6 0,2 | 3 0,1 | 7 0,2 | 88 1,9 |
| Trichoptera % | 949 25,9 | 250 6,8 | 118 3,2 | 135 3,7 | 66 1,8 | 69 1,9 | 48 1,3 | 1635 44,5 |
| Diptera % | 197 5,3 | 163 4,4 | 72 2,0 | 68 1,9 | 94 2,6 | 75 2,0 | 41 1,1 | 709 19,3 |
| Übrigen % | 38 1,0 | 15 0,4 | 3 0,1 | 5 0,1 | 1 0,02 | 1 0,02 | 3 0,1 | 65 1,8 |
| Ges.-Gewicht % | 1615 44,0 | 695 18,9 | 327 8,9 | 284 7,7 | 279 7,6 | 265 7,2 | 206 5,6 | 3671 100,0 |

men war nach der dreimonatigen Fixation nach einer Trocknung in der Zentrifuge nach Kubiček (1961) — bei 5 000 Umdrehungen/min. in der Zeit von 30 Sec. — gewonnen. Von den festgestellten Gruppen wurden Nematoda,

Taf. 3. Umrechnung des Benthos auf die Fläche von 1 m² von jedem Mikrobiotop („Koeffizient der Affinität“)

| Mikrobiotop — 1 m ² | Steine | Geröll | Sand | Detritus | Moos | Laub |
|--------------------------------|---------------|---------------|----------------|----------------|----------------|-----------------|
| Zahl der Org. % | 1047,7 3,9 | 1391,5 5,1 | 2991,4 11,0 | 4309,3 15,9 | 7389,6 27,1 | 10000,0 36,6 |
| Biomasse in mg % | 2780 7,4 | 2552 6,8 | 4678 12,5 | 4749 12,6 | 7213 19,2 | 15588 41,5 |

Taf. 4. Durchschnitts-Zahl der Organismen auf 1 m² im abgegrenzten Abschnitt des Baches von 300 m Länge

| Mikrobiotop Fläche in % | Steine 43,4 | Geröll 22,4 | Detritus 16,9 | Laub 10,6 | Sand 6,7 | Moos 3,8 | Gesamtzahl 100,0 |
|----------------------------|----------------|----------------|------------------|----------------|--------------|--------------|---------------------|
| „Vermes“ | 23,5 0,8 | 18,2 0,6 | 22,0 0,7 | 62,3 2,1 | 12,2 0,4 | 21,3 0,7 | 159,5 5,3 |
| Crustacea % | 53,3 1,8 | 37,6 1,2 | 100,6 3,3 | 61,1 2,0 | 27,9 0,9 | 45,5 1,5 | 326,0 10,1 |
| Ephemeroptera % | 68,1 2,2 | 65,5 2,1 | 65,0 2,1 | 56,7 1,9 | 25,7 0,8 | 9,8 0,3 | 289,8 9,5 |
| Plecoptera % | 62,4 2,1 | 56,7 1,9 | 62,5 2,1 | 272,6 9,0 | 41,4 1,4 | 37,7 1,2 | 533,2 17,6 |
| Coleoptera % | 13,1 0,4 | 15,4 0,5 | 8,2 0,3 | 32,4 1,1 | 9,9 0,3 | 6,4 0,2 | 85,4 2,8 |
| Trichoptera % | 44,1 1,5 | 27,5 0,9 | 57,6 1,9 | 86,7 2,9 | 19,8 0,7 | 13,2 0,4 | 248,9 8,2 |
| Diptera % | 147,1 4,8 | 67,9 2,2 | 387,2 12,8 | 471,4 15,5 | 51,9 1,7 | 142,4 4,7 | 1267,0 41,8 |
| Übrigen % | 43,1 1,4 | 24,1 0,8 | 25,1 0,8 | 16,8 0,6 | 11,7 0,4 | 4,5 0,1 | 125,3 4,1 |
| Gesamtzahl % | 454,7 15,0 | 311,9 10,3 | 728,2 24,0 | 1059,9 34,9 | 200,5 6,6 | 280,8 9,2 | 3036,0 100,0 |

Crustacea und Hydracarina nicht gewonnen, in der Gruppe „Andere“ sind Cnidaria, *Ancylus fluviatilis*, Sialidae und Osmylidae inbegriffen.

Die meisten Individuen des Zoobenthos wurden auf den Steinen (29,1^{0/0}) festgestellt, dann am Geröll (18,1^{0/0}), in dem Moos (13,8^{0/0}), im Detritus (12,3^{0/0}), im Sand (10,0^{0/0}), die kleinste Zahl im Laub (8,1^{0/0}). Bei der Biomasse war die Reihenfolge: Steine (44,0^{0/0}), Geröll (18,9^{0/0}), Sand (8,9^{0/0}), Detritus (7,7^{0/0}), Moos (7,6^{0/0}), Laub (7,2^{0/0}).

Diese Reihenfolgen werden jedoch mehr oder weniger durch die perzentuelle Vertretung der einzelnen Mikrobiotope an den erforschten Flächen der Proben bestimmt. Die war wie folgt: Steine 58,1^{0/0}, Geröll 27,2^{0/0}, Sand 7,0^{0/0}, Detritus 6,0^{0/0}, Moos 3,9^{0/0}, Laub 1,7^{0/0}. Wenn wir jedoch die Organismen auf die gleiche Fläche allen Mikrobiotope umrechnen (konkret auf die Fläche von 1 m²), so stellen wir fest, dass der Zoobenthos im Bach vor allem Laub aufsuchte (26,6^{0/0}), dann Moos (27,1^{0/0}), Detritus (15,7^{0/0}), Sand (10,9^{0/0}), Geröll (5,1^{0/0}) und am wenigsten grosse Steine (3,8^{0/0}). Die Afinität des Makrobenthos zu den einzelnen Mikrobiotopen ist also auf den erforschten Flächen gerade umgekehrt, als der Flächenumfang dieser Mikrobiotope, und sehr ähnliche Verhältnisse sehen wir auch bei der Biomasse des Benthos (Taf. 3).

Es zeigt sich, dass für eine glaubwürdige Beurteilung der Entfaltung des Zoobenthos in einem längeren Abschnitt des Baches unbedingt nötig ist die

Taf. 5. Durchschnittliche Biomasse auf 1 m² im abgegrenzten Abschnitt des Baches von 300 m Länge

| Mikrobiotop Fläche in % | Steine 43,4 | Geröll 22,4 | Detritus 16,9 | Laub 10,6 | Sand 6,7 | Moos 3,8 | Ges.-Gewicht 100,0 |
|----------------------------|----------------|----------------|------------------|----------------|--------------|--------------|-----------------------|
| „Vermes“ % | 105,5 2,2 | 53,5 1,1 | 45,3 0,9 | 155,8 3,2 | 48,9 1,0 | 62,9 1,3 | 471,9 9,8 |
| Crustacea % | — | — | — | — | — | — | — |
| Ephemeroptera % | 86,8 1,8 | 51,7 1,1 | 56,4 1,2 | 106,0 2,2 | 25,9 0,5 | 6,9 0,1 | 333,7 6,9 |
| Plecoptera % | 115,0 2,4 | 100,4 2,1 | 101,7 2,1 | 467,7 9,7 | 44,1 0,9 | 41,2 0,9 | 870,1 18,0 |
| Coleoptera % | 15,6 0,3 | 13,9 0,3 | 11,3 0,2 | 18,7 0,4 | 9,6 0,2 | 5,9 0,1 | 75,0 1,6 |
| Trichoptera % | 709,2 14,7 | 205,6 4,3 | 381,4 7,9 | 430,3 8,9 | 113,1 2,3 | 64,8 1,3 | 1904,4 39,5 |
| Diptera % | 146,3 3,0 | 134,2 2,8 | 192,2 4,0 | 467,7 9,7 | 69,0 1,4 | 92,3 1,9 | 1101,7 22,9 |
| Übrigen % | 28,2 0,6 | 12,3 0,3 | 14,2 0,3 | 6,3 0,1 | 2,9 0,1 | 0,2 + | 64,1 1,3 |
| Ges.-Gewicht % | 1206,6 25,0 | 571,6 11,9 | 802,5 16,6 | 1652,5 34,3 | 313,5 6,5 | 274,2 5,7 | 4820,9 100,0 |

Afinität der Organismen zu den einzelnen Typen des Grundes, sowie das wirkliche Ausmass dieser Mikrobiotopen festzustellen, denn durch die gewohnte mechanische Umrechnung der entnommenen Proben von Benthos auf die Fläche des Stromes begehen wir zwangsweise auch sehr grosse Fehler.

In unserem Fall haben wir zuerst die Afinität des Zoobenthos zu den einzelnen Mikrobiotopen festgestellt (Taf. 3) und zwar auf der Grundlage der Analysen von 11 entnommenen Flächenproben; dann haben wir detailliert 300 Längenmeter des Baches mappiert (insgesamt 460 m²), wo wir die folgende relative Vertretung der Mikrobiotope des Grundes festgestellt haben: Steine 43,4%, Geröll 22,4%, Detritus 16,9%, Laub 10,6%, Sand 6,7%, Moos 3,8%. Erst wenn wir zu diesem wirklichen Stand die Menge des Benthos nach seiner Afinität beziehen, dann nähern wir uns wahrscheinlich zu der wirklichen Entfaltung des Benthos in den erforschten 300 Längenmeter des Baches (Taf. 4 und 5). Überraschend stellen wir fest, dass in diesen 300 Metern des Baches die meisten Vertreter des Benthos im Laub (34,9%) leben, dann im Detritus (24,0%) und auch in anderen Mikrobiotopen bekommen wir erheblich unterschiedliche Resultate gegen den Zustand, den wir durch einfache Analyse der entnommenen Proben festgestellt haben.

(Im Laufe des Jahres kommt es zu bestimmten Veränderungen in der Vertretung einzelner Mikrobiotope. Diese Frage, sowie auch weitere Teilprobleme, sind jedoch der Gegenstand einer anderen Arbeit).

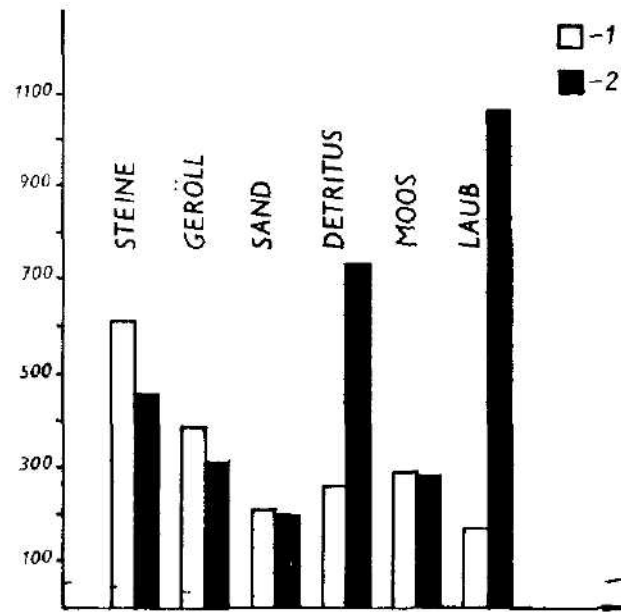


Abb. 1. Zahl der Organismen auf die Fläche von 1 m²; 1 = ∅ aus 11 Proben, 2 = ∅ im abgegrenzten Abschnitt des Baches von 300 m Länge.

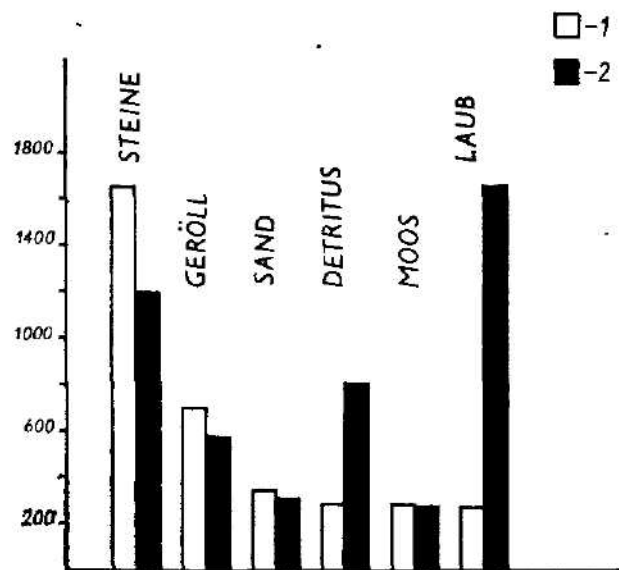


Abb. 2. Biomasse in mg auf 1 m² (siehe Abb. 1).

ZUSAMMENFASSUNG

- 1) Wir haben die Erforschung des Makrozoobenthos eines kleinen Baches, dessen Grund sehr bunt ist, durchgeführt.
- 2) Es wurde ein Abschnitt des Baches (300 m lang) mappiert, und es wurde hier eine zahlenmässige Vertretung aller Mikrobiotopen festgestellt.
- 3) Nach dieser Vertretung und nach der Afinität des Benthos zum Substrat wurde die Abundanz und die Biomasse des Benthos im Bach errechnet, mathematisch wie folgt:

S — Gesamtzahl der Organismen im abgegrenzten Flussabschnitt.

P_1, \dots, P_6 — Flächen der einzelnen Mikrobiotopen in m^2 (Steine — m_1 , Geröll — m_2, \dots , Laub — m_6).

a_1, \dots, a_6 — Koeffiziente der Afinität des Benthos zu den einzelnen Mikrobiotopen $m_1 \dots m_6$, a^i — Zahl der Organismen auf der Fläche von $1 m^2$ des Mikrobiotopes m_i ; $i = 1 \dots 6$

Dann gilt:

$$S = \sum_{i=1}^6 a_i \cdot P_i$$

- 4) Das Verhältniss zwischen dem Substrat und dem Benthos war schon mehrmals verfolgt (z. B. Thorup 1966, Ulfstrand 1967, Uzunov 1982), aber in der Methodik der Bestimmung der Menge des Benthos in einem grösseren Abschnitt des Stromes war diese Frage durchwegs unterschätzt. Unsere Ergebnisse zeigen, dass die Kenntnis der Afinität des Benthos zu den einzelnen Typen des Grundes und die Kenntnis des wirklichen Ausmasses dieser Typen des Grundes in dieser Richtung erstrangig sind.

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**COLUBER RUBRICEPS THRACIUS SSP. N. FROM BULGARIA
(REPTILIA: SQUAMATA: COLUBRIDAE)**

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Abstract. *Coluber rubriceps thracius* ssp. n. from Bulgaria is described on the basis of differences in its external morphology from the Asian specimens. Characteristic of the new subspecies are a relatively small number both of ventrals and subcaudals and a relatively shorter tail, in addition to other minute differences in a larger number of praeoculars and a smaller number of upper labials. As to sexual dimorphism, the tail of the male is relatively longer, and the number of ventrals smaller than in the female. A new faunistic record (Akhtopol) was added to its area of distribution so far known.

INTRODUCTION

Baran (1976) evaluated the form *Zamenis dahlia rubriceps* Venzmer, 1919, described from the Turkish Taurus (Bolkar Dagi), as the independent species *Coluber rubriceps* (Venzmer, 1919) in contrast to earlier authors (Mertens 1940, Bodenheimer 1944) who regarded it as a southern subspecies of the species *Coluber najadum* (Eichwald, 1831). Baran (1976) and Basoglu et Baran (1980) reported the incidence of *Coluber rubriceps* from Israel, the Kingdom of Jordan, the Lebanon, Syria and S-Turkey, NW-Anatolia (Savastepe Balikesir) and from the European side of the Bosphorus near Istanbul (Metris, Hadimköy). The incidence of *Coluber rubriceps* in Bulgaria was confirmed by the recovery of four specimens near the mouth of the Ropotamo river (Bartosik et Beškov 1979, Bartosik 1981). A morphological evaluation of the four specimens from Bulgaria was made by Bartosik, Beškov et Tzénov (1981), unfortunately without information on the sexes involved. These authors gave also further two localities for Bulgaria – Arkutino (very near the first locality) and Lozenec (district Michurin). Biometrics for two further specimens from Bulgaria (Primorsko) were given by Obst (1981), again without an identification of their sex. All these authors drew attention to a relatively small number both of ventrals and subcaudals in the Bulgarian specimens. With regard to their morphology, distribution and ecology, the European population of *Coluber rubriceps* are among the least known snakes of Europe. In the present paper, an evaluation has been made of the external morphology of further specimens of *Coluber rubriceps* from the southern part of the Bulgarian Black Sea coast. The results justified my suggestion to regard the population inhabiting this part of Bulgaria as an independent subspecies.

MATERIAL AND METHODS

The material for this study consisted of eleven specimens obtained by courtesy of several Czechoslovak collectors. Similar to Baran (1976), the method suggested by Dowling (1951) was used for determining the number of ventrals. A morphological evaluation was made separately for the males and the females. Bionomical data are based partly on my own knowledge of all sites in Bulgaria from which the incidence of *Coluber rubriceps* was recorded, partly on information obtained from the individual collectors (personal communication). The material is deposited in the Department of Systematic Zoology, Charles University Prague (catalogue symbol DZCHU).

Coluber rubriceps thracicus ssp. n.

Terra typica: Arkutino (near the left bank of the Ropotamo river close to its opening into the Black Sea), Bulgaria.

Holotype: DZCHU 433, ♂, leg. D. Král, May, 1983.

Paratypes: DZCHU 434, 435, 436, 3 ♂♂, remaining data identical to holotype; DZCHU 437, 438, 439, 3 ♀♀, remaining data as for holotype; DZCHU 440, ♂, Arkutino, leg. V. Malý, June, 1974; DZCHU 441, ♂, Arkutino, leg. J. Moravec, September, 1984; DZCHU 442, ♀, Arkutino, leg. M. Soukup, July 20, 1972; DZCHU 443, ♂, Akhtopol, leg. I. Zwach, July 1983.

Derivatio nominis: The name was derived from the historical name of the area from which all our specimens were recovered.

Diagnosis: A subspecies of *Coluber rubriceps* characterized in both sexes by a small number of ventrals (♂♂ 187–191, ♀♀ 200–203) and subcaudals (♂♂ 84–90, ♀♀ 79–91), a relatively short tail (L/Lcd ♂♂ = 2.53–2.90; L/Lcd ♀♀ = 3.03–3.52), and a frequent incidence of three praeocularia and seven upper labials (eye above the site of its contact with labials 4 and 5).

