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**MORPHOLOGY AND ULTRASTRUCTURE OF THE HEAD END OF
PORROCAECUM ENSICAUDATUM (NEMATODA: TOXOCARIDAE)**

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Abstract: The outer morphology of the head end of *P. ensicaudatum*, particularly of lips, interlabia, labial sense organs and dental apparatus, has been studied by scanning electron microscopy (SEM). The evolutionary significance of lip armament in ascaridoid nematodes is discussed. The photographic documentation is attached.

INTRODUCTION

The morphology and ultrastructure of the superfamily Ascaridoidea, a group of nematodes of both theoretical and practical importance, has been dealt with in a series of original papers published during the last ten years. The authors used the method of scanning electron microscopy and thus supplemented the systematics of this superfamily published previously in the classical monographs by Mozgovo j (1953) and Hartwich (1957, 1975). Considering only the revisions and papers on the ultrastructure of the head end (particularly the dental apparatus of lips) from the wide spectrum of published data, it is evident that SEM has been used in the studies of species belonging to 15 genera of Ascaridoidea. It is of interest to give at least a brief survey of these papers. The genus *Ascaris* has been studied in the above-mentioned extent by Ubelaker and Allison (1972), Ansel and Thibaud (1972), Weise (1973), Madden and Tromba (1976), Prokopič (1979) and Lýsek (1980), *Toxocara* and *Toxascaris*, the species of which are parasitic in mammals, by Baruš et al. (1979). Numerous studies have characterized ascaridoid nematodes parasitizing amphibia and reptiles, particularly a series of brilliant revisions written by Sprent (1977 a, b; 1978 a, b, c, d; 1979 a, b), who studied the species of the genera *Dujardinascaris*, *Sulcascaris*, *Goezia*, *Paraheterotyphlum*, *Gedoelstascaris*, *Ortleppascaris*, *Polydelphis*, *Travassosascaris*, *Hexametra*, *Multicaecum*, *Brevimulticaecum* and *Terranova*. The genus *Sulcascaris* (species *S.sulcatum* = syn *Porrocaecum sulcatum*) was dealt with earlier also by Allison et al. (1973).

It is interesting that only a single study (Wharton 1978) concerns the genus *Porrocaecum* which is very rich and varied in its species composition and includes specific parasites of birds. The author described the ultrastructure of egg surface only in *P.ensicaudatum*. Our rather numerous collection of this species enabled us to study the morphology and ultrastructure of its head

end by means of SEM. We have thus obtained some new data on this widely distributed species which can be used for a comparison with other species (and genera) of ascaridoid nematodes.

MATERIAL AND METHODS

The specimens of *Porrocaecum ensicaudatum* (Zeder, 1800) were recovered from the small intestine of the host *Turdus merula* L. (Passeriformes: Turdidae) in Czechoslovakia. For the SEM studies, 10 males measuring 25–30 mm and 10 females measuring 40–50 mm in length were selected from the collection. They were determined by an optical microscope and there were no deviations from the characteristics of this species given by Mozgovoy (1953) and Hartwich (1975).

After fixation of the specimens in 10% formalin, anterior parts of bodies (5–10 mm long) were cut off. They were then dehydrated through an ethanol series and subjected to the ultrasound for one minute while in an absolute alcohol. The parts of specimens were then critical point dried, mounted on a double-sided tape, coated with gold and examined in a Jeol JSM-S1 and Jeol JSM35 scanning electron microscope operating at 10 kV. All described morphological details are documented in photomicrographs.

RESULTS

The morphology of the head part of body is characteristic of all members of the suborder Ascaridata. In *P. ensicaudatum* the head part is separated from the remaining part of body by a distinct transverse incision. The mouth opening is rather large, triangular in the section and surrounded by three markedly developed (massive) lips. The outer organization and topography of head organs is the same in both males and females.

The lips surrounding the mouth opening are 0.060–0.090 mm high. In the middle part their width is almost the same as their height (Plate I, Figs. 1 and 3). Only in some specimens the lips are slightly higher than wide (Plate I, Fig. 2). The outline of the lips is almost hexagonal. The upper half of lips is always rounded and with a shallow incision at the top. The lower half of lips is markedly wider in its middle part; the lips become distinctly narrower towards posterior extremity. They are attached to the cervical part of body by their base (so-called stem of lip) which is always narrower than their anterior margin. Two types of surface structure can be distinguished on the cuticle covering the lateral aspect of the lips. Near the anterior margin of lips there are two areas running from the median line laterally and caudally up to the level of cephalic papillae. This type of cuticle is characterized by fine and irregularly distributed pits. In the anterior part, this type of cuticle is separated from the remaining parts by a distinct incision. In the middle and lower part of lips, the cuticle is finely longitudinally striated and in the lower part are also deep transverse incisions (Plate I, Fig. 4).

The labial sense organs of *P. ensicaudatum* consist of a pair of massive elliptical papillae (so-called doublet papillae) on the dorsal lip. Each of the two latero-ventral lips have a single papilla of this type. These lips bear also a small latero-ventral papilla which is lacking on the dorsal lip (Plate II, Fig. 5). An amphid is situated on a small elevation laterally to latero-ventral papillae and adjacent to them. Near the upper margin of all three lips, approximately in the middle of the sponge-like structured cuticle, there are two pores, sometimes situated on small protuberances (Plate II, Fig. 6). They are identified as inner labial receptors (after Wright 1977). The system of sense organs

seems to include also the pores distributed in a line near the base of lateral interlabia (Plate II, Fig. 6). These pores are lacking on the ventral interlabium and in its proximity.

These are 5–6 pores at the base of each of the lateral interlabia. The interlabia are distinctly triangular in lateral view. A ridge runs from their relatively sharp tip in median direction and joins the respective margin of the mouth opening. The inner surface of lips is slightly concave and covered with an obviously strongly glandular cuticle. A muscular support is formed on the inner side of each lip in the median longitudinal line. It passes caudally to the pharyngeal elements of the chewing and swallowing system (Plate III, Fig. 9).

Ridges of teeth are distributed in a single line near the medial anterior margins of the lips. The teeth extend laterally and caudally to the level of the lower margin of cephalic papillae (Plate II, Fig. 7). Their tips, which are moderately rounded, extend beyond the border of the lips both anteriorly and along their lateral margins. The teeth are conical and are usually longer than wide (Plate III, Figs. 10, 11, 12) and range in length from 0.001–0.002 mm. Each lip contains 96–98 teeth. It may be supposed that these tips are worn down in older specimens (Madden and Tromba 1976). There occurred some irregularities in their distribution, but they were always arranged in a single line. Near the tip of lips, in their middle part, a group of teeth is situated on a small triangular elevation (usually 5–6 teeth).

In contrast to the cuticle covering the cephalic part, the cuticle on the remaining parts of body is more or less regularly transversely striated (Plate IV, Figs. 13, 14). Individual transverse striae are separated from one another by shallow incisions, rarely irregular (interrupted or incomplete incisions). The structure of the transverse striation of cuticle is more markedly broken only in the vulva region. The opening of vulva has the shape of a transverse slit with slightly elevated margin (lips), the surface of which has a finely granular structure (Plate IV, Fig. 15).