Description of holotype: Male – total length 655 mm. L = 480 mm; Lcd = 175 mm; Lc (from rostrum to posterior end of parietals) = 12.4 mm; Lc (from rostrum to jaw joint) = 15.0 mm; L/Lcd = 2.74; Ventr. 191; A.1/1; Scd. 90; Sq. 19; Rostrale 1; Internasalia 1/1; Nasalia 2/2; Frenalia 1/1; Praefrontalia 1/1; Supraocularia 1/1; Frontale 1; Parietalia 1/1; Lab. 7/7; Sublab. 10/10; Praeocularia 3/3; Postocularia 2/2; Praetemporalia 1/2. Nostrils between nasalia. Eye above point of contact with labials 4 and 5. Body scales smooth, one apical pit in its posterior part. Body slender. Head greatly elongate, faintly constricted from body, relatively small, about 3% of body length (without tail). Tail about 35% of body length (without tail), slightly enlarged at base. Coloration (the specimen preserved in alcohol): ventral side light, without spots. Dorsal side greyish brown. On head upper labials and rostrale white at site of contact with lip, upper part contrastively coloured by a black stripe. This stripe covering rostrale continues at both sides of head backwards by way of nostrils and eye up to end of head; there interrupted by width of one white scale, then continues again along sides of body and soon joining into a black, transverse spot roughly above ventrals 2–6, with an attenuation roughly above ventrals 4–6. The spot is bordered by a row of whitish scales, more conspicuous in posterior than anterior portion. Anteriad, the body is covered irregularly with black spots and dots. The five larger spots are also contrastively bordered by whitish scales. Pupil of eye round.

Variation: The type series consists of seven males and four females.

Males: $L + Lcd = 449$ (568) 655 mm; $L/Lcd = 2.53$ (2.78) 2.90; Ventr. 187 (189) 191; A 1/1; Scd. 84 (87) 90; Sq. 19, smooth, with one apical pit; Lab. 77 (2 specimens), 7/8 (2 spec.), 8/7 (one spec.), 8/8 (one spec.), 9/8 (one spec.), eye above junction of labials 4 and 5; Sublab. 10/10 (5 spec.), 9/10 (2 spec.); Praeocularia 3/3 (6 spec.), 2/2 (one spec.); Postocularia 2/2, Praetemporalia 2/2 (5 spec.), 1/2 (one spec.), 1/1 (one spec.).

Females: $L + Lcd = 443$ (469) 518 mm; $L/Lcd = 3.03$ (3.26) 3.52; Ventr. 200 (201) 203; A 1/1; Scd. 79 (85) 91. Sq. 19 (3 spec.), 21 (one spec.), smooth with one apical pit; Lab. 7/8 (2 spec.), 8/8 (2 spec.), eye above junction of labials 4 and 5; Sublab. 9/9 (2 spec.), 10/10 (2 spec.); Praeocularia 3/3 (3 spec.), 2/2 (one spec.); Postocularia 2/2; Praetemporalia 2/2 (2 spec.), 1/2 (one spec.), 1/1 (one spec.).

Sexual dimorphism: Tail of male longer than that of female, $Lcd/100/L\delta\delta = 34$ (36) 40, $Lcd/100/L\varphi\varphi = 28$ (31) 33 ($CD\delta\delta-\varphi\varphi = 1.37$, i. e., no overlap above 91%). thickened at base. Number of ventrals smaller in male ($CD\delta\delta-\varphi\varphi = 4.40$, i. e., practically no overlapping for the given character).

Coloration similar to that of the holotype. Considerable individual variability in the number, size, shape and pattern of dark spots (larger from 5–20), and dots in anterior part of body. In live specimens, the colour of the iris of the eye is reddish brown, the surface of the head is greyish brown with a reddish sheen, ventral side with an ochreous reddish sheen.

Ecology: All known Bulgarian localities are close to the shore of the Black Sea. The subspecies prefers relatively drier localities with a rough, heterogeneous surface covered with shrubs, grass, rocks and stones, and always close to a source of fresh water — a stream, river, swamp, frequently close to larger shrub — and forest complexes. Its hiding places are crevices in stony debris, in spaces below isolated stones etc. Diurnal activity, very fast, when captured by hand, it releases excrements and an ill-odorous secretion, generally, it does not bite. Apparently a saurophage. In captivity, it catches small lizards holding them either by folds in its body or pressing them to the ground by the weight of its body and ingesting them alive. It refuses to feed on newborn mice.

Comparison: I compared my type specimens from Bulgaria with comprehensive morphological data by Baran (1976) on *Coluber rubriceps* from Israel, the Lebanon, Jordan, Syria and Turkey. The results indicated that the subspecies differed from the Asian specimens of *Coluber rubriceps* in a smaller number of ventrals in both sexes ($CD\delta\delta = 1.65$, i. e., no overlap above 95%, $CD\varphi\varphi = 1.05$, i. e., no overlap above 85%), a smaller number of subcaudals ($CD\delta\delta = 1.86$, i. e., no overlap above 96%, $CD\varphi\varphi = 1.69$, i. e., no overlap above 95%), and in a relatively shorter tail ($CD\delta\delta = 0.65$, i. e., no overlap below 75%, $CD\varphi\varphi = 1.55$, i. e., 94% of no overlap). Frequent in the Bulgarian specimens are 3 praeocularia and 7 upper labials (the last is generally conspicuously big originating from the joining of the last two upper labials, the eye remains above the junction of 4 and 5).

According to the description by Baran (1976) the Asian specimens have as few as 2 praeocularia, and 8 or less frequently 9 upper labials. The variability in the compared characters is very high in the material of *Coluber rubriceps* described by Baran (1976) in comparison with the variability in these characters in our material. This may be ascribed to the fact that the origin of specimens in Baran's material was by far more heterogeneous

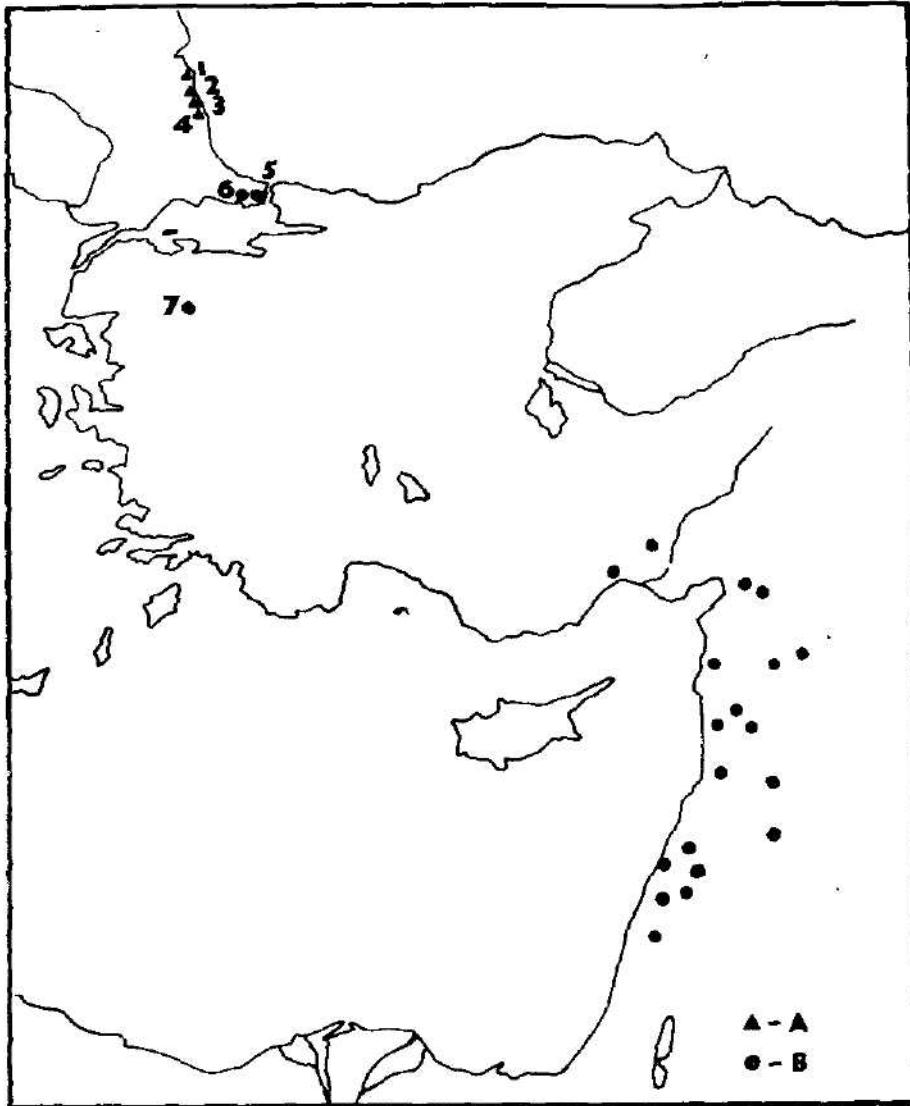


Fig. 3. The distribution of *Coluber rubriceps*.

A — Bulgarian populations — *Coluber rubriceps thracicus* ssp. n.: 1. Arkutino-Ropotamo (Bartosik et Beškov 1979, DZCHU 433–442). 2. Primorsko (Obst 1981). 3. Lozenec (Bartosik, Beškov et Tzénov 1981). 4. Akhtopol (DZCHU 443).

B — Turkish and Asian populations (Baran 1976, Basoglu et Baran 1980). Localities of interest with regard to *Coluber rubriceps thracicus* ssp. n.: 5. Meiris. 6. Hadimköy. 7. Savastepe.

than that of the type series ssp. *thracicus*. It may also explain why sexual differences in the characters under consideration which were so very much marked in my material were less significant in that of Baran (1976).

Distribution: South Bulgarian Black Sea coast.
Remark: It may well be that *ssp. thracicus* is distributed throughout the European part of the area of distribution of the species, but no concrete morphological data are available in the literature on specimens inhabiting the European side of the Bosphorus near Istanbul in support of this assumption. The European distribution of *C. rubriceps* is strictly delimited (sea barrier), and relatively remote from the Asian area of distribution of the species. An exception is a single locality in NW-Anatolia. It is questionable whether the disjunction between the recorded localities of its incidence ought to be ascribed to a secondary disappearance of the species from W. Anatolia (e. g., under the influence of deforestation and aridity), or if it reflects different efforts of collectors in the areas under consideration.

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

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**HIBERNATION OF COCCINELLA QUINQUEPUNCTATA AND PROPYLEA
QUATUORDECIMPUNCTATA (COLEOPTERA, COCCINELLIDAE) IN PINECONES**

Zdeněk RŮŽIČKA, Josef VOSTŘEL

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Abstract. Several species of aphidophagous coccinellids hibernate regularly inside pinecones of *Pinus nigra* Arnold. *Coccinella quinquepunctata* L. and *Propylea quatuordecimpunctata* (L.) were the most numerous species in the hills of northwest Bohemia. Beside these two species diapausing *Coccinella septempunctata* L. can be found in this type of shelter. *Adalia bipunctata* (L.), *Calvia decempunctata* (L.), *Synharmonia conglobata* (L.) and *Thea vigintiduopunctata* (L.) were also noted there.

Some aphidophagous coccinellids wintering in the mountains or highlands form very large aggregations, regularly exceeding thousands of individuals. Life history and details about diapause of species hibernating in aggregations are much better known than those of numerous other species which have been reported to hibernate single or in groups of few individuals only.

Coccinellid dormancy sites in the volcanic hills near the town of Louny are a reliable resource of the coccinellid *S. undecimnotata* and *C. septempunctata* over a major part of the year. Several dormant adults of *Propylea quatuordecimpunctata* emerged from drying pinecones of *Pinus nigra* Arnold which were collected wet and firmly closed in the hill Raná on 26th March, 1980. Our observation stimulated further investigation because hibernating adults of these two species have not been recorded before to have any specific hibernacula at this locality or elsewhere. Harper and Lilly (1982) found hibernating *Hippodamia quinquesignata* Kirby inside pinecones in Canada. According to available information it was always difficult to find a higher number of common coccinellids *P. quatuordecimpunctata* or *C. quinquepunctata* from the beginning of September till the end of May. Collections of diapausing beetles (Bielawski, 1961; Novák, Grenarová, 1967) of either species were rather laborious.

MATERIAL AND METHODS

On the first sampling occasion closed pinecones of *P. nigra* were collected under the trees of a mixed forest covering the west slope of the hill Raná on 12th May, 1980. Samples were taken at its upper part near the top of the hill where coniferous trees prevailed. 33 pinecones were sampled along the north margin of the forest at the uppermost part, 33 by the forest edge above the middle of the slope and the rest 30–50 m inside the forest and parallel with the previous situations (location 1, 2 and 3 respectively in the following text. Pinecones rested in the litter in the first two locations. Some of those from the third location where the forest was less dense were in the grass covering partly the ground. Each pinecone was closed into a small

transparent paperbag and exposed to 20°C at 16 hrs photophase. Temporary inhabitants turned out of the dry and open hiding place during the two following weeks. Insects remaining still inside were shaken out.

On the second sampling occasion pinecones were collected in similar proportions and at the same places of the locality on September 5th, 1980, but they were evaluated as a complex only. Next collections were carried out with the aim of starting a laboratory rearing of *P. quatuordecimpunctata* and *C. quinquepunctata*. Pinecones were brought partly from the upper part of the northwest edge (location 4) on 10th November, 1982, and partly they were collected all around the margin of the whole forest (location 5) on 7th December of the same year and from locations 1, 2 and 4 on 23rd March, 1984. Further samples of pinecones were taken in two locations of the hill Bělouš on 10th April, 1984. Younger trees prevailed in location 1 in comparison with location 2.

RESULTS

Pinecones were a good source of individually hibernating coccinellid species. The occurrence of most common coccinellids in samples is summarized in Table 1. On Raná a three to four times higher number of *P. quatuordecimpunctata* was in pinecones from locations 1 and 2 than in those from location 3. When locations 1 and 2 were compared with location 4, similar differences were observed. A considerably higher number of *C. septempunctata* and *C. quinquepunctata* was in samples from location 4 than from location 5. The number of *P. quatuordecimpunctata* did not differ significantly in these two locations. The latter coccinellid was present in pinecones from Raná every year. Also the

Table 1. Occurrence of most abundant coccinellids hibernating in pinecones

| Sampling date | Location + | No of cones | <i>Coccinella quinquepunctata</i> | <i>Coccinella septempunctata</i> | <i>Propylea quatuordecimpunctata</i> |
|---------------|------------|-------------|-----------------------------------|----------------------------------|--------------------------------------|
| | Raná | | | | |
| 12. 5. 1980 | 1—3 | 100 | 5 | 1 | 41 |
| 5. 9. 1980 | 1—3 | 100 | 0 | 0 | 3 |
| 10. 11. 1982 | 4 | 350 | 70 | 25 | 4 |
| 7. 12. 1982 | 5 | 450 | 20 | 2 | 7 |
| 23. 3. 1984 | 1—2 | 200 | 2 | 3 | 45 |
| | 4 | 200 | 7 | 1 | 3 |
| | Bělouš | | | | |
| 10. 4. 1984 | 1 | 200 | 6 | 2 | 0 |
| | 2 | 200 | 4 | 0 | 3 |

+ See the chapter Materials and methods

highest number of a single coccinellid species noted per 100 samples was found in *P. quatuordecimpunctata* (winter season 1979/1980). However autumn sample of the next season contained only few beetles and during the winter of 1982/1983 the average number of adults of this species hibernating in pinecones was the lowest.

Inside the pinecones the ladybeetles occupied the empty space of seedbeds in the large apophysis. 41 adults of *P. quatuordecimpunctata* hid in 32% of samples. As a rule more beetles were found in larger and well preserved pinecones

than in those bearing signs of deterioration, but at most three beetles were present in one pinecone.

Other coccinellid species found in the samples were *Adalia bipunctata* (L.), *Calvia decemguttata* (L.), *Synharmonia conglobata* (L.) and *Thea vigintiduo-punctata* (L.). Only 3 beetles of *C. decemguttata*, 2 adults of *S. conglobata* and individual specimens of the other species were noted during the whole sampling period.

DISCUSSION

Some coccinellid species prefer somewhat elevated parts of the countryside where the actual hibernation places are chosen not only by the microclimatic requirements but also other demands of the species. *S. undecimnotata* likes to hibernate on the slopes or near the top of bare hills. The hiding places are mostly in cracks of the rocks, empty screw holes in concrete supports for electricity posts or crevices of similar prominence exposed to wind and afternoon sunshine (I p e r t i, 1966) and tufts or lower vegetation serve for this purpose only when the shelters mentioned are absent. *C. septempunctata* prefers to hide under stones or in grass tussocks and at the base of plants but always near the ground. In lofts and especially behind the window frames *A. bipunctata* is usually present. Some beetles of this species were often in aggregations of *S. undecimnotata* in the Louny hibernation quarters if they were situated only slightly above the soil surface and near some wooden material, whereas in those at the soil level some adults of *C. septempunctata* were found regularly. Species *P. quatuordecimpunctata* and *C. quinquepunctata* did not occur in aggregations of *S. undecimnotata*, most likely due to their preference for forest edges or orchards (S a v o i s k a y a, 1965).

C. quinquepunctata can be found on young pine trees as well as among small stones in late summer and in early spring (H o d e k, 1960). *P. quatuordecimpunctata* seems to prefer moist locations to dry ones. As a rule *C. quinquepunctata* and *P. quatuordecimpunctata* hibernate also in the plain. Both prefer to hide in the litter and upper parts of the soil layer. Less often they can be found in crevices or beneath bark scales on the tree trunk where e. g. *Aphidecta obliterata* (L.) (P a r r y, 1980) hibernates. It is quite understandable that pinecones are suitable shelters for these two small species of coccinellids in such localities and it is surprising enough that this regular hiding place during winter was discovered only now.

The difference between the occurrence of *P. quatuordecimpunctata* in various locations of the hill Raná corresponds to the obvious preference of forest edges by this species before and after hibernation. Besides, a particular place (locations 1 and 2) was found to be the most suitable. As to the higher occurrence of coccinellid *C. septempunctata* in pinecones from the upper part of the forest edge, this is in accordance with the preference for higher altitudes observed in beetles hibernating at grass clumps in the locality of Raná. Similar tendency appeared also in *C. quinquepunctata*. Anyhow, species regularly hibernating in the pinecones seem to have similar demands for a type of hiding place and the biotope. The presence of beetles of a particular species in pinecones of certain size or a pine species will of course be limited by the size of their seedbeds.

A certain number of dead insects, some of them attacked by fungal infections, were found in the pinecones. Few dead specimens were crushed between the scales. These, however, could have died earlier.

Size and quality of pinecones have to be taken into account in further studies. If, e. g., a precise study of year to year changes is to be undertaken, selection of standard size pinecones from a certain year only should be advantageous and will minimize any error caused by pinecone quality.

The real advantage of pinecone shelter is its special feature to close or open according to the changes of humidity in the environment. The beetles enter pinecones at the end of summer. This period is usually dry and pinecones are opened. They close later with the coming rainy period and remain so due to mostly high humidity of the litter in late autumn and over winter. During this time pinecones provide a reliable protection from many predators especially birds and small mammals for diapausing insects. In the spring, when coccinellids are ready to leave, the pinecones open again.