DISCUSSION

The general shape and topography of cephalic organs of *P. ensicaudatum*, as visible in the scanning electron microscope, fully conform to the data obtained by using the light microscope (Mozgovoï 1953, Hartwich 1975). Our studies, however, revealed some new details, as the system of labial sense organs (inner labial receptors) situated near the upper margin of lips. Of interest is the finding of a set of 5–6 pores localized near the base of interlabia and belonging obviously to the system of sense organs. We suppose that the structures observed in the mouth cavity of *P. ensicaudatum*, e.g., medial ridge of interlabia and longitudinal muscular support of lips, occur also in other species of the genus *Porrocaecum*.

Attention should be paid also to the armament (so-called dental apparatus) of lips of *P. ensicaudatum*, particularly its comparison with the data concerning other species (genera) of ascaridoid nematodes. As it follows from the published data on the species and genera of ascaridoid nematodes parasitic in amphibia and reptiles (Sprent 1977 a, b; 1978 a, b, c, d; 1979 a, b), the presence or absence of lip armament is undoubtedly a character of generic value. According to Sprent, the lips armed with teeth arranged in one line are characteristic

of the genera *Terranova*, *Multicaecum*, *Dujardinascaris*, *Sulcascaris*, *Polydelphis*, *Travassosascaris* and *Hexametra*, but this armament is lacking in some hitherto studied species and genera of ascaridoid nematodes parasitic in reptiles (*Brevimulticaecum*, *Gedoelstascaris*, *Ortleppascaris*, *Goezia* and *Paraheterotyphlum*) The teeth on lips have been described in detail in the genera of ascaridoid nematodes parasitizing mammals The genus *Ascaris* was studied by many authors and *Toxocara* and *Toxascaris* by Baruš et al (1979)

Also a combination of two characters (both of generic value), namely the presence or absence of interlabia and the presence or absence of teeth on the lips has been used for diagnostic and systematic purposes Both interlabia and armed lips are present only in the genera *Multicaecum*, *Dujardinascaris*, *Travassosascaris*, *Sulcascaris* and *Porrocaecum* Armed lips without interlabia are characteristic of the genera *Terranova*, *Hexametra*, *Polydelphis* and also mammal ascaridoid nematodes — *Ascaris*, *Toxocara* and *Toxascaris*. In three genera, *Brevimulticaecum*, *Gedoelstascaris* and *Ortleppascaris*, the interlabia are present, but the labial teeth are lacking The absence of both these characters was noted only in the genera *Goezia* and *Heterotyphlum* These characters can be used for practical classification, but this is unsuitable for the evolutionary interpretation

The evolutionary significance and interpretation of the presence or absence of lip armament in ascaridoid nematodes seems to follow from the fact that the teeth are lacking in the species of the genera *Brevimulticaecum*, *Gedoelstascaris*, *Ortleppascaris*, *Goezia* and *Paraheterotyphlum* parasitic in hosts of the order Crocodylia and in sea Ophidia These genera are probably phylogenetically very old perhaps primitive The second numerous group of these nematodes possesses the armed lips (see above) Their definitive hosts are not only cold blooded vertebrates, but also birds and mammals Consequently, it may be supposed that the division into forms (groups) with armed or unarmed lips occurred very early in evolutionally old and primitive ascaridoid nematodes parasitic in fishes and other coldblooded vertebrates At the present time, the ascaridoid nematodes with armed lips are more numerous and are consequently morphologically and therefore also systematically more varied, not only in the categories of species and genera, but also of subfamilies and families

It should be noted that in the evolutionary scheme made by Petter (1977) the genus *Porrocaecum* is regarded as a basic source for the process of adaptation of other genera and subfamilies *Toxocarinae* and *Ascaridinae* to the parasitic life in the so-called higher vertebrates (mammals) The presence of teeth on the lips in *Porrocaecum* species (and in the mentioned scheme also in *Toxocara*, *Toxascaris*, *Ascaris* and others) is considered to be one of the features supporting this evolutionary hypothesis

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The plates will be found at the end of this issue

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**TESTING THE EFFICIENCY OF THE RODENTICIDE BRODIFACOU M ON THE
NORWAY RATS AND HOUSE MICE**

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Abstract: In laboratory tests with the rodenticide brodifacoum, which was given to experimental animals in baits, rats started to perish at the intake of a dose of 0.26 mg a. i. kg⁻¹. Doses of 0.52 mg a. i. kg⁻¹ produced 100% mortality which means that every rat weighing 250 g is killed at the intake of 2.6 g bait containing 0.005% of brodifacoum. In house mice there was a 100% mortality at a dose of 2.56 to 7.14 mg a. i. kg⁻¹. Both species accepted the bait with brodifacoum very well.

In the field, too, brodifacoum was very efficient. If on every 10 m² of treated area 6.3 to 14 g bait was put, and provided the rats did not migrate, they were completely exterminated within 13 to 43 days. At the use of a dose of 84 bait per 10 m² house mice were controlled under the same condition within 23 days. In both cases 0.005% bait was used.

Brodifacoum is a new anticoagulant rodenticide selectively toxic for rats (oral LD₅₀ = 0.22–0.26 mg kg⁻¹). It is very effective also for the house mice (oral LD₅₀ = 0.4 mg kg⁻¹) (Redfern et al., 1976). It is efficient at a single intake, but has also a very good cumulative effects (Redfern et al., 1976). It has a good effect on rats resistant to warfarin (Renningson and Dubock, 1978, Redfern et al., 1976).

Results are presented of tests in which its efficiency in our condition was verified.

MATERIAL AND METHODS

a) Laboratory tests

In our experiments we used commercial finely granulated bait marketed as Talon^R, containing 0.005% brodifacoum, i. e. 3-(3-4 bromo/1,1-biprenyl/4-yl-1,2,3,4, tetrahydro-1-naphthalenyl)-4 hydroxy-2H-1-benzopyran-2-one, intended for direct use and 2.5% concentrate of the active substance used for the preparation of oat bait composed of 10% vegetables oil, 90% oatflakes and 0.005 brodifacoum.

In the laboratory tests we used Norway rats (*Rattus norvegicus*) captured in Olomouc (northern Moravia) and the house mice (*Mus musculus*) captured in various localities in the Olomouc district. The captured animals were kept, prior to the test, in the laboratory for more than 10 days and fed oatflakes, wheat and barley grain. In all tests the animals were placed individually in special cages of 12 × 25 × 40 cm. Food and the bait were given in metalplate dishes of 7–10 cm diameter and 3 cm height. Consumption of food and the bait as well as mortality were read daily (except the weekend days). Throughout the experiments the animals received water ad libitum and temperature was maintained at 20 °C.

For testing the toxicity of Talon^R 16 rats, weighing 118–443 g, were given such an amount of Talon^R over 24 hours to ensure a graded dosage of the active substance per 1 kg live weight. In the following days the rats were fed their usual

diet and mortality was monitored. Acceptability was tested in such a way that individual rats were given Talon^R or the oat bait with 0.005% brodifacoum in an amount which contained 0.52 mg a. i. kg⁻¹ and simultaneously they were given nonpoisoned food in excess. We monitored daily consumption of the bait, the nonpoisoned food and mortality.

Individual house mice received over 24 hours either only the oat bait with 0.005% brodifacoum or the same amount of bait and simultaneously 1 g nonpoisoned oat-flakes, and mortality was monitored. In the following days the mice were given their normal diet and mortality was monitored daily.

b) Field tests

The effectiveness of Talon^R in the field against the rats was observed in four different localities in the Olomouc district. Locality A was a medium infested calf-shed which contained also a small storage room and feed preparation room (dried milk, bran etc.).