The final number of beetles of a species hibernating inside the pinecones certainly depends on the weather conditions shortly before and at the time when beetles search for their hibernation places. If the pinecones are already closed the beetles hide elsewhere and only some of them will perhaps look for a new shelter later. Due to the fact that the time of migration into dormancy sites varies among the coccinellid species, weather conditions can naturally influence the relative abundance of species hibernating in pinecones.

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**BIOMASS AND SPECIES DIVERSITY OF THE MACROBENTHOS OF TWO CARP
PONDS IN SOUTHERN MORAVIA**

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Received February 18, 1985

Abstract. For a period of 17 months quantitative and qualitative investigations of the macrobenthos in two small ponds in southern Moravia (Czechoslovakia) were carried out in 1980–1981. Annual dynamics of the pond bottom populations was followed and the relationship of the changes in the benthos populations to physical, chemical and biological factors studied. In the investigation of the two ponds, pond Karlov showed to be a pond with balanced species diversity with biologically controlled stability. Pond Křídlovický was characterized by a not too stable environment governed by several abiotic factors.

MATERIAL AND METHODS

The seasonal dynamics of the benthos was investigated in two ponds in southern Moravia, approximately 30 km east of the town of Znojmo, near the village Božice. Studied were pond Křídlovický (area 0.009 km², max. depth 1.8 m) and pond Karlov (area 0.017 km², max. depth 2.2 m).

Both ponds are situated on the same brook (Příční Brook). The distance between them is about 3 km, pond Křídlovický being situated in the upper part of the valley, pond Karlov in its lower part. The Příční Brook is only a ditch collecting precipitation water so that it is dry during the period of a long-lasting summer drought. For this reason, the upstream pond Křídlovický has rather the character of a precipitation reservoir. The downstream pond Karlov exhibits a better water balance, because in its close vicinity there are numerous groundwater springs.

Benthos samples were collected from May 1980 till October 1981 in monthly intervals. The sampling was done from an inflated boat using an Ekman-Birge grab with a sampling area of 100 cm². On each collection site, 300–400 cm² of substrate from the bottom area were always collected. The first washing of the substrate was done in situ through a 1-mm mesh net. The washed substrate with benthos organisms was preserved by adding formaldehyde. The separation, determination and weighting of the organisms was carried out after several months in the laboratory. The biomass of the benthos organisms is, however, expressed as fresh weight. For the conversion of formalin weight to values of fresh biomass, corrections after Borucký (1934) and Zhadin (1956) were taken into account. Diversity indices for benthos populations were calculated after Odum (1971).

On both ponds, fundamental physical and physico-chemical characteristics of the environment were simultaneously investigated. The temperature (stratifications as well as the temperature of the bottom), dissolved oxygen content in the free water and near the bottom (measured by the Winkler method), as well as the content of the basic nutrients NH₄⁺, NO₃⁻ and PO₄⁻³ were determined according to Hrbáček et al. (1972).

Samplings on the two ponds were carried out on two predetermined sites. Point D was in the deeper part of the pond near the dam (mean depth 1.5 m) and on point S in the shallower part of the pond (mean depth 1.2 m).

RESULTS

Seasonal dynamics of the changes in the dissolved oxygen content at the pond bottom: In pond Karlov the values varied from 0.085 to 11.2 mg l O₂. Minima were observed in the winter months, when the pond surface was completely frozen.

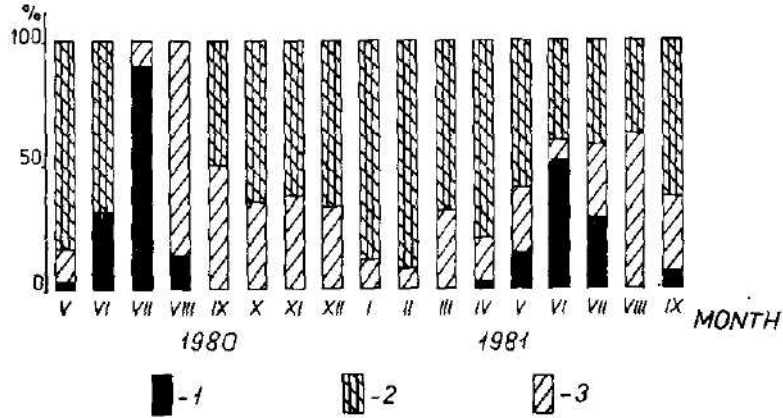


Fig. 1. Relative representation of the most frequently occurring groups of Oligochaeta in pond Karlov in point D. 1 - Naididae family, 2 - genus *Potamothenis* (fam. Tubificidae), 3 - genus *Limnodrilus* (fam. Tubificidae), 4 - genus *Tubificoides* (fam. Tubificidae).

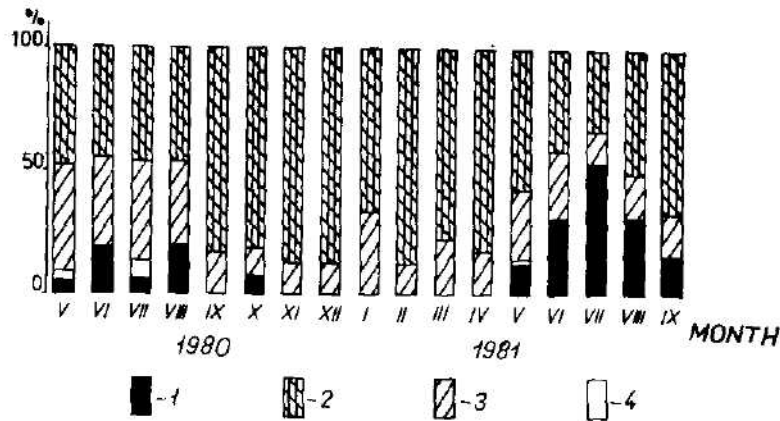


Fig. 2. Relative representation of the most frequently occurring groups of Oligochaeta in pond Karlov in point S. 1 - family Naididae, 2 - genus *Potamothenis* (fam. Tubificidae), 3 - genus *Limnodrilus* (fam. Tubificidae), 4 - genus *Tubificoides* (fam. Tubificidae).

Pond Křídlovický exhibited variations in the O₂ content from 0.0 to 16.8 mg l O₂. The oxygen minima were encountered in July as a result of the maximum aquatic vegetation growth. In the winter this pond was always emptied.

Bottom fauna

Oligochaeta — predominated as typical permanent benthic component in pond Karlov, forming here 70% of the zoobenthos on the average in the samples (both in abundance and biomass). On the contrary, in pond Křídlovický this group of benthic fauna was almost lacking in the samples.

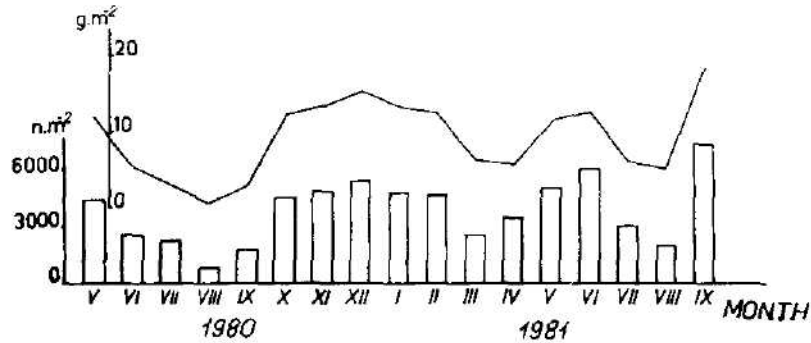


Fig. 3. Seasonal dynamics of *Oligochaeta* in pond Karlov in point D. The bars represent density and the full line biomass.

In pond Karlov a total of species of *Oligochaeta* was found (point D — 13 species; point S — 18 species; common for both sites were 11 species). Representatives of two families predominantly participated — Naididae and Tubificidae (relative representation see Figs. 1 and 2). From the Tubificidae family the species *Potamothrix hammoniensis* (Michaelsen) was found that occurred here with a frequency of almost 100%. The occurrence of the common species *Tubifex tubifex* (O. F. Müller) was suppressed and was encountered only in the period of maximum *Oligochaeta* development. The seasonal dynamic of *Oligochaeta* shows a marked annual cycle with two peaks (Figs. 3 and 4).

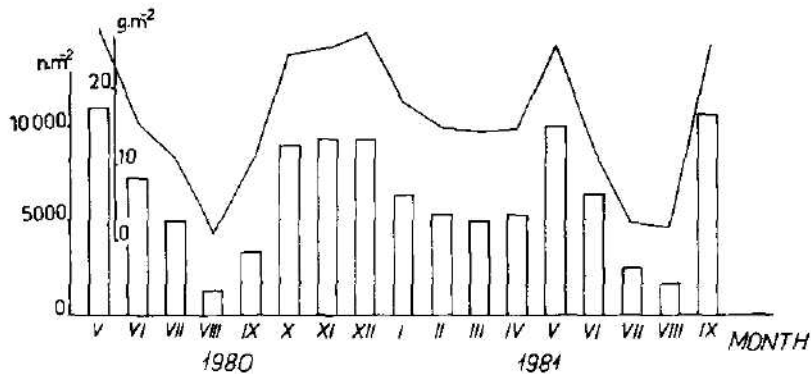


Fig. 4. Seasonal dynamics of *Oligochaeta* in pond Karlov in point S. The bars represent density, the full line biomass.

Chironomidae this group was a significant component of the temporary benthic fauna in both ponds. In pond Karlov altogether 15 taxons of chiro-

nomid larvae were found (in point D — 13 taxons; point S — 12 taxons; common were 10 taxons). In pond Křídlovický 13 taxons of this group of bottom fauna were encountered (in point D — 12 taxons; point S — 6 taxons; common were 5 taxons).

In pond Karlov a great abundance of *Tanytarsus* gr. *gregarius* (Kieffer) was found that was encountered here with a 100% frequency. Its mean

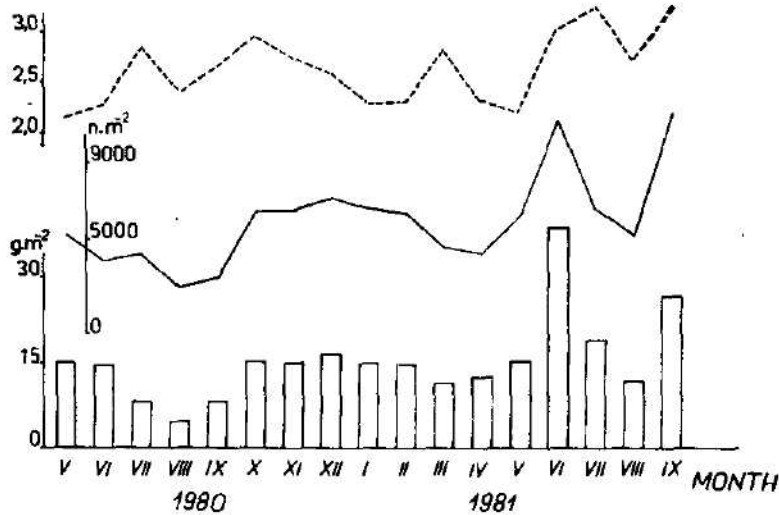


Fig. 5. Seasonal dynamics of the bottom fauna in pond Karlov in point D. The bars represent biomass, the full line — density, the broken line — diversity index.

abundance was 720 sp.m⁻² and considerably exceeded the mean abundance of *Chironomus* gr. *plumosus* Linné which was only 350 sp.m⁻². The taxon *Tanytarsus* gr. *gregarius* presented in point S also an absolute maximum of abundance of all chironomid larvae taxons — 6160 sp.m⁻². Such a rich abundance of Tanytarsini is a rather exceptional phenomenon for ponds. In the case of pond Karlov it can be assumed that this abundance is supported by the entry of groundwater from springs on the pond banks.

In pond Křídlovický, Chironomidae larvae occurred with a frequency 70% and a mean abundance of 200 ind.m⁻². The most frequent taxon was *Chironomus* gr. *plumosus* with a 40% frequency. Certain differences in the abundance in the years 1980 and 1981 were most probably due to different water level in the pond which also affected other components of the population. Chaoboridae — were the most important component of the benthos in pond Křídlovický. In samples from this pond the occurrence of two species was recorded — *Chaoborus crystallinus* (De Geer) and *Chaoborus flavicans* (Meigen). *Chaoborus crystallinus* being found only occasionally in the period of maximum abundance of Chaoboridae larvae. Maximum Chaoboridae larvae abundance was encountered in the late summer (August), when a maximum — 735 sp.m⁻² was found at point S (Fig. 8).

The Chaoboridae larvae populations were different in 1980 and 1981, as can be seen in Figs. 7 and 8. Since Chaoboridae larvae are not strictly benthic

organisms, I evaluated their presence in the plankton as shown in Figs. 7 and 8, where larvae of lower instars were found.

In pond Karlov the Chaoboridae larvae were not a numerically too marked group, nevertheless regularly occurring in the period June – October. The average abundance was 350 sp.m^{-2} , and only *Chaoborus flavicans* was represented.

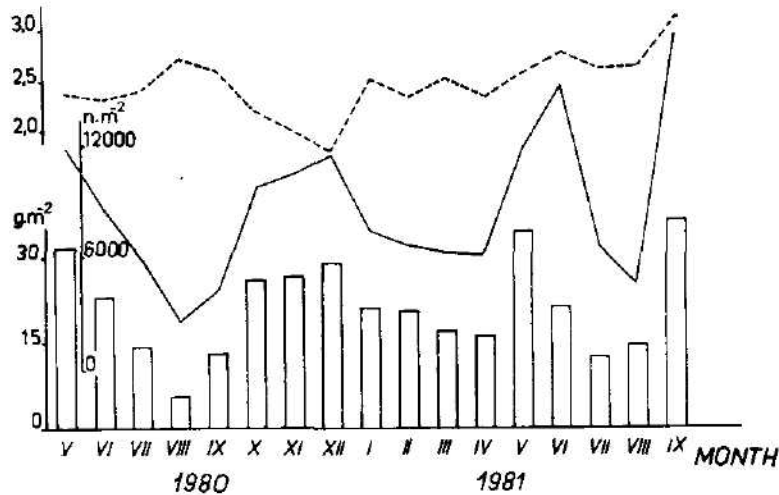


Fig. 6. Seasonal dynamics of bottom fauna in pond Karlov in point S. The bars represent biomass, the full line – density, the broken line – diversity index.

Ceratopogonidae – a numerically not too significant group, but in pond Karlov they were permanently present with an average abundance of 200 sp.m^{-2} , represented by two species of the genus *Sphaeromias*.

In pond Křídlovický Ceratopogonidae larvae were not such a numerous group (60% frequency) and in addition to *Sphaeromias* also the genus *Bezzia* was recorded here.

Hirudinea – a group that was of significance only in pond Křídlovický. With a view to the low abundance of the other groups of benthic fauna, it was a relatively important group especially as to its share in the biomass.

Furthermore, in samples of both ponds representatives of the groups Isopoda, Hydracarina, Ephemeroptera, Coleoptera, Odonata, Heteroptera, Lepidoptera and Muscidae were occasionally found.

Comparison of species diversity in the two ponds

In pond Křídlovický I determined 42 taxons of benthos organisms, in pond Karlov 54 taxons, 23 taxons were common for both ponds.

For pond Křídlovický the mean Shannon index of diversity was found to be 1.54; for pond Karlov 2.56, respectively.

The index for pond Karlov corresponds to the environment of balanced species variety with biologically controlled stability (Odum, 1971). In the case of pond Křídlovický, the index signalizes a not too stable environment,

governed rather by abiotic factors. The difference can be better seen when we compare the seasonal variability of the diversity index. In pond Karlov the diversity index varies within the range of 1.98 – 3.09; in pond Křídlovický within the range of 0.12 – 3.13.

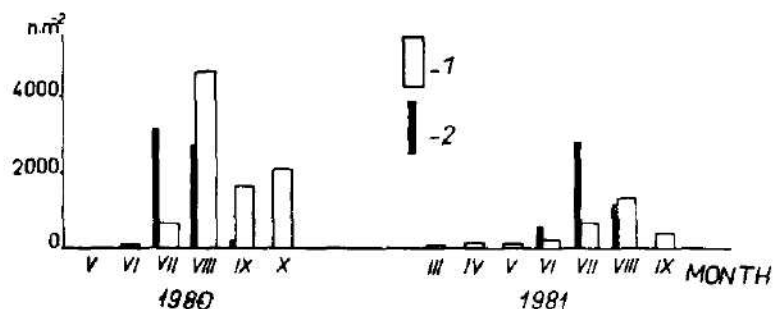


Fig. 7. Seasonal dynamics of chaoborid larvae density in pond Křídlovický in point D. 1 – Density of benthic larvae of Chaoboridae; 2 – Density of chaoborid larvae in the water column above a surface of 1 m² (the numbers correspond to the value on the benthos axis).

In pond Křídlovický a marked relationship between the diversity index of the population and the percentage oxygen saturation near the pond bottom was found. The correlation coefficient $r = 0.97$ was determined for values with time shift – i. e. changes in dissolved oxygen manifest themselves in the diversity index only with a certain delay (by one monthly sampling interval).

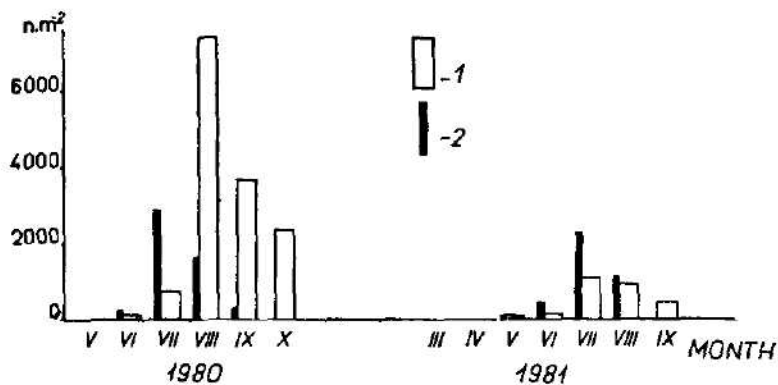


Fig. 8. Seasonal dynamics of chaoborid larvae on pond Křídlovický in point S. 1 – Density of benthic larvae of Chaoboridae; 2 – Density of chaoborid larvae in the water column above a surface of 1 m² (the numbers correspond to the value on the benthos axis)

For pond Karlov this correlation appeared at the margin of statistical significance ($r = 0.66$).