Locality B₁ was a farm yard containing a small garden with glasshouses and objects for breeding small domestic animals. In both of these localities the immediate neighbourhood of the experimental area was not rat-infested and only a low migration of rats from the vicinity was assumed.

In the other 2 localities C and D migration from the vicinity was considerable. Both these localities were very near to other rat-infested objects where no treatment was made. Locality C was a former mill used as a fodder store (bran, pollard, grain) and locality D a gingerbread factory in Olomouc.

The effect of oat baits with 0.005% brodifacoum was studied in locality E, a calf-shed in a farm, which was the most infested part together with the store room and feed preparation room. The effect of the oat bait was observed also in locality B₁ where the effect of Talon^R had been monitored, after its re-infestation the following year. It is denoted B₂.

The field test for the control of the house mice was performed in a dairy, using oat bait with 0.005% brodifacoum. To prevent the migration of the mice from the vicinity, neighbouring objects were also treated with the same bait.

Talon^R and the oat bait were placed in one half of Petri dishes in an amount of 10–20 g per dish in the experimental area for rats, and in an amount of 10 g for mice.

The dishes with the baits were put primarily near burrows. No pre-baiting was performed. The experimental localities were monitored for 15 to 55 days, during which they were visited 4–11 times. At the same time we monitored the decrease of the baits which were supplemented according to need. The presence of live rats was ascertained (observation in the evening hours) as well as the number of dead rats in which signs of poisoning were determined.

The consumption of bait was evaluated on average per one day in percents of initial consumption when the first animals perished, i. e. on the 5th to 8th of the experiment as recommended by Hudson (1980) for monitoring the effectiveness of acute rodenticides.

RESULTS

Results of laboratory tests showed that at the application of baits with 0.005% brodifacoum rats started to perish at a dose of 0.26 mg a. i. kg⁻¹ and that doses of 0.52 mg and higher produced 100% mortality (Tab. 1). Acceptability of Talon^R and oat bait was very good in comparison to the nonpoisoned food (Tab. 2). The rats perished with typical symptoms of external and internal hemorrhage in time intervals only somewhat greater than in previous experiments (Tab. 2). In two animals there was a distinct cumulative effect, the rats surviving the first dose perished after 21 and 38 days following application of very small doses (Tab. 1 a 2).

House mice accepted the oat bait just as well as the nonpoisoned food. If the bait was given alone the amount of the ingested active substance during 24 hours ranged between 2.56 to 7.14 mg kg⁻¹ (mean = 4.83), in a preferential

Table 1. Toxicity of Talon^R for rats with no presence of other food

| Brodifacoum dose in mg.kg ⁻¹ | Mortality of tested animals number of dead total number | Death in days |
|--------------------------------------------|------------------------------------------------------------|---------------|
| 0.13 | 0/2 | — |
| 0.26 | 1/4 ¹ | 5 |
| 0.39 | 2/3 | 6.7 |
| 0.52 | 3/3 | 6 |
| 0.79 | 2/2 | 6 |
| 1.04 | 2/2 | 5.6 |

¹ The surviving male, weight 233 g, was again tested after 38 days and died in 5 days after dose of 0.13 mg a.i. kg⁻¹

test the amount of ingested active substance was between 2.76 to 6.94 mg kg⁻¹ (mean = 4.67). In both cases the mice perished between the 3rd to 14th day of the experiment, whereby in 3 mice which perished up to the 3rd day of the experiment there were no distinct signs of hemorrhage.

In the localities with no migration of rats from the vicinity (locality A — beef cattle house, B₁ — farm yard with horticulture) Talon^R proved very effective (Tab. 4). The largest decrease in baits and the greatest number of baits with a decrease was between the 2nd and 13th day of the experiment.

In localities with a food surplus and medium infested the greatest decrease was only in some baits which were replenished, while other remained untouched. Talon^R was consumed even next to good quality feed such as pollard, dried milk, kitchen waste, etc. A consumption was relatively small, it corresponded to number of rats. The greatest number of perished animals was found between the 6th and 9th day when the consumption of baits was 77% in comparison to that in the first 5 days of the experiment. Consumption decreased to 44% between the 13th and 16th day and to 2% between the 17th and 23rd days.

In locality B₁, however, dead animals with signs of typical hemorrhages occurred already 2 days after placement of the bait and culminated by the 6th day, when daily consumption was 247 g. By the 10th day it decreased to 49% and was zero between day 11 to 13.

The enormous consumption of baits in locality B₁ was probably due to the collection of the baits by people. The effect of Talon^R was excellent in both cases and rates were exterminated.

In the localities with a large migration of rates from the vicinity the consumption of Talon^R in the former mill (locality C) was enormous and did not

Table 2. Acceptability of Talon^R and oat bait for rats at the simultaneous afford of food

| Type of bait | Dose of a.i. in mg.kg ⁻¹ | Type of nonpoisoned food | Mean intake of bait in days | Mortality of tested animals number of dead/total number | Mean days to death |
|--------------------|-------------------------------------|---------------------------|-----------------------------|---------------------------------------------------------|--------------------|
| Talon ^R | 0.52 | oatflakes and wheat grain | 1.4 | 12/13 ¹ | 6.5 |
| Oat | 0.52 | oatflekes | 1.2 | 9/9 | 6.7 |

¹ One treated rat survived, after 21 days was again given Talon^R in a dose of 0.26 mg a.i. kg⁻¹ after which he died on the 7th day

Table 3. Toxicity and acceptability of oat bait for the house mouse in the laboratory with and without the presence of other food

| Mean dose of a.i. in mg.kg ⁻¹ | Type of food | Mortality of tested mice number of dead total number | Range of days and (mean) until death |
|------------------------------------------|--------------|------------------------------------------------------|--------------------------------------|
| 4.83 | — | 10/10 | 4—13 (8) |
| 4.67 | oat flakes | 10/10 | 3—14 (7.4) |

decrease even after repeated replenishments within 15 days. There we found 2 perished adult cats with bleeding from the rectum. According to the date of finding the first cat probably consumed the Talon^R directly, whereby in this case only about 100 g of Talon^R was placed since this was before the experiment proper was initiated. No dead rats were found at the end of the experiment, presumably they perished in the vicinity, probably in the mill race. In another locality (D) with migration from the neighbourhood we found repeatedly continuous consumption near the distribution of cables, installation equipment and sewerage, when between day 8 to 20 of the experiment it reached only 46% of the initial consumption, but only rarely dead rats. During the experiment of 20 days traces of rats did not disappear.

Treatment with oat bait in locality B₂ resulted in the complete control of the rats. This effect was achieved with almost a single supply of the bait. Maximum number of dead animals was found within 7 days and lasted till the 14th day of the experiment.

Consumption between day 7 to 14 was merely 0.3% of initial consumption and was observed only on a limited amount of baits. Remaining traces of rats occurring as late as on the 17th day disappeared after placement of an additional baiting of 120 g between the 27th and 43rd day, when consumption of the bait represented 7% of the initial intake. These traces might have been

Table 4. Effect of Talon^R on rats in the field

| | Locality | | | |
|------------------------------------------------------|-------------------|--------------------|-------------------|-------------------|
| | A | B ₁ | C | D |
| Date of start of the experiment | March 14, 1979 | May 15, 1979 | March 27, 1979 | June, 26, 1979 |
| Duration of experiment in days | 23 | 15 | 15 | 20 |
| Extent of treated area in m ² | 550 | 1 600 | 523 | 800 |
| Mean amount of poisoned bait in g.10 m ⁻² | 6.3 | 13.7 | 20.9 | 10.6 |
| Number of dishes with the bait | 22 | 46 | 45 | 24 |
| Number of dishes with decrease (total) | 18 | 107 | 110 | 34 |
| Total amount of consumed bait (in g) | 99 | 1 960 ¹ | 1 110 | 615 |
| Number of dead rats | 12 | 14 | 8 | 2 |
| No occurrence of rats determined (day of experiment) | 23 | 13 | not determined | not determined |

¹ There was decrease in the poisoned bait also at not visited by rats

Table 5. Effect of oat bait on rats in locality B₂ and E and on house mice in locality F

| | Locality | | |
|----------------------------------------------------------|-----------------|------------------|----------------|
| | B ₂ | E | F |
| Date of start of experiment | January 8, 1980 | January 23, 1980 | April 11, 1980 |
| Duration of experiment in days | 43 | 55 | 23 |
| Extent of treated area in m ² | 700 | 700 | 77 |
| Mean amount of poisoned bait in g.10 m ⁻² | 12 | 32.4 | 83.6 |
| Number of dishes with poisoned bait | 36 | 40 | 22 |
| Number of dishes with decrease (total) | 67 | 118 | 59 |
| Total amount of consumed bait (in g) | 840 | 1 903 | 264 |
| Number of dead rats or house mice | 7 | 45 | 32 |
| Nil occurrence of rodents determined (day of experiment) | 43 | — | 23 |

of rats coming from the neighbourhood. After placing the bait in the beginning of the experiment we noted its decrease already in the first day and by the 7th day 713 g out of 720 had been consumed.

The same bait used in locality E — calf-shed in a farm — had to be replenished intensively because of its great diminishment already within the first week. The peak perishment was from the 13th to 28th day of the experiment. Consumption of the bait was considerable for a very long time, between the 28th to 35th day it still represented 54⁰/₀ of initial consumption. Since the rats were not completely controlled we conducted from the 35th day extensive treatment using oat bait in the whole farm by distributing 5.5 kg of the bait in an area of 2500 m², that is, a dose of 22 g per 10 m². Near burrows this bait was eaten up entirely, in the feed preparation rooms and the sheds to about 50⁰/₀. Nonetheless there was still some occurrence of rats even after 20 days; some could have come from the neighbourhood. Consumption of the bait represented between day 42 to 55 decreased already to 11⁰/₀. The fact remains that some of the bait remained unconsumed even at the presence of rats.

In field experiments mice, too, accepted the bait very well right from the beginning, the peak of the death was observed already on the fifth and sixth day from placement of the bait and continued up to 17th day with typical symptoms of anticoagulant poisoning. There was no further occurrence of mice, except some individuals coming from the neighbourhood. These individuals were controlled by further treatment. Consumption of the bait decreased considerably at the end of the second week (consumption of the bait between the 6th to 10th day represented 35⁰/₀ of initial intake), but continued until the end of observation, when it represented 5–6⁰/₀ of initial consumption.

DISCUSSION

The results of our study confirm that brodifacoum is more efficient than other known anticoagulants (Redfern et al., 1976). The toxicity for rats (Tab. 1) agrees with data in the literature, LD₅₀ for wild Norway rats will probably be somewhat higher than for white laboratory rats which according to Redfern et al. (1976) is 0.26 mg kg⁻¹. A dose of 0.52 mg kg⁻¹ at the appli-

cation of 0.005% of the bait killed virtually all rats which agrees with the results of Homoláč (1979, personal communication) in whose experiments white Wistar rats perished after a dose of 0.51 mg kg^{-1} . This means that ingestion of 2.6 of the bait containing 0.005% of the active substance should kill every rat weighing 250 g. The only observation in two rats (Tab. 1 a 2) who survived a single dose but perished after the next application of the lower dose confirms the cumulative effects found by Redfern et al., (1976), Hädler (ex Dubock and Kaukeinen, 1979) and confirmed by Homoláč (1979, personal communication). Talon^R as well as the oat bait were not markedly less preferred than nonpoisoned food, both baits were well consumed by rats even at the possibility of choice, which agrees with findings of Redfern et al., (1976), Homoláč (1979, personal communication) and Dubock and Kaukein (1978). Acceptability of Talon^R and of oat bait in the field was equally good, already in the first days of the experiments the bait was intensively eaten up.

When comparing results, particularly in locality A and locality E, it appears that Talon^R was accepted better than the oat bait. The rapid acceptance of the bait in the field suggests not only the ready acceptability of particularly the formulation Talon^R, but also, that the suitable sites both from the aspect of the rats movements as well as the suitability of these sites for food intake (sufficient quiet, cover, nearness to the usual food, etc.). All these aspects play their part in vector control.

Consumption in individual places differs considerably apparently according to the density of the rat population, the natural food, and probably according many other factors. In the extensive, uniformly rat infested places in locality A consumption was low, while in locality B, where the rats virtually formed one defined colony and competition was greater, consumption was high. Consumption in locality E, with a large density of rats, was also high.

The above observations as well as the fact that in most cases the bait had to be renewed, and also the result of the direct test with a single placement of the bait in locality B₂, in which the place was isolated and where there was no longer influx of rats from the neighbourhood, and where it was nonetheless necessary to place an additional bait to achieve satisfactory control, all these indicate that a single distribution of the bait will not suffice either with a view to success or with a view to efficient use of the relatively expensive bait. There is a certain similarity with the findings of Rennison and Dubock (1978) who in a field control of warfarin resistant rats achieved, after 1, 4 and 7 treatment with 0.002% brodifacoum, an efficiency of 41, 51 and 68%, respectively. To prevent extensive consumption of the bait by some individuals it is necessary, especially in the case of high infestation, to distribute the bait in small doses in many suitable places and after the first peak of control (about 7 days) or somewhat later to renew distribution of the bait according to need.

On the basis of our results it is possible to suggest approximate dosage for differently infested objects according to area (Tab. 4 and 5). If we proceed from our successful experiments, i. e. in localities A, B₁, B₂ and E, it can be assumed that at moderate infestation a dose of less than $2 \text{ g} \cdot 10 \text{ m}^{-2}$, at medium infestation that of from 2 to $15 \text{ g} \cdot 10 \text{ m}^{-2}$ will suffice. At strong infestation repeated doses of up to $30 \text{ g} \cdot 10 \text{ m}^{-2}$ are to be recommended.

Acceptability of 0.005% bait as well as efficiency for mice was also excellent

and comparable with the results of Redfern et al. (1976) who found a good control of warfarin resistant house mice within 4–20 days after 2 and 1 day treatment. Mice accepted the bait rapidly from the beginning of the experiment. This agrees with the findings of other authors (Rowe and Bradfield, 1976 and Rowe et al., 1978). Since house mice live predominantly in dry and roofcovered places and consume relatively little food the bait can be left for some longer period. In our case the locality was highly infested and 264 g of the bait were used which corresponds to a dose of $34.2 \text{ g} \cdot 10^{-2}$. This dose can be recommended as the maximum dose for practical purpose.