DISCUSSION

Population dynamics of benthos

The majority of authors studying the seasonal dynamics of benthos in this country (Laupy 1970; Lellák 1953, 1958, 1961; Winkler 1951) ascertained that the maximum values of the total abundance as well as biomass are encountered in the winter period. During spring and summer benthos

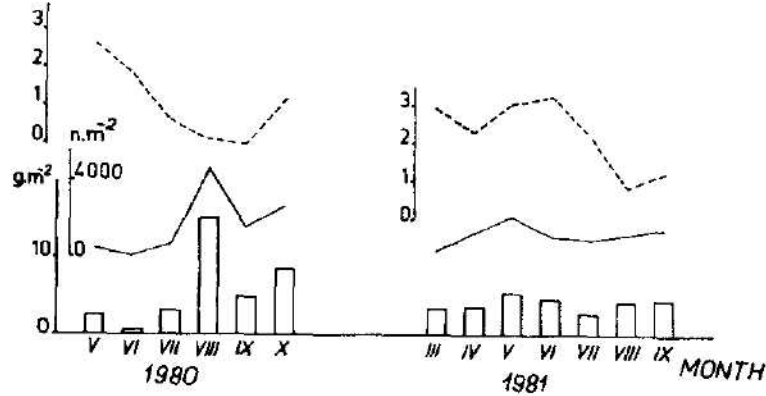


Fig. 9. Seasonal dynamics of bottom fauna in pond Křídlovický in point D. The bars represent biomass, the full line — density, and the broken line — diversity index.

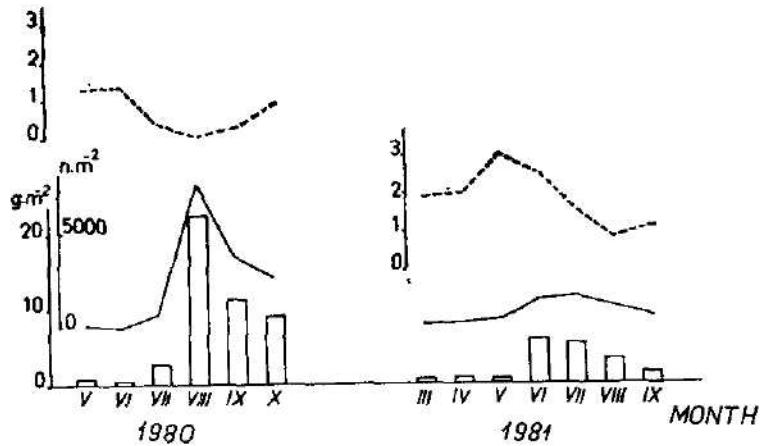


Fig. 10. Seasonal dynamics of bottom fauna in pond Křídlovický in point S. The bars represent biomass, the full line — density, and the broken line — diversity index.

organisms decrease due to the emergence of insects and the increasing feeding activity of the fish. In autumn the benthos organisms start to increase again, especially insect larvae. The seasonal pattern of abundance and biomass in pond Karlov is in agreement with the above mentioned authors.

In pond Karlov, the period from August till December represented a time of continuous increase in abundance and biomass. In late winter a decrease

was observed apparently due to the perishing of part of the population. This decrease, in connection with the spring emergence of the insect imago, was prolonged till April. In May and June an increase in abundance and biomass followed; in August there is a marked summer minimum.

Absolute maxima were not recorded during the winter season as reported by Laupy (1970) as well as Lellák (1958, 1961), nor early in spring (Sukop 1973), but in the months when an overlapping of the maxima of the development cycles of Oligochaeta and Chironomidae occurred.

The dominant group of benthic organisms in pond Karlov were Oligochaeta. The character of their seasonal dynamics determined the resultant annual course of the whole association. However, the pattern of the seasonal dynamics of Oligochaeta is not in agreement with the conclusions of Borodičová (1962). In ponds in the surroundings of Vodňany maximum development of this group was observed in June (up to 10,000 ind.m⁻²) and the following decrease of their numbers till the period of the next reproduction period that is, according to Gavrilov (1968), at the end of June. In pond Karlov the seasonal dynamics of Oligochaeta showed two marked peaks (a spring and an autumn peak) separated by the summer minimum (Figs. 3 and 4). Also Jónasson (1972), who also investigated the dynamics of *Potamothrix hammoniensis* (i. e. a species that predominated in pond Karlov) is convinced of a two-peak cycle. The results of Borodičová (1962), Sukop (1973) and others, who report only a main spring maximum, could be influenced by the fertilization of the ponds. Losos and Pár (1971) proved (for instance) that fertilization of ponds has a positive effect on Chironomidae larvae. However, the effect on the development of Oligochaeta proved to be negative. Hence it is possible that in the above described instances, when no autumn development of Oligochaeta was recorded, this could have been the consequence of the weakening of the population by continuous fertilization.

Jónasson (1972) reported about the profundal of lake Eström (Denmark) that the minimum time of maturing of the species *Potamothrix hammoniensis* is three years. The stable ratio between juvenile and adult individuals (1 : 1) suggests that in pond Karlov juvenile individuals of *Potamothrix hammoniensis* mature during one year only. Also the temperature conditions are much more favourable here for the faster development and maturing.

The reproduction of the family Naididae in pond Karlov was found to be in the summer months. It was apparently affected by the lack of suitable plant food, since Naididae are marked phytophages. A similar development of Naididae in the summer months was also reported by Dvořák (1970) in the littoral region of the pond Radov.

The seasonal dynamics of chironomid larvae was similar as described by Lellák (1953). Typical were the autumn and late spring maxima separated by the spring and summer minima. Characteristic for pond Karlov was the occurrence of *Tanytarsus* gr. *gregarius* larvae, in a frequency much higher than in any of the studies carried out hitherto in similar localities. *Tanytarsus* gr. *gregarius* occurred in all samples, whereas *Chironomus* gr. *plumosus* only with an 88% frequency. It has already been pointed out several times that the conventional classification of ponds into the *Chironomus* and *Tanytarsus* types cannot be accepted as a general phenomenon. In spite of this, however, the great abundance of the Tanytarsini indicates less eutrophic conditions

Table 1. Comparison of the average and maximum benthos abundance and biomass in ponds and oxbows

| | Average | | Maximum | |
|--|----------------------------------|------------------------------|----------------------------------|------------------------------|
| | Abundance ind.m ⁻² | Biomass g.m ⁻² | Abundance ind.m ⁻² | Biomass g.m ⁻² |
| Oxbow Kozi Chlub | over grown p. 16400 | | over grown p. 44100 | |
| Lelák (1896) | veget. free p. 2800 | | veget. free p. 5800 | |
| Lnáře ponds Winkler (1951) | 1100—1225 | | 2650—2750 | |
| Kyjský pond Lelák (1958) | 1660 | | 4350 | |
| Blatná ponds Lelák (1961) | 2040—3710 | 14.8—17.1 | 15440 | 32.2 |
| Southern Moravian pools Gajdůšek (1967) | 340—720 | 1.7—6.6 | 2500 | 23.0 |
| Lednice ponds Sukop (1973)* | 2550 | 36.6 | 13020 | 81.8** |
| Karlovy pond frescut study | 7310 | 18.5 | 17920 | 38.8 |
| Křídlovický pond frescut study | 1550 | 4.9 | 7510 | 22.5 |

* The average is given for the June to September period

** A considerable proportion of biomass (aprox. 90 %) is represented by *Cryodrilus lucum*

that are certainly affected by the penetration of groundwaters specific of pond Karlov.

The uniform occurrence of certain size groups of larvae and their continuous growth, just as the discovery of larvae only indicated, contrary to the assumption by Lelák (1953), that Tanytarsini can develop during one generation per year. The same conclusion was reached in the case of Tanytarsini also by Humpries (1938) in the lakes of northern Germany.

Pond Křídlovický is in its nature and dynamic abundance and biomass markedly different from pond Karlov. The dominating species in the benthos is *Chaoborus flavicans*. The same species of Chaoboridae was found by Lelák (1953) in the benthos of the back water Poltruba. The seasonal dynamics of chaoborid larvae of this pool and of pond Křídlovický is, however, very different. Poltruba exhibited maxima in autumn and minimum numbers in summer. Pond Křídlovický exhibited the highest numbers, represented mainly by chaoborid larvae, on the contrary in summer (August), in winter the pond was emptied. The Poltruba back water in the central lake region did not dry out in winter so that the comparison is somewhat indirect. The study of the larval number ratio that inhabit the bottom and "plankton" larvae confirmed the assumption of Prokešová (1959). The bottom is mainly inhabited by

higher instars (3rd and 4th instar). For this reason, the seasonal dynamics of chaoborid larvae inhabiting the bottom had a peak in August, predominantly individuals of the 4th instar. The maximum of plankton chaoborid larvae was found in July (2nd and 3rd instar). Generally, the share of chaoborid larvae inhabiting the bottom increases with the maturing of the lower instars, which is usually the case at the end of the vegetation period. The dynamics of plankton chaoborid larvae exhibited a similar character to that found by Albertová (1959) for *Chaoborus obscuripes*. As far as the resistance of the larvae against anoxia is concerned, it is possible to agree with the conclusions of Prokešová (1959) who in her study of two pools in the Labe valley evaluated the chaoborid larvae as the most resistant group against long-lasting oxygen deficits (except organisms adapted to permanent life in H₂S media).

Trophic conditions and fishery

A general problem in evaluating briefly the trophic potentials of the investigated ponds and their utilization for fishery is the estimation of the benthos population production. It is evident that the most precise estimation of production could be obtained as the production sums of populations of different species. However, the estimation is very labourious. One of the possibilities how to approach the estimation of production is the expression of seasonal increment of the benthos standing crop by means of the maximum achieved biomass. The actual production for a longer time period is seldom lower, especially if the seasonal dynamics of the biomass exhibit several peaks. Basic data to this problem are given in Tab. 2. It is evident that there are marked

Table 2. Comparison the trophic condition of Karlov and Křídlovický ponds

| Karlov pond 1980 | Karlov pond 1981 | Křídlovický pond 1980 | Křídlovický pond 1981 |
|------------------------------|-----------------------------|-----------------------------|----------------------------|
| T ₁ 238 220 (170) | C ₁ 325 83 (200) | C ₁ 189 190 (88) | C ₁ 55 115 (33) |

T₁ — the fish population was formed by *Tinca Tinca* (typical benthophage) in the size of 10 to 15 cm

C₁ — the fish population was formed by *Cyprinus carpio* in the size of 10–15 cm

Numerator of fraction = estimation of benthos production by expressing its seasonal increment as mean maximum of the attained biomass in kg/0.01 km²; denominator of fraction = natural seasonal increment of fish in kg/0.01 km; number in brackets = average annual biomass of benthos organisms in kg/0.01 km².

differences between the two ponds and also the situation was different in the different years. The utilization of the bottom production is, among others, also dependent on the composition of the fish stock in the pond. As example can serve the difference in pond Karlov in 1980 and 1981. In pond Křídlovický the seasonal dynamics of the biomass is greatly variable and, consequently, the estimation of production very inaccurate. However, in any case a great share in the production has also a littoral region which is given by the nature of the pond.

SUMMARY

- (1) The average density in pond Karlov was 7,310 ind.m⁻² corresponding to an average biomass of 18.5 g.m⁻². In pond Křídlovický these values were lower, the average density being 1,550 ind.m⁻² and the average biomass 4.9 g.m⁻².
- (2) In pond Karlov there were 54 taxons of benthic organisms, in pond Křídlovický 42 taxons, 23 taxons were common to both ponds.
- (3) In pond Karlov the ratio of the individuals of temporary and permanent fauna was 1:2.5 (average biomass ratio = 1:2.8). In pond Křídlovický this ratio was reverse — abundance ratio — 7.8:1 (average biomass ratio = 5.2:1).
- (4) In pond Karlov the index of diversity varied in the range of 1.98 — 3.09 (mean — 2.56). In pond Křídlovický the Shannon index of diversity varied from 0.12 — 3.13 (mean — 1.54).
- (5) The seasonal dynamics of the total abundance as well as biomass of the bottom fauna exhibited on pond Karlov a marked cycle with early spring and summer minima. It varied in the range of 2,500 — 17,900 ind.m⁻² (biomass: 5.6 — 38.8 g.m⁻²).
The seasonal dynamics of the total abundance and biomass of the bottom fauna in pond Křídlovický was affected by the different water level during the two vegetation periods investigated. The summer minimum was suppressed by the development of *Chaoborus flavicans* larvae. The values of the total abundance varied in the range of 150 — 7,500 ind.m⁻² (biomass 0.5 till 22.5 g.m⁻²).
- (6) In pond Karlov the dominant group were Oligochaeta. The seasonal dynamics of Oligochaeta showed two marked peaks separated by the summer minimum. The abundance varied in the range of 1,500 — 10,000 ind.m⁻². In pond Křídlovický the Oligochaeta were suppressed.
- (7) In pond Křídlovický *Chaoborus flavicans* larvae dominated numerically. Their seasonal cycle had a marked peak in late summer. The abundance varied from 0 — 7,400 sp.m⁻². In pond Karlov Chaoboridae larvae were recorded only in the summer period with an average abundance of 350 sp.m⁻².

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**TWO MICROSPORIDIA (MICROSPORIDA, PROTOZOA) INFECTING MOSQUITOS
IN SUDAN**

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Abstract. The microsporidia *Parathelohania arabiensis* sp. n. from *Anopheles arabiensis* and *Amblyospora kadunae* Weiser, 1981 from *Culex pipiens fatigans* in Khartoum, Sudan, are described and illustrated.

In all regions of their distribution larval mosquitos have two endemic microsporidian infections caused by different species of the genus *Parathelohania* (mainly in Anopheline mosquitos) and *Amblyospora* (typical for Culicine and Aedine hosts). Both have a similar complex system of development and transmission in having one, octosporous, cycle with well apparent white cysts in the fat body of (prevailing male) larvae and a cycle with thinwalled single spores in adults (and female larvae). A trans-ovum transmission is the known continuation of the infection, direct infections by feeding are not demonstrated. The general low incidence of 3–5% in most distribution areas is in content with the general hypothetic scheme of distribution. The role of the octosporous pansporoblasts and thickwalled spores in maintaining and transmission of these infections is not yet clear. An density dependent increase of infection rate under specific conditions was not reported and cases with high local incidence of some infections (Andreadis, 1983) could be a result of selective activity of the microsporidian on infected eggs on their hatching efficiency or time.

The missing experience with induced infections and experimental transmissions prepare difficulties in identifications of species because they often differ in minor morphological details which easily could be caused by a different host. (Spore size and shape, intensity of development, frequency of thickwalled octospores in male and female larvae). Therefore most authors describe the organisms with some morphological aberations in a new host as new species.

The material described in this note was collected during laboratory rearings of mosquitos for testing of transmission of experimental malaria as accidental infections and further studies in continuous laboratory rearings could not been performed. The reported data contribute to the knowledge of regional distribution of diseases of mosquitos.

MATERIAL AND METHODS

Culex pipiens fatigans is reared in a laboratory colony at the Section of Medical Entomology, National Health Laboratories, Khartoum. In a few animals an infection present with irregular white patches distributed segmentary. Dry smears were

prepared of the infected animals and stained with Giemsa after fixation with methanol. Although there were collections made in localities in the field, the overall recorded frequency of the infection was far below 1% of larvae in the habitats or laboratory colonies.

Anopheles arabicus was maintained in the laboratory for experimental malaria transmission and the infection with the microsporidian was recognized only in a single larva. The contact of this rearing with the field was the water which was brought from the adjacent pools, often with a rich algal growth. The infection was recognized only on a smear and there was no further material for other ways of evaluation. Part of the smear stained with Giemsa was treated with HCl (Weiser, 1976) and re-stained for identification of the nuclei, on a part of the smear the addition of India ink identified the shape of mature spores.

RESULTS

In both cases the infections were caused by microsporidia of the "dimorphic" type, localized in the fat body of infected last instar larvae.

Amblyospora kadunae Weiser, 1981 infected *Culex pipiens fatigans* and was recorded from several infected larvae in the laboratory colony and another larva from the field. Only pansporoblasts with immature sporoblasts and with eight thickwalled spores were present in the infected fat body. Fresh spores in water mounts were broad oval to subspherical, $3-3.5 \times 2.5-3$ μ m, easily separated from spherical pansporoblasts 10 μ m in diameter (Fig. 1, B). The spore wall was soft and deformed during drying on the slide, but with blunt poles. The exospore wall was visible only in parts of the smear where spores were closed in remains of host cells. In the interior stained with Giemsa the anterior vacuole was visible, an irregular germ and a spherical dense posterosome. Hydrolysed spores show a kidney-shaped nucleus (Fig. 1, D). In sporoblasts the nucleus is larger and sometimes well visible. There are no secretion granules among sporoblasts inside the pansporoblast. In some parts of the smears polar filaments were extruded 90-110 μ m long (Fig. 1, C, 2 A-D). Many of them were totally extruded and torn away from the spore. On the distal end they all have a minute spherical bead (b, Fig. 2, A) and on the end which is anchored in the spore is a ghost membrane of the endospore (polar disc?). The filament has the anterior part (50-55 μ m) twice as thick as the basal part. In the material there is no good evidence of a thin part of the spore wall on the anterior pole or the posterior pole and no stained episporium. For the classification in the genus *Amblyospora* is typical the type of sporogony, the polar filament of anisofilar type. Compared with the microsporidian collected in Nigeria, the spore size and shape is identical in the range of individual variability. The spore wall is less prominent and more flexible.

Parathelohania arabiensis sp. n. (Fig. 3) is localized in the fat body of *Anopheles arabicus* and only mature spores were present. Octosporous groups were rare, most spores were released from the pansporoblasts in the studied materials. Broad oval spores, $3.5-4 \times 2-3$ μ m, had on their posterior pole a more refringent "cap". Some spores were larger, $6.5-7 \times 2.5-3$ μ m. (Less than 3%). Uninucleate spores have a thickening of the exospore on the posterior pole and on dry smears a typical mitral protrusion of the episporium is well visible, lightly stained with Giemsa. (Fig. 1, 4 and Fig. 3). On the anterior pole the episporium form a less distinct collar, not overlapping the spore end. Spores of this species are larger than spores of *P. africana* Hazard and Anthony, 1974 in *A. gambiae* from Nigeria and smaller than *P. octolagenella* from *A. pretoriensis* from Nige-

ria. Three other species are mentioned without description from *A. nili*, *A. pharoensis* and *A. funestus* from Nigeria by Hazard and Oldacre (1975).