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THE FLIGHT OF CARABIDAE (COLEOPTERA) TO LIGHT TRAP

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Abstract: In 1973—1979 the beetles of the family Carabidae (Coleoptera) were sampled daily from April to Nov. by light trap at Praha-Ruzyně (central Bohemia). In total 11,905 individuals of 63 species were captured. The dominant species was *Trechus quadristriatus* (Schrank) (6,164 individuals), which together with another 14 abundant species (of the genera *Agonum*, *Amara*, *Bradycellus*, and *Harpalus*) formed 97.3% of the total sample. Most abundant species flew from nearby field biotopes, migrants from distant habitats (e. g. riparian or steppe species) were scarce. Every year the peak flight activity of abundant species was concentrated to a small number of July and Aug. nights. Catch size in a particular night depends both on favourable weather conditions and on the proportion of species' population which is able to fly at a given moment. In general, the period when species flew to light trap extended over only a small part of their imaginal life. Large variation in total year catch was observed in all species. The pattern of annual variation was irregular and differed between species. In all but one of 5 species investigated the sex ratio did not significantly depart from 1:1.

Many species of the family Carabidae (Coleoptera) are capable of flight and several of them have been captured when flying to light sources at night (e. g. Štěrba, 1910. Scherf and Drechsel, 1973). However the quantities of carabid beetles captured by light traps in temperate zones were usually small (thus e. g. the classic work of Williams, 1939, does not mention them at all). By contrast, the light trap used since 1967 at Praha-Ruzyně provided large samples of carabids of many species. We attempt at ecological and faunistic evaluation of these catches.

MATERIAL AND METHODS

The material of carabid beetles was sampled by light trap from 1973 to 1979 at Praha-Ruzyně. The trap was designed and constructed by Novák (1970, in press). It consists of 250 W mercury vapour lamp (Tesla RVL 250, luminosity 1,200 lm, about 25% UV light), whose light both directly shines into the surrounding space and is projected on 1 × 1.2 m white panel attached on the wall of a building. A grid of thin wires stretched 7 mm apart is placed about 20 cm before the white panel and is charged with 2,000—3,000 V, 2 mA electric current. Insects flying to the light to the light source are knocked down by the electric shock and sampled, through a large funnel, into a bottle containing chloroform vapour. Every year the trap was run daily, from sunset to sunrise, from April to November.

The trap is sited 8 m above ground level by the southern-facing wall of a building. The immediate surroundings of the trap is a garden sparsely planted with various ornamental coniferous and deciduous trees, with grassy undergrowth. The garden is surrounded by the arable fields (from S, W and N) and by an urban area (from E). The nearest fields are about 150 m from the trap. Other types of habitats are at greater distance: small stream with muddy banks covered by vegetation (at about

600 m distance), a pond (about 1,600 m), two forests (about 1,100 and 1,300 m), and the steppe localities (about 1,800 m). Many light sources of equal or greater intensity operated every night in the surroundings of the trap.

The classification of species according to the type of activity into diurnal, predominantly diurnal, plastic (both diurnal and nocturnal), predominantly nocturnal, and nocturnal species is based on published information on running activity of carabids (Novák, 1971), and on the personal experience of J. Pulpán. The same applies to the faunistic and chorological classification of the species (cf. Pulpán and Rešková, 1971). This author is responsible also for the determination of materials.

For the comparison of similarity between samples we used Renkonen's index (Renkonen, 1939). This index (Re) indicates „percentage similarity“ and may be defined as $Re = \sum \min(p_{1i}, p_{2i})$, where p_{1i} is the proportion of the i -th species in sample A, p_{2i} is the proportion of the i -th species in the sample B. This index appears a good indicator of the similarity of the samples (Huhta, 1979).

RESULTS

1. The composition of samples

In 1973—1979 a total of 11,905 carabid beetles of 63 species were captured (Tab. 1). Only a fraction of the species were the abundant ones. In 15 species (24% of all species captured) more than 50 individuals were caught during the 7 years of investigation. Their members represented 97.3% of all individuals collected. Further 9 species were captured in more than 10 specimens, representing only 1.8% of individuals in the total sample. The rest of 39 species (62% of all species captured) were occasional fliers which flew in single specimens in some years only. They shared by only 0.9% on the total quantity of individuals captured.

The most abundant species was *Trechus quadristriatus* (6,164 individuals, 51.8% of the total sample). Other dominant species belonged (with two below exceptions) to the genus *Amara* and *Harpalus*. These dominant species are typical elements of lowland field or ruderal biotopes. Most of them prefer rather xeric and warm, unshaded habitats, though some (e.g. *T. quadristriatus*) are abundant also on wet, shaded field surfaces, within the dense stands of cereals. All these species have predominantly nocturnal or nocturnal activity and are fully winged. Two dominant species do not conform with this general scheme. *Bradycellus verbasci* is generally considered a rare species. In Bohemia it prefers xeric and warm forest margins and clearings; it has been found from lowland to submontane regions. *Agonum gracilipes* lives in xeric biotopes of various character (forest, steppe, pasture), from lowland to submontane regions. Both species are fully winged, with nocturnal activity. Thus all abundant species in our sample (perhaps with exception of *B. verbasci*, which might fly from near forests) belong to abundant inhabitants of field or urban habitats, resident in the near vicinity of the trap, with nocturnal activity.

Among the scarcely captured species only a small fraction were the really rare species (e.g. *Perigona nigriceps*, *Polistichus connexus*, *Tachys fulvicollis*). Other species captured in low quantities either live in habitats, which do not lie near our light trap, or the species have predominantly diurnal flight activity. Thus typical riparian (*Dyschirius aeneus*, *Bembidion semipunctatum*), forest (*Bradycellus harpalinus*), psammophilous (*Harpalus froelichii*), or steppe species (*Harpalus melancholicus*, *H. calceatus*, *H. puncticollis*) were rare in our samples. As far as the type of activity is concerned, among 9 species, which were captured in 10—50 ex., only 5 are nocturnal or predominantly nocturnal species, 3 have plastic activity, and one has predominantly diurnal activity.

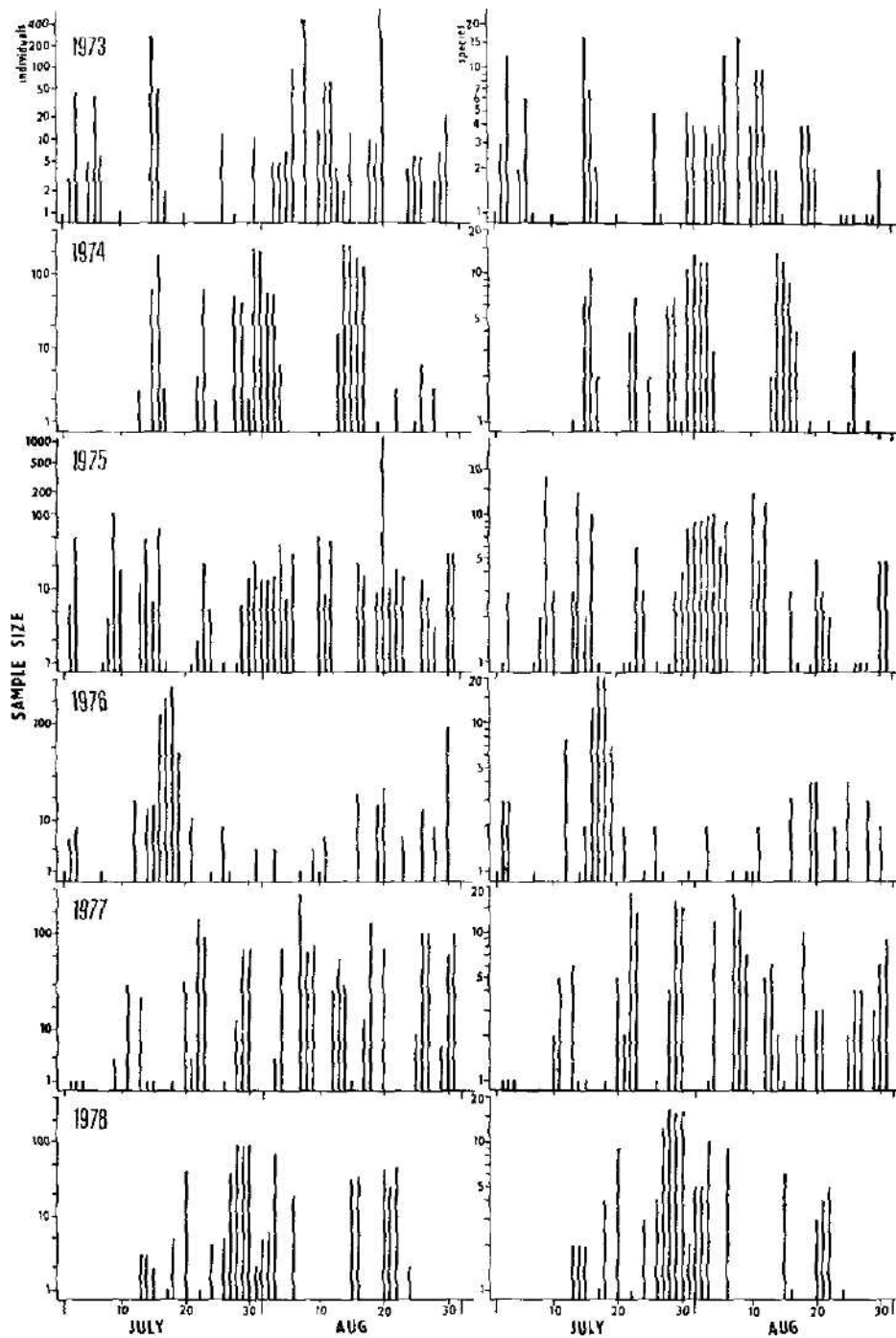


Fig. 1. The total number of carabid beetles captured per night (left), and the number of species per night (right) in the period of July–August, 1973–1978.

Tab. 1 — continued

| Species | Catch sizes* | | | | | | | | Total |
|---------------------------------------------|--------------|----------|------------|----------|----------|----------|------------|-------------|-------|
| | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | | |
| 33. <i>Bradycellus harpalinus</i> (Serv.) | 2 (2) | 1 (1) | 1 (1) | 1 (1) | 4 (4) | | 6 (3) | 14 (11) | |
| 34. <i>Bradycellus verbosus</i> (Duft.) | 59 (13) | 56 (10) | 27 (13) | 24 (7) | 21 (10) | 55 (10) | 244 (19) | 486 (82) | |
| 35. <i>Calanthus melanocephalus</i> (L.) | 8 (2) | | | 1 (1) | 1 (1) | | | 5 (4) | |
| 36. <i>Chloneurus vestitus</i> (Tnyk.) | 1 (1) | 2 (2) | 8 (5) | 18 (13) | 5 (4) | 6 (5) | 2 (1) | 42 (31) | |
| 37. <i>Dromius agilis</i> (F.) | | 3 (3) | | 1 (1) | | | | 4 (4) | |
| 38. <i>Dromius fenestratus</i> (F.) | | | 2 (2) | | | | | 2 (2) | |
| 39. <i>Dromius quadrimaculatus</i> (-) | | 8 (8) | 7 (6) | 5 (4) | 7 (4) | | | 27 (22) | |
| 40. <i>Dromius schneideri</i> Crotch | | | 2 (2) | | | | | 2 (2) | |
| 41. <i>Dyschirius aeneus</i> (Dej.) | 2 (2) | 1 (1) | | | | | 2 (2) | 3 (3) | |
| 42. <i>Harpalus calceatus</i> (Duft.) | | | 1 (1) | | | | | 3 (3) | |
| 43. <i>Harpalus froelichi</i> Sturm | | | 1 (1) | | | | | 2 (2) | |
| 44. <i>Harpalus graseus</i> (Panz.) | 15 (3) | 19 (6) | 20 (9) | | 1 (1) | | 8 (2) | 93 (36) | |
| 45. <i>Harpalus melancholicus</i> Dej. | | 1 (1) | | | 24 (12) | 7 (4) | | 1 (1) | |
| 46. <i>Harpalus mellettii</i> Heer | | | 3 (3) | 12 (8) | 7 (5) | | 2 (2) | 24 (18) | |
| 47. <i>Harpalus puncticeps</i> (Steph.) | 35 (6) | 37 (10) | 16 (8) | 11 (6) | 23 (9) | 68 (10) | 20 (9) | 210 (58) | |
| 48. <i>Harpalus puncticolis</i> (Pavk.) | | | | 1 (1) | 2 (2) | 3 (1) | 1 (1) | 7 (5) | |
| 49. <i>Harpalus rufibarbis</i> auct. | 12 (6) | 7 (5) | 1 (1) | 2 (1) | 25 (5) | 14 (1) | 7 (4) | 68 (23) | |
| 50. <i>Harpalus rufipes</i> (Deg.) | 81 (10) | 237 (17) | 52 (8) | 166 (10) | 55 (9) | 51 (8) | 18 (8) | 603 (70) | |
| 51. <i>Harpalus ruficollis</i> Sturm. | 26 (4) | 8 (4) | 29 (8) | 23 (6) | 24 (7) | 2 (1) | 11 (4) | 123 (34) | |
| 52. <i>Harpalus seladon</i> Schaub. | 24 (8) | 26 (7) | 18 (4) | 20 (6) | 51 (3) | 55 (4) | 12 (8) | 206 (40) | |
| 53. <i>Harpalus tenebrosus</i> Dej. | | | 1 (1) | | | | | 1 (1) | |
| 54. <i>Lasiotrechus dascus</i> (F.) | 5 (2) | 1 (1) | 2 (2) | 14 (3) | 2 (1) | | 1 (1) | 25 (10) | |
| 55. <i>Loricera pilicornis</i> (F.) | | | 1 (1) | 1 (1) | | | | 2 (2) | |
| 56. <i>Perigona nigricipes</i> (Dej.) | | | 2 (2) | 2 (1) | | | | 4 (3) | |
| 57. <i>Polsiichus connerus</i> (Pours.) | 1 (1) | | | | | | | 1 (1) | |
| 58. <i>Stenolophus minutus</i> (Herbst) | 2 (2) | 2 (2) | 1 (1) | 6 (5) | 2 (2) | | | 13 (2) | |
| 59. <i>Tachys fulvicollis</i> (Dej.) | | | | 1 (1) | | | | 1 (1) | |
| 60. <i>Tachys histricus</i> (Duft.) | | | | 1 (1) | | | | 1 (1) | |
| 61. <i>Tachys parvulus</i> (Dej.) | | | | | | | | 1 (1) | |
| 62. <i>Trechus quadristriatus</i> (Schrank) | 1,291 (22) | 626 (18) | 1,461 (23) | 163 (17) | 842 (26) | 178 (14) | 1,603 (42) | 6,164 (162) | |
| 63. <i>Trichocelus placidus</i> (Gyll.) | | | | 2 (2) | | | | 2 (2) | |
| Total | 2,143 | 1,733 | 2,096 | 944 | 1,686 | 700 | 2,806 | 11,905 | |

*) Number of individuals and number of nights when the species flew to light trap (in brackets).