DISCUSSION

Culex p. fatigans, the host of *Amblyospora kadunae* is widely distributed in Africa, with coalescent populations and it most probably has the same microsporidia in different regions. Compared with the frequency in other areas, the infection in Sudan is rather rare, but the differences may eventually reflect merely the different sampling techniques of different collectors. The infection

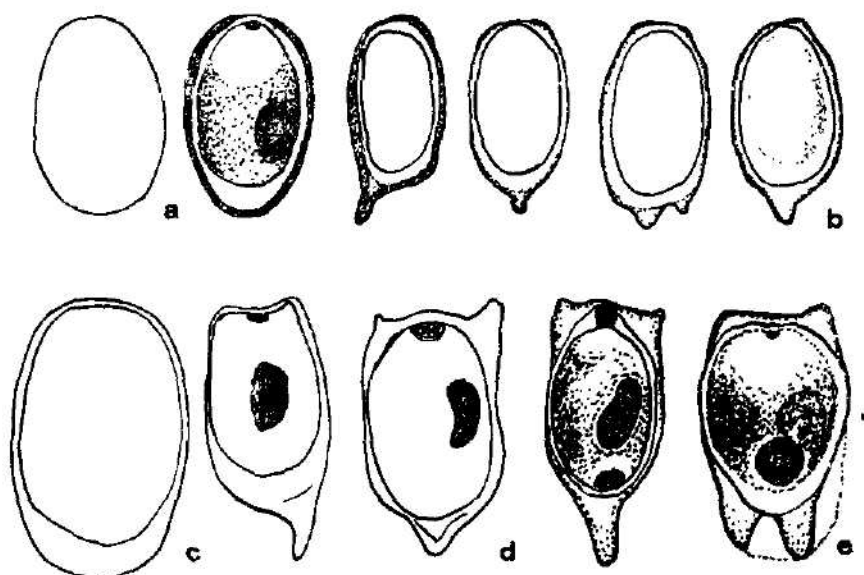


Fig. 3. *Parathelohania arabiensis*, spores. a— Shape of fresh spore, b— ordinary size spores, c— makrospore, d— spores after staining of nuclei, with pigmented ending of the filament, e— Giemsa stained makrospores. Dimensions indicated in the text.

does not play any important role in the regulation of the population of the host. The release of polar filaments in the studied material was initiated by re-moistening of a dried unfixed smear. Different situations, as they are presented in Fig. 2, A—D show the visible composition of the filament of two parts. The thin and thick part keep their diameter even when inverted, after release. The minute bead on the thin end of the filament is not very common but most filaments have on the end of the thick part an end-knob which is the polar disc (polar granule) anchoring the filament in the spore. In most cases the filament is totally extruded or the extrusion is initiated with the central part of the filament or with both ends first, with a coil of filament still inside the spore. Fig. 2, A, B). There are no planonts close by the end of the filament and it is questionable if the germ will pass the tube of the filament in most cases. In the

spores with a half-released filament the germ remains in the background (Fig. 2, B, C—g).

It is typical for spores of the genus *Parathelohania* that they have a thickening of the spore wall at the posterior end. The true nature of this structure and its variability was not fixed by any definition. In ultrathin sections the area of the posterior pole seems to be rather plastic and the electron negative wall of the exospore is not well differentiated from any surface layer. Whereas the exospore is contracted by fixation, the episporium is less contracted and forms on the surface a folded thin layer. The structures which appear under this surface layer in materials under the scanning EM let expect entirely different arrangements. In *P. legeri*, *P. anophelis* or *P. obesa* as shown in Hazard and Oldacre, 1975, a knob-like mass adhering to the posterior pole and held in position by the folds of the episporium is formed. On ultrathin sections this part of the spore is uniform, without any such differentiation. In cases where in the light microscope is a turricate structure of two cylinders of different diameter, as in *P. octolagenella*, the SEM pictures do not show a double knob on the posterior pole and the transmittent EM shows a system of protrusions identical with the picture in the light microscope. The folding of the episporium in Giemsa-stained smears of different species is more consistent and characteristic in known species than the SEM or TEM pictures. The degree of maturation of the spores in ultrathin sections may eventually play some role, or the variability in the larger series of the scanned material. For the folding of the episporium in *P. arabiensis* it is typical that the folding does not have the pitcherlike arrangement of the structures. It usually forms a mitral cap with a central peak from one profile and two or three waves from the other profile. The waves surpass the exospore (or spore-) wall for one half of its length.

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

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**LA RÉVISION DES ALEURODES DES PAYS TCHÈQUES (STERNORRHYNCHA:
ALEYRODINEA) I.**

Jiří ZAHRADNÍK

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Abstract. This first part deals with the classification, morphology, relation to the host plants, development and hibernation, geographical distribution and a survey of the knowledge of Czech white-flies. In the systematic part the species of the genera *Siphoninus* Silvestri, *Aleurolobus* Quaintance et Baker, and *Calluneyrodes* Zahradník are revised.

INTRODUCTION

Les aleurodes représentent dans l'ordre des Sternorrhyncha un groupe d'insectes fort intéressant, d'une part par ses caractères morphologiques, d'autre part par sa bionomie et leur développement. Mais, l'exploration de ce sous-ordre avait été auparavant assez négligée non seulement dans les pays tchèques, mais aussi dans les pays voisins. C'est seulement à l'époque récente qu'on a publié en Europe centrale une monographie et un catalogue des aleurodes en Roumanie (Dobreaanu et Mamolache, 1969) et en Pologne (Szelegiewicz, 1979).

Je me suis efforcé d'accomplir cette lacune dans les connaissances de l'entomofaune de notre pays par la présente révision. Celle-ci est basée sur un riche matériel des pupariums surtout — stade évolutif le plus important pour la taxonomie du groupe traité. Le matériel, collectionné dès 1955, provient des biotopes les plus différents. L'attention élevée a été consacrée même à l'exploration des réserves naturelles d'Etat en Bohême (environs de Karlštejn, Český Ráj, Krkonoše, Šumava) et en Moravie (Mohelno, environs de Brno, Pavlovské vrchy etc.), d'où proviennent aussi des aleurodes nouveaux ou auparavant inconnus sur le territoire tchèque.

La plus grande partie du matériel a été collectionnée par moi-même, au cours des dernières années aussi par mon ami M. Zdeněk Nigrin. Tous le matériel est monté au Baume de Canada. Les préparations microscopiques font part des collections entomologiques du Muséum National des Sciences Naturelles à Praha — Kunraticce et de la collection Zahradník (Chaire de la Zoologie Systématique, Faculté des Sciences, Université Charles, Praha).

La partie systématique de la révision est arrangée d'une manière uniforme. À la citation de la première description font suite des synonymes, puis la description du puparium (caractères macroscopiques et microscopiques), la liste des plantes-hôtes, les données sur la bionomie, la répartition, données littéraires et l'énumération du matériel. Chez les espèces largement réparties sur le territoire tchèque, je ne cite pas toutes les localités, mais seulement leurs

exemples. Les noms des localités sont accompagnés (entre parenthèses) par le code numérique de la carte carroyée.

Vu que le manuscrit est assez étendu, il était nécessaire, pour des raisons techniques, de le diviser en 3 parties. Cette première contient des chapitres généraux et la révision des genres *Siphoninus* Silvestri, *Aleurolobus* Quaintance et Baker et *Calluneyrodes* Zahradnik, la seconde et la troisième représentent la révision des genres suivants. La troisième partie contiendra aussi la clé des genres.

Remerciements

Mes collègues et amis m'ont aidé à terminer ce travail. Ce sont surtout M. Dr L. A. Mound (British Museum, Natural History, London), Mme Dr. L. M. Russell (Ministry of Agriculture, Washington D. C.), M. Prof. L. Goux (Marseille), M. Prof. Dr. R. Folhot (Faculté des Sciences, Rennes), M. Dr. F. Ossiannilsson (Lantbruks-högskolan, Uppsala), Mme Dr. E. Danzig (Institut Zoologique de l'Académie des Sciences, Leningrad), M. Dr. F. M. Iaccarino (Istituto di Entomologia Agraria, Portici) et M. Dr. M. C. Rapisarda (Istituto di Entomologia Agraria dell' Università di Catania). Ils m'ont obligeamment prêté le matériel de comparaison ou m'ont fourni la littérature. Je suis heureux de pouvoir les remercier très vivement. Mes remerciements cordiaux appartiennent aussi à mon ami Zdeněk Nigrin (Orlické museum, Choceň) qui a collectionné un riche matériel surtout dans la Bohême orientale et qui m'a aidé à faire des macrophotographies des aleurodes pour la 2^{ème} et 3^{ème} partie de cette révision.

LA CLASSIFICATION DES ALEURODES

La stabilisation systématique des aleurodes dans le système des insectes — comme d'ailleurs d'autres groupes des Sternorrhyncha — évolua plusieurs dizaines d'années. Les aleurodes étaient connus déjà en époque pré-linnéenne, comme par exemple au Réaumur (1734) qui avait décrit "La Phalène culiciforme de l'éclair".¹⁾ Elle lui semblait identique à celle qui avait été trouvée sur *Brassica*. Il figura les caractères morphologiques de l'espèce et remarqua que la poussière cireuse sur les ailes et la forme de l'appareil buccal différent de celles d'autres phalènes. Il supposait que cette phalène pouvait appartenir à un groupe nouveau d'insectes. C. Linnaeus (1758) qui range cette espèce parmi les Lépidoptères, lui donne le nom scientifique *Phalaena (Tinea) proletella*²⁾. Geoffroy (1762) a décrit d'érable *Chermes aceris ovatus*³⁾. Ce nom n'est pas valable, étant trinomial. En 1796, Latreille a créé le premier genre *Aleyrodes*, mais sans l'indication de l'espèce — type. Dans ses travaux, Latreille (1807, 1825 etc.) regarde les aleurodes comme étant des représentants de l'ordre des Hémiptères, de la section des Homoptera, de la famille des Hymenelytra et du tribe des Aphidii.

La forme aplatie des larves de tous les stades des aleurodes rappelle souvent des cochenilles (sous-ordre des Coccinea). En effet, quelques auteurs décrivant des espèces nouvelles d'aleurodes, les rangent dans des genres déjà existants des cochenilles. Notons par exemple Modeer (1778) et son *Coccus aceris* en Suède,⁴⁾ Schrank (1801) avec *Coccus asari*⁵⁾ ou Baerensprung (1849) avec *Lecanium complanatum*⁶⁾. Les autres distinguent, il est vrai, le

¹⁾ *Aleyrodes proletella* L., vivant sur *Chelidonium majus* et sur d'autres plantes-hôtes (p ex. sur les Brassicacées).

²⁾ P. 537, No. 261: "alis albidis punctis duobus fuscis, lingua inflexa, +, ... Habitat in Brassica, Chelidonio, an etiam in Quercu? ..."

³⁾ *Aleurochiton aceris* (Mod.)

⁴⁾ *Aleurochiton aceris* (Mod.)

⁵⁾ *Aleyrodes asari* (Schr.)

nom générique *Aleyrodes* Latr., mais ils considèrent leurs représentants comme étant des cochenilles. C'est par exemple Burmeister (1835) qui indique le genre *Aleyrodes* avec l'espèce unique *A. chelidonii* Latr.⁶⁾, comme des représentants de la famille des Coccina ("Scharlachläuse. Schildläuse. Gallinsecta). Aussi, Bouché (1851), en décrivant les espèces nouvelles des aleurodes — *Aleyrodes aceris* et *Aleyrodes phyllicae*⁷⁾ les regarde comme Coccina ("Scharlachläuse") et plus tard encore, Kùnow (1880) décrit *Aleyrodes vac-cinii*⁸⁾ comme une cochenille ("Schildlaus"). D'autre part, le genre *Spondylaspis* par exemple, créé par Signoret (1879) comme un genre des aleurodes, appartient en réalité au sous-ordre des Psyllinea. Westwood (1840) a établi la première famille des Aleyrodidae.

Au sens de la taxonomie moderne, les aleurodes représentent un sous-ordre des Aleyrodinea avec une famille unique — Aleyrodidae. Déjà Quintance et Baker (1913–15) divisent cette famille en 3 sous-familles: Udamoselinae, Aleurodicinae et Aleyrodinae. Cette division est suivie dans le Catalogue des espèces du monde entier (Mound et Halsey, 1978).

LA CARACTÉRISTIQUE DU SOUS-ORDRE DES ALEURODES

Les aleurodes représentent un groupe homogène parmi les Sternorrhyncha. Les adultes ne mesurent que 1 à 3 mm. Tous les deux sexes possèdent deux paires des ailes et leurs corps ainsi que les ailes sont couverts d'une poudre cireuse blanche. Le dimorphisme sexuel, tant prononcé par exemple chez les cochenilles, n'est pas remarquable. Les stades larvaires sont aplatis, ils ne sont mobiles qu'au commencement de leurs cycle évolutif. Le dernier stade larvaire — le puparium — est activement immobile, ayant extrémités et l'appareil buccal rabougris.

Le puparium, le stade le plus important pour la taxonomie des aleurodes, possède un bon nombre de caractères morphologiques constants, et la détermination de l'espèce se fait surtout d'après les caractères de la morphologie externe des pupariums. La plupart des espèces ne sont connues qu'à ce stade évolutif. C'est pourquoi les caractères morphologiques du puparium sont étudiés plus en détail.

Le puparium est le plus souvent de forme ovulaire ou pyriforme, aplati ou convexe, atteignant environ un millimètre de longueur. Il est le plus large au niveau du 2^{ème} segment abdominal. Le coloris du puparium est différent. Le puparium de beaucoup d'espèces est clair — jaune ou jaunâtre (genre *Pealius*) ou blanchâtre (genre *Aleyrodes*), d'autres sont sombres: noir (genres *Aleurolobus*, *Tetralicia*) ou brun (*Aleurochiton* etc.). Le puparium est couvert d'une mince couche de la cire. Mais les pupariums de certains genres sont munis d'une riche ornementation cireuse. Elle forme de courts filaments périphériques blancs (genre *Tetralicia*), de longs filaments périphériques et des lamelles dorsales (genre *Aleurolobus*), des plaques dorsales (genre *Aleurochiton* etc.). Dans d'autres cas la cire blanche est concentrée au débouchement des sillons trachéaux (genre *Asterobemisia* etc.).

La détermination exacte des pupariums est possible seulement chez les

⁶⁾ *Aleyrodes proletella* (L.)

⁷⁾ *Siphoninus phillyreae* (Halid.)

⁸⁾ *Asterobemisia carpini* (Koch)

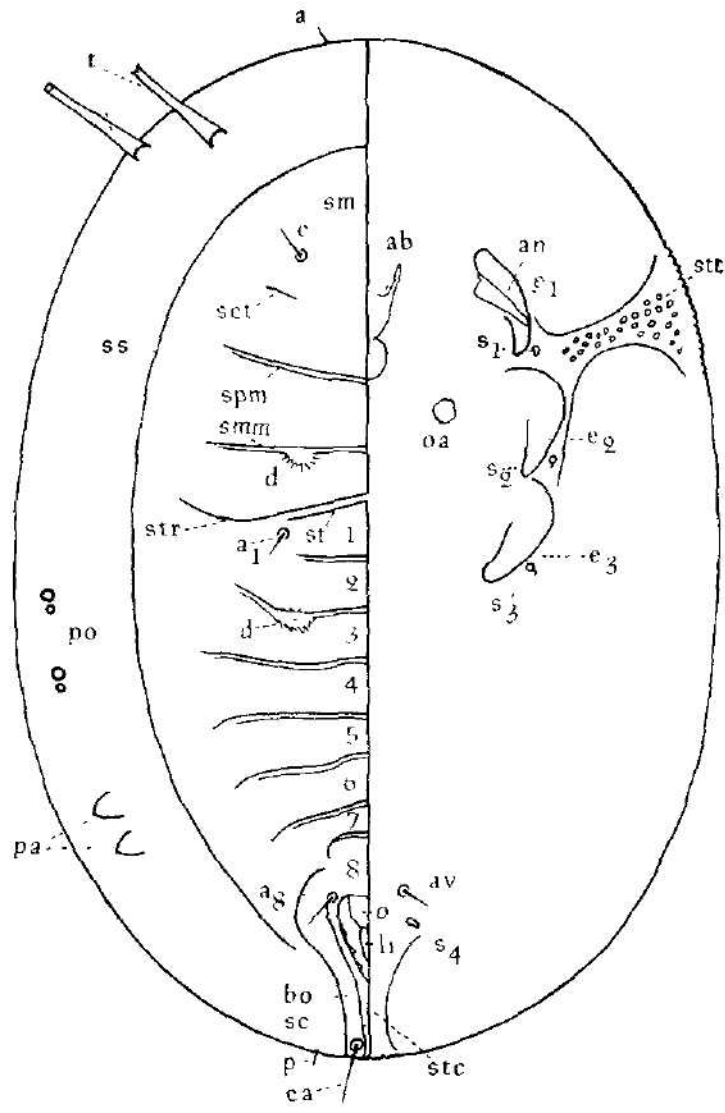


Fig 1 — Puparium. Schéma montrant la terminologie utilisée. a — soie antérieure, a₁ — soie du 1^{er} segment abdominal; a₈ — soie anale; ab — appareil buccal; an — antenne; av — soie abdominale ventrale; bo — bordure de l'appareil anal; c — soie céphalique; ca — soie caudale; d — dépression cuticulaire; e₁ — e₂ — extrémités; li — lingula; o — opercule; oa — organe adhésif; p — soie postérieure; pa — papilles; po — pores; s₁ — s₄ — spiracules; sc — sillon caudal; sct — suture céphalothoracique; sm — suture médiane; ssm — suture mésométathoracique; spm — suture promésothoracique; ss — suture submarginale; st — suture thoracoabdominale; stc — sillon trachéal caudal; str — suture transversale; stt — sillon trachéal thoracique; t — tube sécréteur; 1 — 8 — segments abdominaux.

individus, montés aux préparations microscopiques. Des caractères les plus importants sont les suivants:

- la forme du bord du corps
- la forme des dents périphériques et leurs nombre dans l'espace de 100 μm
- la forme des sutures et leurs longueur
- la présence, l'arrangement et la longueur des soies périphériques et dorsales
- la forme de l'appareil anal, sa longueur et sa distance de la dernière suture abdominale et du bord postérieur du corps
- la longueur relative des segments abdominaux
- la longueur du 7^{ème} segment abdominal
- la présence ou l'absence du sillon caudal
- la forme des sillons trachéaux

La terminologie utilisée dans cette révision ressort nettement du schéma adjoint (fig. 1). Elle correspond à la terminologie des travaux fondamentaux sur les aleurodes français de G o u x (l. c.).

Les pupariums de quelques espèces sont munis de longues tubes sécréteurs, chez les autres, on trouve des papilles dorsales et périphériques, qui sont bien connues p. ex. chez le genre *Trialeurodes*.

Le bord du puparium est soit lisse, soit dentellé. Les dents périphériques ont la même longueur et largeur ou elles sont plus longues que larges ou au contraire. Leur nombre dans l'espace de 100 μm est plus ou moins constant. Parfois, toutes les dents sont d'une forme et grandeur égales de l'une à l'autre, mais, chez quelques genres ou espèces, les dents au niveau des sillons trachéaux thoraciques et du sillon abdominal sont plus accentuées; elles sont plus sclérifiées et parfois plus longues ou larges que les autres dents périphériques. Parfois, on remarque au niveau des sillons trachéaux une échancrure bien distincte. Exceptionnellement le bord du puparium est plié. Dans ce cas, on distingue le bord réel et le bord apparent (par exemple chez le genre *Tetrália*).