Table 1. Annual catches of carabid species in the light trap at Praha-Ruzyně

| Species | Catch size* | | | | | | | Total |
|--------------------------------------------|-------------|----------|----------|----------|----------|---------|----------|-------------|
| | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | |
| 1. <i>Acupalpus conspicius</i> (Duft.) | 1 (1) | | 1 (1) | | 1 (1) | | | 3 (3) |
| 2. <i>Acupalpus dorsalis</i> (F.) | 5 (3) | | 1 (1) | | 1 (1) | | | 9 (7) |
| 3. <i>Agonum dorsale</i> (Pout.) | | 2 (1) | 15 (4) | | | | 1 (1) | 17 (5) |
| 4. <i>Agonum gracile</i> Sturm. | | | | 1 (1) | 5 (6) | | | 6 (6) |
| 5. <i>Agonum gracilipes</i> (Duft.) | 1 (1) | | 152 (17) | 7 (4) | | 1 (1) | | 166 (25) |
| 6. <i>Agonum micans</i> (Nicol.) | | | | | | | 1 (1) | 1 (1) |
| 7. <i>Agonum thoreae</i> Dej. | | | | 1 (1) | | 1 (1) | | 3 (3) |
| 8. <i>Amara aenea</i> (Deg.) | | | | | | | 2 (1) | 3 (2) |
| 9. <i>Amara apricaria</i> (Payk.) | 171 (13) | 203 (12) | 80 (20) | 99 (12) | 253 (20) | 38 (9) | 327 (14) | 1,171 (100) |
| 10. <i>Amara aulica</i> (Panz.) | 34 (7) | 42 (12) | 19 (10) | 78 (8) | 44 (8) | 23 (9) | 17 (8) | 277 (62) |
| 11. <i>Amara bifrons</i> (Gyll.) | 18 (6) | 117 (12) | 43 (16) | 182 (11) | 114 (13) | 87 (12) | 114 (9) | 675 (79) |
| 12. <i>Amara consularis</i> (Duft.) | | 4 (2) | 4 (3) | | 6 (3) | 9 (3) | 61 (12) | 84 (23) |
| 13. <i>Amara consularis</i> (Mann.) | 10 (6) | 3 (2) | 8 (7) | 4 (3) | 36 (13) | 16 (9) | 42 (9) | 119 (49) |
| 14. <i>Amara familiaris</i> (Duft.) | | 1 (1) | | | 1 (1) | 5 (3) | 2 (2) | 9 (7) |
| 15. <i>Amara majuscula</i> (Chaud.) | 307 (22) | 324 (16) | 109 (26) | 82 (13) | 111 (21) | 70 (9) | 79 (11) | 1,082 (118) |
| 16. <i>Amara selidiosa</i> (Serv.) | 1 (1) | | | | | | | 1 (1) |
| 17. <i>Baolister dilatatus</i> Chaud. | | | | | | | | 1 (1) |
| 18. <i>Baolister striatulus</i> Hans. | | | | | | | | 3 (3) |
| 19. <i>Baolister peltatus</i> (Panz.) | 3 (1) | | | 1 (1) | | | | 4 (2) |
| 20. <i>Bembidion articulatum</i> (Panz.) | | | | | | 1 (1) | | 1 (1) |
| 21. <i>Bembidion assimile</i> Gyll. | 1 (1) | | | | | | 1 (1) | 2 (2) |
| 22. <i>Bembidion biguttatum</i> (F.) | 1 (1) | | | | | | | 1 (1) |
| 23. <i>Bembidion doris</i> (Panz.) | | | | | 1 (1) | | | 1 (1) |
| 24. <i>Bembidion femoratum</i> (Sturm.) | | | 2 (2) | | | | | 5 (4) |
| 25. <i>Bembidion fumigatum</i> (Duft.) | 1 (1) | | | 1 (1) | | | | 2 (2) |
| 26. <i>Bembidion minimum</i> (F.) | | | | 1 (1) | | | | 1 (1) |
| 27. <i>Bembidion octomaculatum</i> (Goeze) | | | | | | | | 1 (1) |
| 28. <i>Bembidion properans</i> Steph. | | | 1 (1) | | | 1 (1) | | 2 (2) |
| 29. <i>Bembidion quadrimaculatum</i> (L.) | 1 (1) | | 2 (1) | 2 (2) | | 3 (2) | | 12 (9) |
| 30. <i>Bembidion semipunctatum</i> (Don.) | | | | | | | | 1 (1) |
| 31. <i>Bembidion varium</i> (Ol.) | 6 (5) | | 3 (3) | 12 (7) | | 6 (4) | | 42 (28) |
| 32. <i>Bradycellus caskei</i> Laczo | | | | | 1 (1) | | | 2 (2) |

From 39 rare species (< 10 ex. captured) only 14 species (36%) have nocturnal or predominantly nocturnal activity, while the rest has plastic or diurnal activity.

2. Seasonal variation of catches

In all years the carabids were captured in relatively small number of nights (25—43 in different years). In only a few favourable nights (in July and Aug.) the carabids flew in large quantities. In the total period of 1973—1978 we observed only 34 nights when more than 50 individuals were captured (Fig. 1). The five largest one night catches represented 53—82% of the total quantity of individuals captured in a given year.

The favourable nights (> 50 individuals captured) had particular weather conditions. The mean temperature at 2100 h was 19.1°C (range 14.1—25.3°C), and the wind speed was low. The favourable nights followed usually after a period of relatively inclement weather. The mean temperature of three evenings prior to massive flight was in the average by 2.2°C lower than at the evening of large catch. On the other hand, every year there were several nights with apparently favourable weather, in which abundant flight did not occur. Thus in 1973—1978 we observed 53 July and Aug. nights with temperature greater than 19.1°C, but without large flight activity of carabids. The large number of individuals caught in a few favourable nights was determined by coincidence of the peak flight activity of abundant species in a small number of nights. Thus the maximum flight activity in all dominant species was concentrated into 4 (in 1977), 5 (in 1973 and 1978), 6 (in 1974, 1976 and 1979) and 8 (in 1975) favourable nights.

Large differences have been sometimes observed in the composition of samples from adjacent nights with similar (favourable) weather conditions. Thus e.g. the percent similarity (Re) between Aug. 7 and 8, 1977 was only 53.6%, and between Aug. 8 and 9, 1977 only 45.9%. These differences may be due to the fact that the fraction of population which were, in different species, prepared to fly, underwent rapid changes.

In abundant species there were only slight differences in the seasonality of flight activity (Fig. 2). Most species had peak flight activity between approx. July 15 and Aug. 15. Only the activity of *T. quadristriatus* and *Harpalus griseus* seems to be slightly shifted towards the autumn, while *A. gracilipes* and *Harpalus rufipes* tend perhaps to fly slightly earlier. Also most of rare species had the flight activity in July — Aug. Only two species of the genus *Amara* (*A. aenea* and *A. familiaris*) flew in April and May.

We suppose that in all species flight activity is essentially unimodal. The apparent bimodality of some frequency polygons of sums of pentad catches from 1973—1979 (Fig. 2) is an artefact. The timing of maximum catches in different years differed by up to 20 days. The pentad sums of 7 year catches could not completely smooth these differences.

3. Annual variation in abundance of species

Both the size of total annual catch of all carabids and the annual catches of different species varied between the years. According to the size of total annual catch the years may be ranked in a descendent order: 1979, 1973, 1975, 1974, 1977, 1976, and 1978.