Les sutures sont développées sur la partie dorsale du puparium. La suture submarginale est plus ou moins parallèle au bord du puparium. Elle est développée seulement chez un petit nombre des genres (par exemple chez *Aleurolobus*). La suture médiane court au milieu du cephalothorax et le divise en parties gauche et droite. Cette suture atteint soit le bord antérieur du puparium, soit elle se termine dans la partie submarginale. La suture transversale est régulièrement très accentuée, elle est modérément ou fortement courbée. Soit, elle atteint le bord latéral du puparium, soit elle se termine dans la partie submarginale ou submarginale du puparium. La suture médiane et la suture transversale sont désignées comme suture en T ayant la forme du majuscule T renversé. Dans la partie thoracique se trouvent encore les sutures céphalothoracique, promésothoracique et mésométathoracique. La suture céphalothoracique est souvent indistincte. la suture promésothoracique est le plus souvent courbée vers l'avant la mésométathoracique est rectiligne. La suture thoracoabdominale se trouve immédiatement derrière la suture transversale, mais elle est parfois indistincte. Les sutures abdominales 1 - 7 ont une longueur et la forme différente. Les extrémités des premières sutures se courbent vers l'avant du puparium, les sutures médianes sont plus ou moins rectilignes et les dernières sutures abdominales se courbent vers le bord postérieur du

puparium. Sur les sutures et sur la face dorsale du puparium se trouvent régulièrement des dépressions cuticulaires.

Les soies sont développées chez la plupart des genres. Elles se trouvent au bord du puparium et sur ses deux faces. Les soies marginales antérieures et postérieures se trouvent par paires non loin de l'axe médiane du corps. Les soies postérieures sont plus longues que les antérieures. Chez quelques espèces se trouvent des soies marginales supplémentaires. Les soies dorsales portent leurs noms suivant leur position: les soies céphaliques se trouvent dans la partie antérieure du céphalothorax, les soies du 1^{er} segment abdominal sont situées dans la partie subdorsale, les soies du 8^{ème} segment abdominal (les soies anales) se trouvent au côté antérieur de l'appareil anal. Les soies caudales sont développées près du bord postérieur de l'appareil anal. Les paires supplémentaires des soies dorsales peuvent être présentes sur d'autres segments du corps. La longueur et le nombre des soies sont stables dans la cadre d'une espèce, ou leur nombre et leur longueur dépendent de la plante-hôte (*Aleyrodes lonicerae*, *Bemisia tabaci* etc.).

L'appareil anal est situé toujours sur la face dorsale du puparium. Il est formé de l'ouverture anale, de l'opercule et de la lingula. Sa forme est très variable parmi les genres différents. Il est triangulaire ou triangulaire-allongé, cordiforme, ovalaire, subcirculaire ou arrondi. La distance de l'appareil anal de la 7^{ème} suture abdominale et la distance du bord postérieur du corps sont constantes et ont une importance taxonomique. L'opercule est triangulaire (*Aleurolobus*), subtrapézoïdal (*Siphoninus*), subcirculaire etc. Aussi la lingula est d'une forme diverse. Elle est allongée et pointue à l'apex (*Asterobemisia*, *Bemisia*), elle a la forme d'une massue (*Aleyrodes*) etc. La lingula soit dépasse la longueur de l'opercule (*Asterobemisia*, *Bemisia*, *Siphoninus*), soit elle est totalement cachée sous lui (*Tetralicia*, *Aleurolobus* etc.).

La longueur des segments (mesurée dans la partie médiane): quelques espèces ont les segments 1 — 7 de l'abdomen de même longueur, chez d'autres le segment 7 peut être très court (*Asterobemisia*). Le 8^{ème} segment est de la longueur maximale parmi tous les segments.

Les pores dorsaux se trouvent soit solitairement, soit par paires; leurs structure est obscure.

Chez un bon nombre d'espèces se trouve un sillon caudal qui court dès l'appareil anal jusqu'au bord postérieur du corps (*Asterobemisia carpini*, *Dialeurodes chittendeni* etc.). Il est parfois richement orné.

Les sillons trachéaux se trouvent, au nombre de 3, sur la face ventrale du corps. Deux sont thoraciques, un est abdominal. Même les sillons trachéaux sont parfois sculptés.

L'adulte est semblable au petit papillon, son corps et les ailes sont couverts de la poussière de cire blanche.

La longueur du corps varie de 1 à 3 millimètres. La plus grande espèce connue dans les serres hongroises — *Ceraleurodicus kesselyaki* (Visnya) — mesure plus de 6 mm de longueur (Visnya, 1941).

La tête est prognathe, portant des antennes, des yeux composés et l'appareil buccal.

L'antenne est composée de 7 articles, dont les deux premiers ont la forme globuleuse, le 3^{ème} article est le plus long chez la plupart d'espèces. Les

articles 3 à 7 sont annelés et munis de soies. Sur quelques articles se trouvent des sensoria et des poils sensoriaux. L'organe sensoriel est formé d'une cupule entourée de soies.

L'oeil composé est sombre, du type acône. Une bande, couverte de soies, divise l'oeil en deux parties: dorsale et ventrale. Il semble que l'adulte possède 4 yeux. A la base de la bande transversale sont insérées des antennes. Les parties dorsale et ventrale d'oeil composé sont, à peu près, de la même grandeur. La partie dorsale est aplatie, la ventrale modérément convexe. Le nombre d'ommatidies et leurs rôle diffèrent dans les deux parties. Suivant Weber (1934) chez *Aleyrodes proletella*, les ommatidies de l'oeil dorsal sont plus petites que celles de l'oeil ventral, et leur nombre est plus grand que celui d'ommatidies de la partie ventrale. Aussi, la cornée des ommatidies dorsales est plus mince que celle des ommatidies ventrales. La cornée des ommatidies est plus souvent clair jaune-brun, mais, à peu près un quart du nombre total des ommatidies sont incolores.

A la partie supérieure de chaque oeil dorsal se trouve un ocelle latéral.

Les ailes sont pliées en toit sur le corps. Elles sont toujours présentes et à la nervation très réduite surtout quant aux ailes postérieures.

Les pattes sont longues, bien développées. Les pattes postérieures sont capables du saut ayant les hanches allongées et élargies. Mais, l'insecte ne saute pas d'une manière comme le font des psylles ou des cicades. Leurs saut signifie le commencement de vol. La patte est terminée de tarse aux 2 articles et c'est sur ces articles que l'insecte marche. Parmi les unguicules paires se trouve un paronychium impair de forme différente. Il peut être lobuleux, mais souvent, il est en forme de lame.

A la base ventrale de l'abdomen se trouvent des glandes cirières sécrétant la poussière de la cire blanche.

Comme chez beaucoup d'autres groupes des Insectes, les organes copulateurs ont certainement la signification taxonomique chez les aleurodes. Notamment les paramères de l'organe copulateur mâle possèdent des caractères microscopiques importants. Mais, comme la taxonomie actuelle des aleurodes est édiflée sur les caractères de la morphologie externe des pupariums, ces organes ne sont pas suffisamment explorés.

RÉGIME ALIMENTAIRE

Les aleurodes sont des insectes phytophages. Ils se rencontrent le plus souvent sur la face inférieure des feuilles de leurs plantes-hôtes, où ils sont protégés des influences défavorables des vents et des pluies. Ils y trouvent aussi l'humidité relative plus favorable pour leur vie et leur développement.

D'après leur comportement par rapport aux plantes — hôtes, les aleurodes sont monophages, oligophages ou polyphages. La plupart des espèces de la faune tchèque appartient aux espèces monophages. Ce sont, par exemple, *Calluneyrodes callunae* vivant sur *Calluna vulgaris*, *Siphoninus immaculatus* sur *Hedera helix*, *Asterobemisia pavli* sur *Euphorbia*, *Asterobemisia obenbergeri* sur *Thymus serpyllum*, *Aleurochiton aceris* sur *Acer platanoides*, *Aleurochiton acerinus* sur *Acer campestre*, *Aleyrodes asari* sur *Asarum europaeum* etc.

Les espèces oligophages sont rares dans la faune tchèque. On y compte *Tetralicia ericae* vivant sur *Erica carnea* et *E. tetralix* et *Dialeurodes chitten-*

deni qui est inféodé aux différentes espèces et variétés du genre *Rhododendron*.

Les aleurodes polyphages ont leur régime alimentaire limité et se trouvent sur des plantes-hôtes, faisant partie de différentes familles botaniques. La polyphagie des aleurodes n'est pas accentuée d'une telle manière comme il en est par exemple chez les cochenilles. Aux aleurodes polyphages appartiennent p. ex. *Aleurolobus wunni* connu sur *Asarum europaeum*, sur les espèces de *Lonicera*, *Symphoricarpus*, *Clematis* etc., *Aleyrodes proletella* sur *Chelidonium majus*, sur les Brassicacées etc., *Aleyrodes lonicerae* sur *Fragaria* spp., *Lonicera*, *Oxalis acetosella*, *Impatiens noli tangere* etc.; *Pealius quercus* est connu surtout sur *Carpinus betulus*, *Quercus* spp., *Corylus avellana* etc., *Asterobemisia carpini* sur *Corylus avellana*, *Carpinus betulus*, *Betula* spp., *Fraxinus* spp. etc., *Siphoninus phillyreae* sur *Fraxinus* spp., *Crataegus* spp., *Pirus* etc.

Les aleurodes habitent leur plante-hôte soit solitairement, soit en colonies. La plupart des espèces de la faune tchèque appartiennent aux espèces solitaires et on n'en trouve que peu d'individus sur une feuille de la plante-hôte (p. ex. *Aleurolobus wunni*, *Tetraticia ericae*, *Asterobemisia obenbergeri* etc.) au contraire *Aleyrodes asari*, *Aleyrodes proletella*, *Siphoninus phillyreae*, *Siphoninus immaculatus* se montrent toujours en colonie avec un nombre élevé d'individus.

LE DÉVELOPPEMENT. L'HIVERNAGE

Le développement des aleurodes — allometabolie — est une métamorphose très spéciale même parmi les Sternorrhyncha. Les femelles pondent leurs oeufs sur la face inférieure des feuilles soit en demi-cercle, soit en groupes. Le mode de l'oviposition dépend de la qualité de la feuille. Les endroits de la fixation des oeufs sont couverts de la pousse cireuse blanche qui les protège des influences défavorables.

La métamorphose suit 4 instares larvaires: la larve du premier stade qui est hexapode, trouve une place favorable sur une feuille, où elle se fixe et sécrète autour de son corps une couche périphérique de la cire. Les larves du deuxième et troisième stade sont très aplaties, avec les extrémités et les yeux réduits alors ne bougeant pas activement d'une place à l'autre. Le quatrième stade larvaire — le puparium — a les pattes et les yeux aussi réduits, mais il est plus convexe et ne prend plus de la nourriture.

Les adultes échappent du puparium par l'ouverture, formée des sutures médiane et transversale. Après l'éclosion, le puparium vide persiste encore un temps à la plante-hôte.

Les aleurodes de la faune tchèque ont une, deux ou plusieurs générations annuelles. Les espèces ayant une seule génération sont p. ex. *Calluneyrodes callunae* ou *Tetraticia ericae*. Les espèces à deux générations comme par exemple *Aleurochiton acerinus*, *Al. aceris*, offrent une génération estivale et une génération hivernale. Les pupariums de ces générations montrent les caractères morphologiques très distinctes. Les pupariums estivaux d'*Aleurochiton aceris* et *A. acerinus* sont minces, verdâtres, fortement aplatés. La marge du corps est munie par une haute palissade cireuse. Les pupariums hivernaux sont épais, brun-foncé et convexes, avec une riche ornementation cireuse dorsale. Ils sont toujours plus robustes que les formes estivales.

Les espèces polyvoltines offrent plusieurs générations annuelles qui se superposent. C'est le cas des espèces du genre *Aleyrodes*.

L'hivernage des aleurodes se fait soit au stade du puparium (chez la plupart d'espèces), soit au stade d'individus adultes (les espèces du genre *Aleyrodes*). La durée de la diapause hivernale des pupariums se prolonge à plusieurs mois. C'est le cas, p. ex. chez les espèces du genre *Aleurochiton*, dont les pupariums hivernaux se rencontrent depuis le mois de juillet jusqu'à la fin d'avril ou au commencement du mai de l'année suivante etc.

RÉPARTITION GÉOGRAPHIQUE

Les aleurodes ont leur centre d'évolution et de répartition dans les régions africaine, orientale et neotropicale, où on rencontre la plus grande richesse spécifique de ces insectes. Dans les régions tempérées, ils sont représentés seulement par quelques dizaines d'espèces.

La distribution des aleurodes, vivant dans les pays tchèques, n'est pas encore connue suffisamment. Quelques-uns sont répartis très largement, les autres ont été observés seulement dans les localités sporadiques ou dans une localité unique. Montrons quelques exemples. *Aleyrodes proletella* est connu de toute l'Europe, de l'Afrique du Sud (Mound, 1966). *Aleurochiton aceris* qui est inféodé aux érables, se rencontre avec sa plante-hôte presque dans toute l'Europe. Une large répartition a été observée aussi chez *Siphoninus phillyreae* qui est répandu dans les régions paléarctique, africaine et orientale. L'espèce thermophile *Asterobemisia obenbergeri* doit aussi avoir une vaste répartition, allant de l'Europe méridionale jusqu'à l'Europe centrale, quoiqu'elle ne soit connue que de l'Albanie, de la Yougoslavie et de la Tchécoslovaquie, où elle atteint probablement la frontière septentrionale de sa dispersion. Au contraire *Calluneyrodes callunae* décrit de la Suède et *Asterobemisia pavli*, provenant de la Moravie, n'ont été observés que dans des localités sporadiques.

APERÇU HISTORIQUE

Les premiers travaux contenant les indications sur les aleurodes en Tchécoslovaquie proviennent de Dlabola (1941, 1943). L'auteur y mentionne la présence de *Trialeurodes vaporariorum* dans une serre de Prague et la présence d'*Aleyrodes menthae* en Bohême (= *Aleyrodes lonicerae*). En 1946, Lang publie son premier travail sur les aleurodes, dont le sujet sont la morphologie de *Siphoninus dubiosa* (= *S. phillyreae*) et sa répartition en Moravie. Une année plus tard, le même auteur (Lang, 1947) cite *Aleurolobus puripennis* en Moravie (= *A. wunni*) et enfin, (Lang, 1957), dans un travail sur les parasites des aleurodes (dont les noms il n'indique pas), cite aussi les localités de 4 espèces. Dès 1955, l'auteur de cette révision a publié plusieurs travaux sur la morphologie, taxonomie, bionomie et répartition des aleurodes (Zahradník, 1955 — 1963). Il a créé des genres nouveaux et a décrit les espèces nouvelles de la Tchécoslovaquie.

SYSTÉMATIQUE

Famille Aleyrodidae Westwood, 1840

Genre *Siphoninus* Silvestri, 1914

(Boll. Lab. Zool. Gen. Agr. 9 : 245)

Espèce-type : *Siphoninus finitimus* Silv., 1914

Le puparium est ovalaire, clair ou brunâtre, avec une mince sécrétion creuse.

Le bord du puparium est lisse ou formé de dents irrégulières qui sont plus accentuées au bord des zones tracheales (les dents dans les zones tracheales thoraciques étant moins accentuées que celles de la zone abdominale). La surface dorsale du puparium n'est pas sculptée. Le puparium est muni de tubes sécréteurs, dont le nombre, surtout sur les segments abdominaux, est assez variable.

Les sutures sont bien marquées. La suture médiane atteint le bord antérieur du corps, la suture transversale se courbe d'abord modérément vers l'arrière derrière la moitié de sa longueur, elle se courbe modérément vers l'avant, sans atteindre le bord latéral du puparium. Les dépressions cuticulaires sont développées comme d'habitude, les dépressions meso- et métathoraciques sont peu marquées. Les 4 dépressions antérieures sont bien visibles.

Les soies. Les soies antérieures et postérieures sont développées, relativement courtes. Les soies dorsales (les soies céphaliques, les soies du 1^{er} et 8^{ème} segments abdominaux et les soies caudales) sont massives, longues.

Les pores ne sont pas développés.

L'appareil anal est aussi long que large ou il est un peu plus long que large, son intérieur est orné d'une sclérification réticulaire. La distance de l'appareil anal de la dernière suture abdominale est égale ou légèrement inférieure à sa longueur, sa distance du bord postérieur du corps est égale ou légèrement plus longue que sa longueur. L'opercule est petit, plus large que long, la lingula est visible, elle est élargie à l'apex, munie de 2 soies de longueur différente.

Le sillon caudal et les sillons trachéaux ne sont pas marqués.

On connaît 2 espèces en Tchécoslovaquie qui diffèrent comme suit.

- 1 (2) Les tubes sécréteurs sont profondément bilobés à leur apex. La longueur moyenne de l'appareil anal fait 75 μm , sa distance de la 7^{ème} suture abdominale à peu près d'un tiers plus courte que sa longueur. La lingula relativement grande, avec 2 soies atteignant à peu près 30 μm . Les soies submarginales mesurent de 3,5 à 5,6 μm *S. immaculatus*
- 2 (1) Les tubes sécréteurs ne sont pas bilobés à l'apex. La longueur moyenne de l'appareil anal fait 50 μm , sa distance de la 7^{ème} suture abdominale est à peu près la même que sa longueur. La lingula est petite, munie de 2 (parfois 4) soies de 4 à 6 μm de longueur. Les soies submarginales ont environs de 25 μm de longueur *S. phillyrea*

Siphoninus immaculatus (Heeger, 1856)

(S. Ber. Akad. Wiss., matem.-naturwiss. Cl., 18 34, *Aleurodes*)

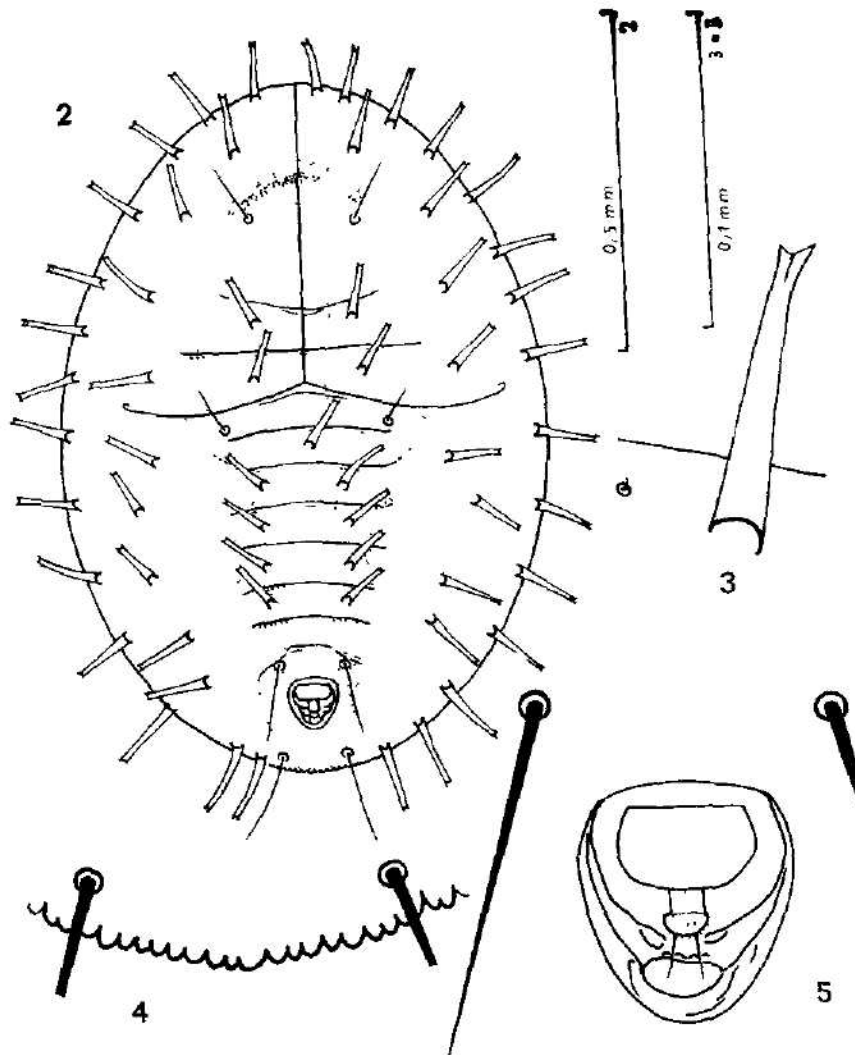
Syn. *heegeri* Haupt, 1935 (*Siphoninus*)

Caractères macroscopiques.

Le puparium est ovalaire, clair, avec les parties médiane et submédiane embrunies. Il atteint environs 1 mm de longueur sur 0,7 – 0,8 mm de largeur maximale au niveau du 2^{ème} segment abdominal.

Caractères microscopiques (fig. 2).

Le bord du puparium est délimité par de fines dents irrégulières, dont on compte de 9 à 12 dans l'espace de 100 μm . Le bord de la zone trachéale thoracique est limité par de 6 à 9 dents un peu plus régulières que les autres. Au niveau du sillon caudal, il y a une rangée de 20 à 22 dents saillantes et plus sclérifiées (fig. 4).



Figs. 2 — 5. *Siphonius immaculatus*: 2 — puparium (vue dorsale); 3 — tube sécréteur; 4 — dents du sillon trachéal abdominal; 5 — appareil anal.

La forme des sutures correspond à la caractéristique du genre.

Les soies sont toujours présentes, atteignant la longueur suivante. Soies antérieures $17 \mu\text{m}$, soies postérieures $34 - 45 \mu\text{m}$, soies submarginales $3 - 6 \mu\text{m}$, soies céphaliques $80 - 105 \mu\text{m}$, soies du 1^{er} segment abdominal $53 - 77 \mu\text{m}$, soies anales $105 \mu\text{m}$, soies caudales $105 - 130 \mu\text{m}$.

Les tubes sécréteurs (fig. 3) sont nombreux, ramifiés à l'apex. On distingue des tubes marginaux, submarginaux et médians. Les tubes marginaux composent une rangée périphérique de 15 à 17 éléments. Dans la rangée submarginale, on trouve de 8 à 11 éléments. par 2 tubes se trouvent sur les segments méso- et métathoracique. Le nombre des tubes sur les segments abdominaux

1 à 8 est le suivant: segment 1 (0), 2 (0-1), 3 (0-2), 4-6 (1-2), 7 (0-1), 8 (0).

L'appareil anal (fig. 5) atteint environ 75 μm de longueur sur un peu plus de 70 μm de largeur, possédant une sclérisation interne. Sa distance de la dernière suture abdominale fait de 34 à 52 μm , la distance du bord postérieur du puparium mesure 67 à 75 μm . L'opercule est plus large que long, la lingula est élargie à l'apex, portant 2 soies environ 30 μm longues.

S. immaculatus est inféodé à la lierre (*Hedera helix*), sur laquelle il semble monophage. Les pupariums et les adultes se trouvent sur la face inférieure des feuilles. Les adultes se montrent au juin.

Les données sur la présence de „*Siphoninus phillyreae* et *dubiosa*“ ou d'autres formes vivant sur la lierre correspondent vraisemblablement au *S. immaculatus*.

L'espèce est connue de l'Autriche, de la Hongrie, de la Tchécoslovaquie, de l'Allemagne, de la Suède, de la France, de l'Angleterre et de l'Italie.

Repartition dans les pays tchèques. Zahradník (1961). Exemples des localités Český Krumlov (7151), Sychrov (5356), Náchod (5563), Opočno (5762), Průhonice (6053), Mohelno (6863), Lednice (7266) etc

Siphoninus phillyreae (Haliday, 1834)

(Ent. Mag., 2 : 119; *Aleurodes*)

Syn.: *phillyreae* Bouché, 1851 (*Aleurodes*); *dubia* Heeger, 1859 (*Aleurodes*); *finitimus* Silvestri, 1915; *inaequalis* Gauthier, 1923 (*Trialeurodes*); *granati* Pries. et Hos., 1932, *dubiosa* Haupt, 1935; *phillyreae multirubulatus* Goux, 1949.

Caractères macroscopiques

Le puparium est ovalaire, mince et claire, les parties médiane et submédiane sont embrunies. Palissade marginale cireuse développée, couche cireuse dorsale mince. Le puparium atteint de 0,7 à 1,0 mm de longueur sur 0,5 à 0,7 mm de largeur.

Caractères microscopiques (fig. 6).

Le bord du puparium est légèrement irrégulier, seulement le bord de la zone trachéale abdominale est limité de 10 à 14 dents plus sclérifiées (fig. 8).

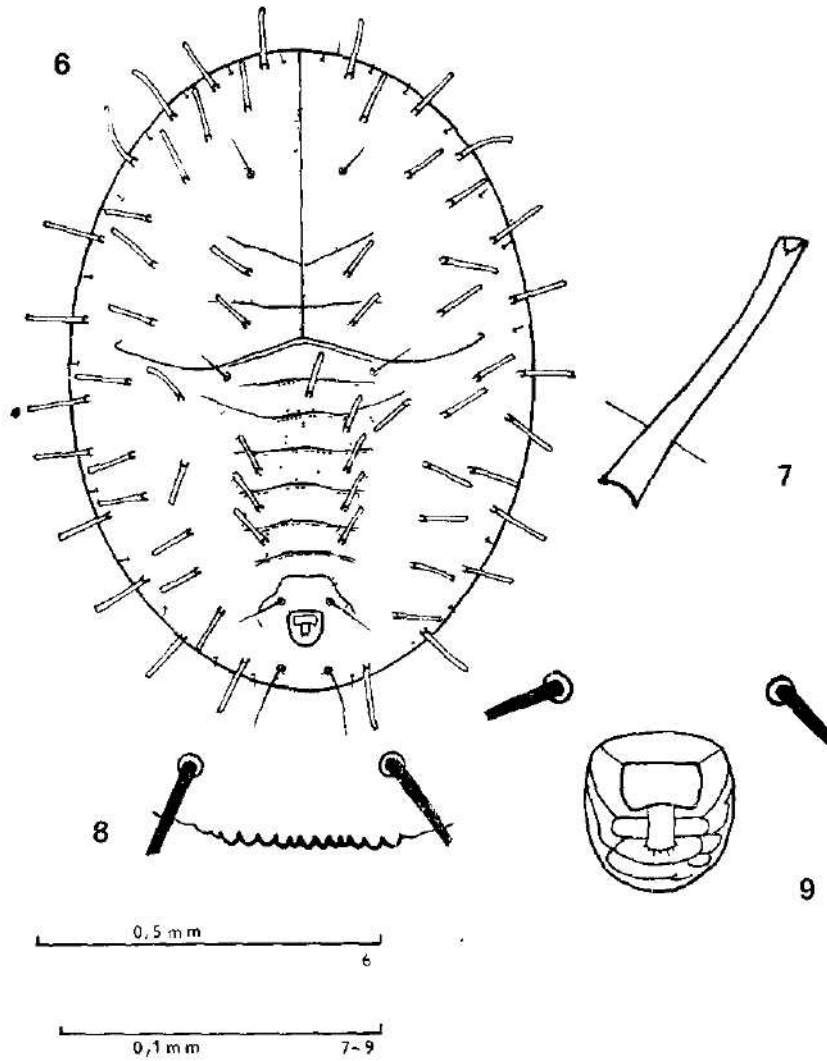
Les sutures correspondent à la caractéristique du genre.

Les soies sont développées, leurs longueur est la suivante: soies antérieures 9 - 17 μm , soies postérieures 30 - 44 μm , soies submarginales 25 μm , soies céphaliques 35 - 61 μm , soies du 1^{er} segment abdominal 27 - 47 μm , soies anales 54 - 70 μm , soies caudales 70 - 95 μm .

Les tubes sécréteurs (fig. 7) nombreux, ils ne sont pas ramifiés à l'apex. Les tubes marginaux composent une rangée périphérique de 11 à 14 éléments, la rangée submarginale comprend de 10 à 14 tubes. Sur les segments méso- et métathoracique se trouve par 2 tubes. Le nombre de tubes sur les segments abdominaux est comme suit: 1 (0), 2 (0-1), 3 (0-2), 4 (0-2), 5 (1-2), 6 (0-2), 7 et 8 (0).

L'appareil anal (fig. 9) atteint de 45 à 54 μm de longueur sur 44 à 47 μm de largeur. Sa distance de la dernière suture abdominale mesure 40 - 49 μm , la distance de l'appareil anal du bord postérieur du corps dépasse légèrement sa propre longueur. L'opercule est très mince, 12 - 14 μm de longueur sur 25 à 27 μm de largeur. La lingula est terminée par 2 soies très minces, longues de 4 - 6 μm .

S. phillyreae est une espèce polyphage, vivant sur les feuilles de différents arbustes et arbres. En Tchécoslovaquie, il est connu surtout sur *Fraxinus excelsior*, *F. ornus*, *Crataegus oxyacantha*, *C. monogyna*, *Pirus communis* et *Pirus malus*.



Figs. 6 — 9. *Siphoninus phillyreae*: 6 — puparium (vue dorsale); 7 — tube sécréteur; 8 — dents du sillon trachéal abdominal; 9 — appareil anal.

Sans importance économique dans les pays tchèques, mais nuisible sur les arbres fruitières dans l'Europe méridionale (Patti et Rapisarda, 1981; Rapisarda et Patti, 1983 etc.).

La répartition de cet aleurodes est très vaste, il est indiqué des régions paléarctique, africaine et orientale (Mound et Halsey, 1978).

Distribution dans les pays tchèques: Lang (1940). L'espèce est commune surtout dans les endroits plus chauds. Exemples des localités: Český Krumlov (7151), Karlštejn (6051), Praha (5952), Poděbrady (5856), Lysá nad Labem (5755), Olomouc (6469), Brno (6865), Moheino (6863), Lednice (7266) etc.

Genre *Aleurolobus* Quaintance et Baker, 1914

(U.S. Dept. Agr., Bur. Ent., Tech. ser. 27 (pt. II) : 108)

Espèce-type: *Aleurodes marlattii* Quaint., 1903

Le puparium est ovalaire, le plus souvent noir, orné de plaques ciréuses thoraciques et abdominales et de filaments périphériques.

Le bord du puparium est denticulé, dans les zones trachéales se trouvent 3 – 4 dents plus saillantes. La surface dorsale est souvent richement sculptée.

Les sutures sont toujours bien marquées. La suture submarginale est redoublée, elle fait la frontière des faces submarginale et subdorsale du puparium. La suture médiane n'atteint pas le bord antérieur du puparium, elle se termine à la suture submarginale. La suture transversale est en forme d'une courbe. Les dépressions cuticulaires sont bien visibles comme des taches claires sur le céphalothorax et sur les segments abdominaux.

Les soies: il y a une paire de soies antérieures et une paire de soies postérieures périphériques. Les soies dorsales sont situées sur le céphalothorax, sur le 1^{er} et 8^{eme} segments abdominaux et une paire sont des soies caudales. Il y a aussi une rangée de petites soies dans la partie submarginale.

Les pores sont nombreux sur toute la surface dorsale.

L'appareil anal est triangulaire, de longueur et largeur égales ou légèrement plus long que large. L'opercule remplit la plupart de l'appareil, il a la forme d'un triangle aux angles arrondis. La lingula est cachée sous l'opercule, ou son apex seulement le dépasse.

Le sillon caudal est développé, avec l'intérieur orné. Les sillons trachéaux sont bien marqués.

Le genre est représenté par une espèce dans les pays tchèques.

Aleurolobus wunni (Ryberg, 1938)

[(K. fysiogr. Sällsk. Lund Förh., 8 (1938) : 20 (*Aleurodes*)]

Syn.: *asari* Wünn, 1926 (*Aleurodes*); *clematidis* Goux, 1942; *puripennis* Ossiannilsson, 1944.

Caractères macroscopiques.

Le puparium est ovalaire, le plus souvent de couleur noire. Quelques fois il est clair, aux sutures et d'autres sculptures moins prononcées (comp. Iacchino, 1981). Le puparium est couvert d'une mince pellicule ciréuse et des lamelles ciréuses dorsales, notamment abdominales. Le puparium est entouré des soies ciréuses blanches d'une longueur de 0,25 – 0,30 mm. Le bord du corps est quelquefois irrégulier. Le puparium mesure de 1 à 1,35 mm de longueur et de 0,7 à 0,9 mm de largeur au niveau du 1^{er} segment abdominal.

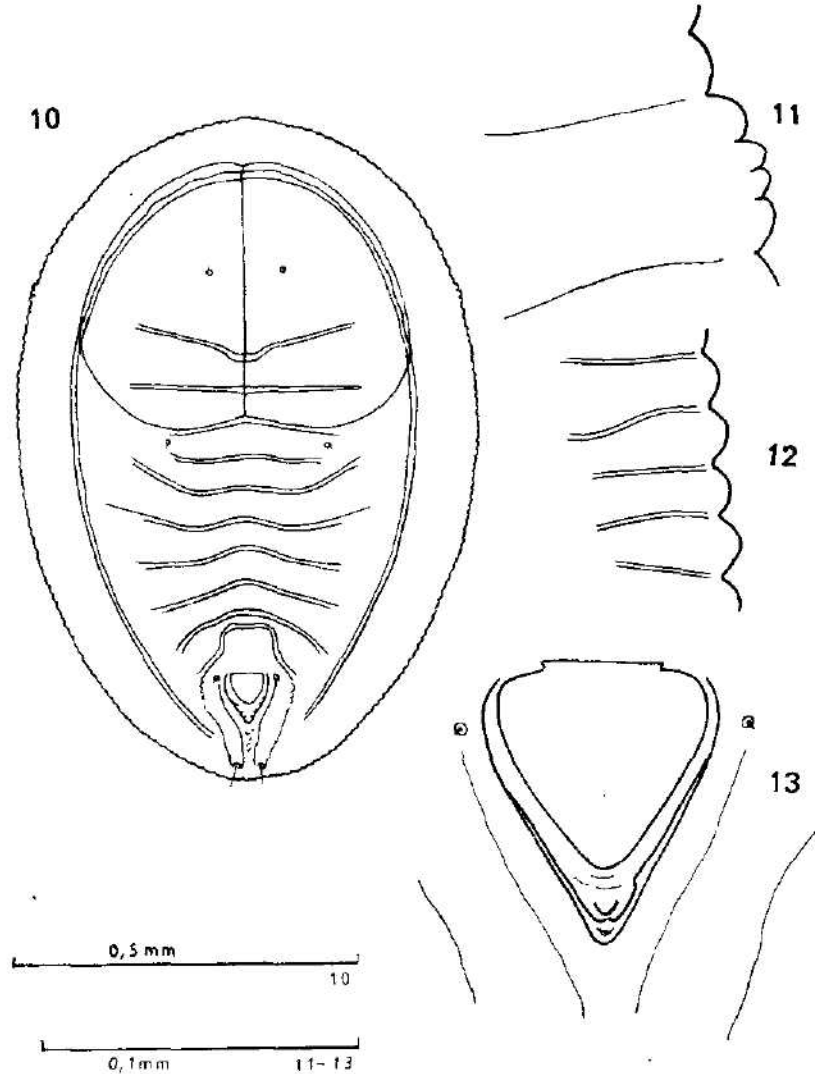
Caractères microscopiques (fig. 10).

Le bord du puparium est limité de larges dents, arrondies à l'apex (fig. 12). Souvent, ces dents sont à l'apex finement bilobées ou trilobées. On compte d'environ 5 à 6 dents dans la longueur de 100 μ m. Les 3 – 4 dents situées

au niveau des sillons trachéaux sont un peu plus saillantes que les autres dents marginales.

Tout de corps du puparium est très finement sculpté.

Sutures: la suture submarginale est très marquée, elle parcourt tout le corps et se termine près de l'appareil anal. La suture médiane atteint en avant la courbe de la suture transversale. La suture promésothoracique est modérément recourbée, la mésométhoracique est rectiligne. Ces sutures n'atteignent pas par leurs extrémités la suture submarginale. Les parties médianes des sutures abdominales sont courbées, à l'exception de la dernière. Les extrémités des



Figs. 10 — 13. *Aleurolobus wunni*. 10 — puparium (vue dorsale. Les pores et les soies submarginales ne sont pas marqués); 11 — sillon trachéal thoracique; 12 — dents marginales; 13 — appareil anal.

trois premières sutures se dirigent vers l'avant, la 4^{ème} est rectiligne, les extrémités des sutures 5 — 7 sont dirigées vers l'arrière. Les dépressions cuticulaires sur les sutures (et hors sutures) sont bien visibles.

Les soies sont de la longueur suivante: les soies antérieures 17 — 26 μm , soies postérieures 23 — 39 μm , soies céphaliques 21 — 26 μm , soies du 1^{er} segment abdominal 15 μm , soies anales 9 — 10 μm , soies caudales 37 μm . En outre de soies nommées, on trouve encore une rangée de 14 + 14 soies dans la zone submarginale.

Les pores et les porettes sont nombreux et bien visibles, répartis surtout dans la partie submarginale du corps.

L'appareil anal (fig. 13) est triangulaire-cordiforme, long de 76 à 88 μm et large de 56 à 72 μm . Sa face interne est remplie d'une ornementation. Il est entouré d'une large bordure. Sa distance de la dernière suture abdominale fait de 67 à 81 μm , sa distance du bord postérieur du corps fait de 108 à 132 μm . L'opercule est triangulaire, long de 55 à 69 μm et large de 53 à 65 μm . La lingua est totalement cachée sous l'opercule.

Le sillon caudal est distinct, les sillons trachéaux sont larges, sans l'ornementation (fig. 11).

A. wunni est une espèce polyphage qui se rencontre en Tchécoslovaquie sur les plantes-hôtes des familles suivantes: Rhamnaceae (*Frangula alnus*), Aristolochiaceae (*Asarum europaeum*), Ranunculaceae (*Clematis vitalba*), Lonicericaceae (*Lonicera nigra*, *L. xylosteum*, *Symphoricarpos albus*).

Le puparium hiverne. L'éclosion des adultes a lieu au mois de mai. Les premiers pupariums se montrent déjà dans la deuxième moitié de juillet.

A. wunni, décrit d'Alsace, est actuellement largement réparti en Europe, manquant dans les Iles Britanniques (Mou n d, 1966).

Répartition dans les pays tchèques: Lang (1947, 1957), Zahradník (1957). L'espèce est connue sur tout le territoire à l'exception des montagnes. Exemples des localités: Mariánské Lázně (6042), České Budějovice (7052), Český Krumlov (7151), Karlštejn (6051), Lomnice nad Popelkou (5458), Lázně Bělohrad (5559), Olomouc (6469), Vyškov (6767), Brno (6865), Mohelno (6863), Pavlovské kopce (7165) etc

Genre *Calluneyrodes* Zahradník, 1961

(Acta faun. ent. Mus. Natl. Pragae, 7 : 65)

Espèce-type: *Bemisia callunae* Ossiannilsson, 1947

Le puparium est ovalaire, avec la surface dorsale très fortement convexe. Il est couvert d'une mince couche de cire, l'ornementation cireuse périphérique est très faible.

Le bord du puparium est limité de dents irrégulières. Les dents des zones trachéales ne diffèrent pas d'autres dents périphériques. La surface dorsale est richement ornée. Aussi la face ventrale submarginale est ornée de polygones irréguliers.

Les sutures sont longues, très marquées, parfois sclérifiées. La suture médiane atteint le bord antérieur du puparium. La suture transversale, modérément incurvée, atteint le bord latéral du puparium. Les dépressions cuticulaires sont distinctes.

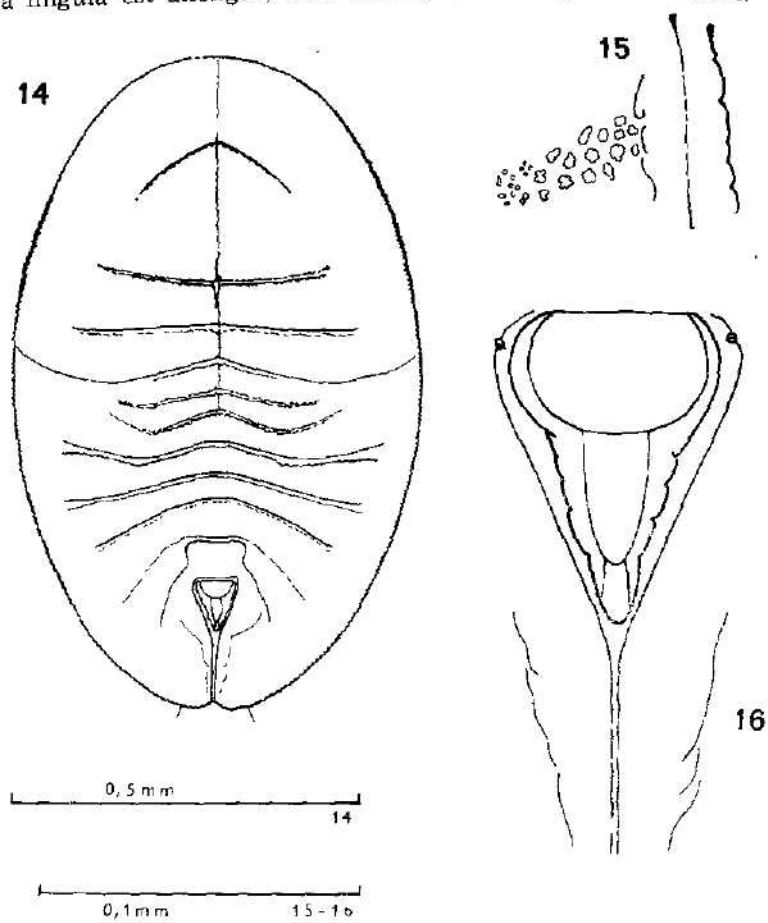
La longueur du segment 7 de l'abdomen ne dépasse pas un quart de la longueur du segment précédent.

Les soies: Les soies antérieures marginales manquent, les soies postérieures

sont développées. Les soies céphaliques et les soies du 1^{er} segment abdomina sont absentes, les soies du 6^{ème} segment sont développées, très courtes.

Les pores sont nombreux sur toute la surface dorsale.

L'appareil anal est triangulaire, plus long que large, sa distance du bord postérieur du corps dépasse légèrement sa longueur. L'opercule est semicirculaire, la lingula est allongée, bien visible, terminée par 2 soies.



Figs. 14 — 16. *Calluneyrodes callunae*: 14 — puparium (vue dorsale. Les pores ne sont pas marqués); 15 — sillon trachéal thoracique; 16 — appareil anal.

Le sillon caudal est bien marqué, très étroit et sans sculptures; les sillons trachéaux thoraciques sont bien accentués et abondamment ornés.

Ce genre est représenté par une espèce:

Calluneyrodes callunae (Ossiannilsson, 1947)

(Ent. Tidskr. 68 : 1; *Bemisia*)

Caractères macroscopiques.

Le puparium est vert olive, parfois vert brun olive, étroitement ovalaire.

Sa surface dorsale est très convexe en forme de toit. Le bord creux est faiblement marqué. La longueur du puparium est de 0,9 à 1,09 mm, sa largeur de 0,5 à 0,7 mm. Il est très difficile à discerner le puparium sur une feuille de la plante-hôte.

Caractères microscopiques (fig. 14)

Le bord du corps est denticulé, les dents ont la longueur et la largeur variables. Les dents du bord de la zone trachéale thoracique ne diffèrent pas d'autres dents marginales. Il y a 1 à 3 petites dents au bord de la zone trachéale abdominale.

La surface dorsale est richement ornée de nombreux polygones irréguliers. Une sculpture caractéristique, formée par des polygones en rangées, orne aussi la surface ventrale submarginale du puparium.

Les sutures. La suture médiane est très longue mesurant de 0,40 à 0,48 mm, c'est à dire parfois un peu plus que la moitié de la longueur totale du puparium. Elle atteint le bord antérieur du puparium. La suture transversale se dirige d'abord modérément vers l'arrière, puis, elle s'incurve modérément vers l'avant et se termine au bord latéral du puparium. La 1^{ère} suture abdominale est courte, la 2^{ème} est plus longue, dirigée vers l'avant, la 3^{ème} se dirige d'abord vers l'arrière, mais, n'atteignant pas la moitié de sa longueur, elle s'incurve modérément vers l'avant et se termine dans la région submarginale, non loin du bord. La 4^{ème} suture est dirigée vers l'arrière et se termine, comme la précédente, dans la région submarginale. La 5^{ème} est presque parallèle à la 4^{ème} suture. La 6^{ème} suture a la forme d'un demi-cercle, la 7^{ème} est rectiligne dans sa partie médiane, avec les extrémités à peu près parallèles aux extrémités de la suture précédente. Les sutures 3, 4 et 5 sont les plus longues de toutes les sutures abdominales. Elles sont aussi plus sclérifiées que les autres.

Les dépressions cuticulaires se trouvent à la face extérieure des sutures pro-mésothoracique, méso-métathoracique et abdominales. Les dépressions se voient aussi sur le céphalothorax, hors des sutures.

Le segment 7 est extrêmement court, sa longueur varie de 4 à 10 μm . La longueur du segment 8 fait de 50 à 60 μm , la longueur du segment 6 varie de 54 à 67 μm .

Les soies. Les soies marginales antérieures sont absentes, les soies postérieures atteignent de 23 à 30 μm . Les soies dorsales céphaliques et les soies du 1^{er} segment abdominal ne sont pas développées. Les soies du 8^{ème} segment sont très minces, insérées au côté antérieur de l'appareil anal.

Les pores gemines sont très nombreux, ils sont dispersés sur toute la surface dorsale du puparium. Dans chaque paire, un pore est nettement plus grand que l'autre.

L'appareil anal (fig. 16) est triangulaire, à peu près 100 μm de longueur et de 70 μm de largeur. Sa distance du bord postérieur du puparium dépasse sa longueur et varie de 95 à 130 μm . L'opercule est semi-circulaire. La lingula est allongée, dépassant l'opercule. Elle est terminée par 2 soies. Le sillon caudal est nettement accentué, très étroit, sans sculptures.

Les sillons trachéaux thoraciques (fig. 15) et le sillon abdominal sont abondamment ornés.

La répartition de cette espèce est très peu connue. Elle est actuellement citée de la Suède (Ossiannilsson, 1947) et de la Tchécoslovaquie (Zahradník, 1961).

Matériel. Boh. or. Prachovské skaly (5557) 12. 5. 1957 et 21. 4. 1960, pupariums.

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Rehák, I.: *Coluber rubriceps thracius* ssp. n. from Bulgaria

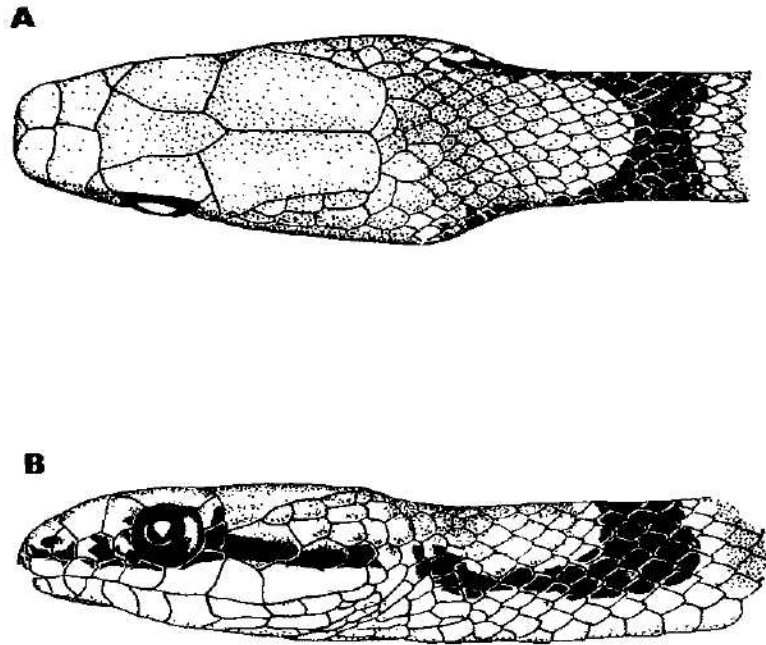


Fig. 1. *Coluber rubriceps thracius* ssp. n., the head of the holotype. A. Dorsal view
B. Lateral view.

Reháč, I.: *Coluber rubriceps thracicus* ssp. n. from Bulgaria

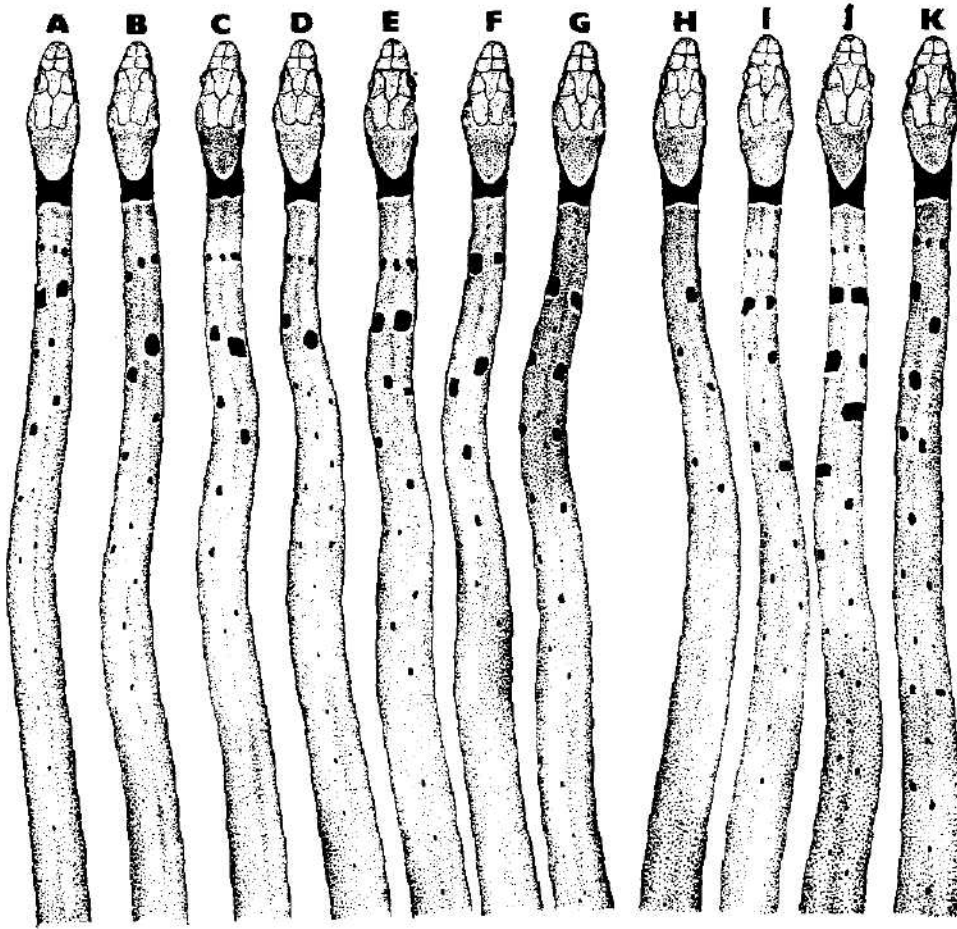


Fig. 2. *Coluber rubriceps thracicus* ssp. n., the distribution of dorsal spots in type specimens. A-G. Males. H-K. Females.

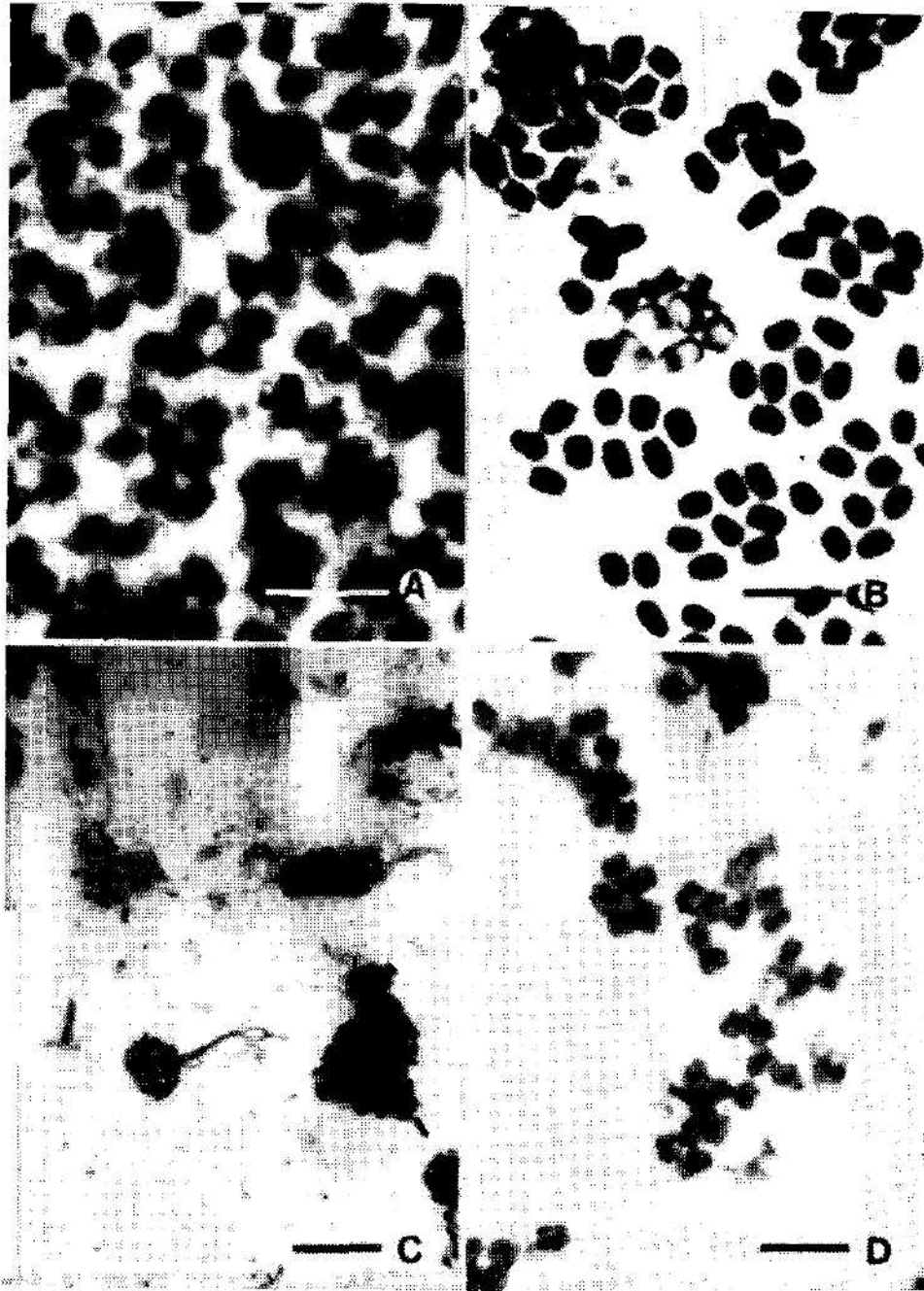


Fig. 1. A— *Parathelohania arabiensis*, spores on dry smear, evident membranous epispore. B— *Amblyospora kadunae* pansporoblasts with mature spores and sporoblasts. C— *A. kadunae* spore with extruded polar filament. D— Spores of *A. kadunae* stained after Weiser, visible elongated nuclei. All stainings Giemsa, rods = 10 nm.



Fig. 2. *A. kadunae*, polar filaments. A— Filaments with visible thick and thin parts. Evident extrusion of both ends at once. End -bead = b. B— Extrusion of polar filament with germ remaining inside (g). C— Germ of the spore (g) in the background of the extruded filament. D— Three polar filaments with visible thick and thin part and the end knob of the thick part (n)

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

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

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

V rukopisu nepředepisujte zásadně žádné typy písma, označte pouze tužkou podstraní části, které mají být vysazeny *petitem*.

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