The pattern of annual variation of catches of particular species was different from this overall trend (Fig. 2). Nearly every year some species were relatively

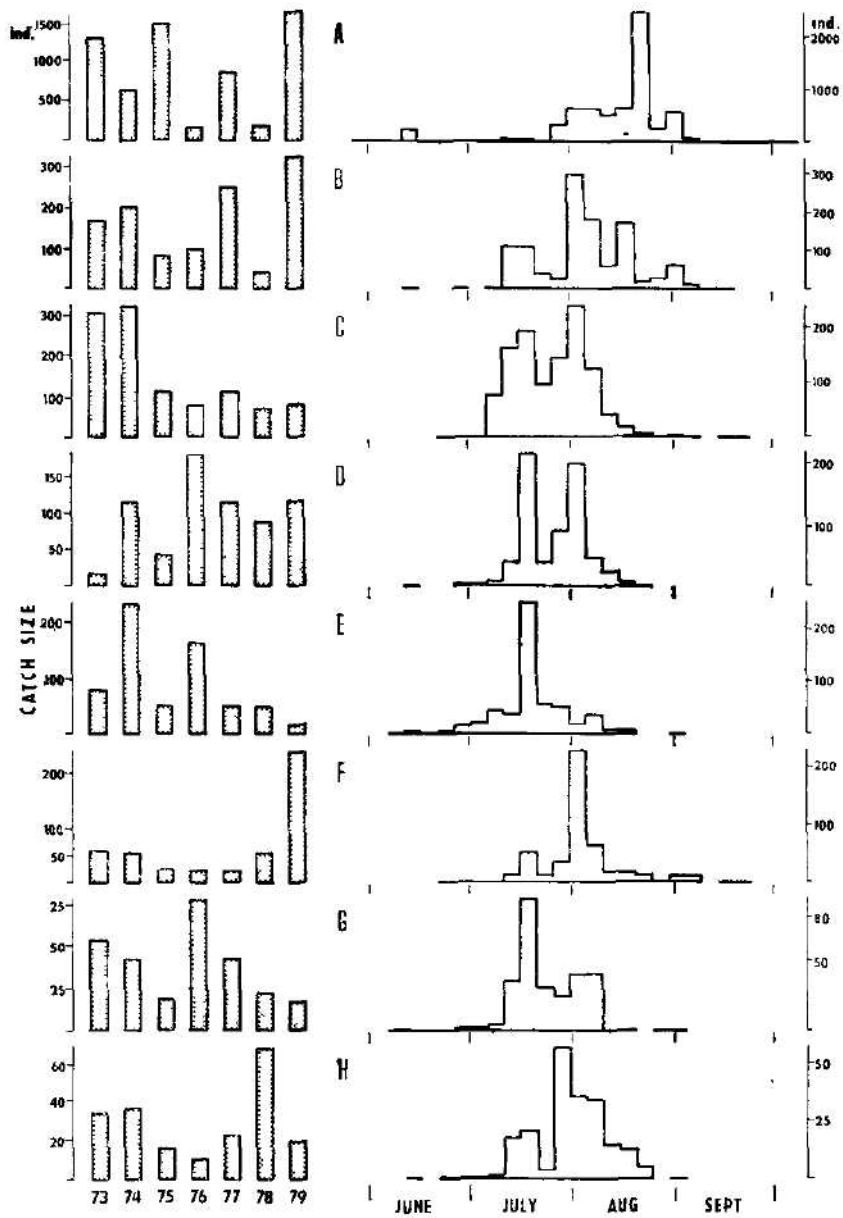


Fig. 2 A The size of annual catches from 1973 to 1979 (left), and the seasonal distribution of flight activity as revealed by pentad sums of catches in pooled sample from 1973-1979 (right). A - *Trechus quadristriatus* (n = 6,164), B - *Amara apricaria* (n = 1,171), C - *Amara majuscula* (n = 1,082), D - *Amara bifrons* (n = 675), E - *Harpalus rufipes* (n = 660), F - *Bradycellus verbasci* (n = 486), G - *Amara aulica* (n = 277), H - *Harpalus pucticeps* (n = 210)

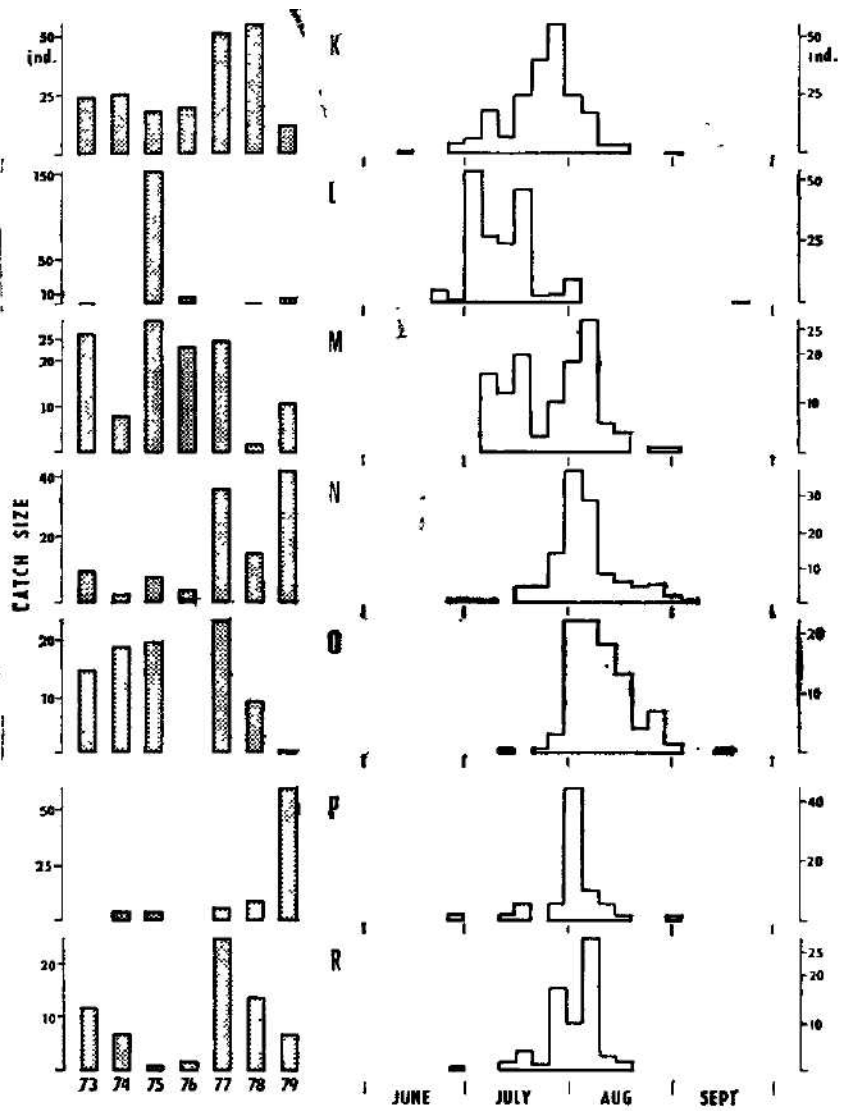


Fig 2 B The size of annual catches from 1973 to 1979 (left), and the seasonal distribution of flight activity as revealed by pentad sums of catches in pooled sample from 1973-1979 (right) K - *Harpalus seladon* (n = 206), L - *Agonum gracilipes* (n = 166), M - *Harpalus rupicola* (n = 123), N - *Amara convexiuscula* (n = 119), O - *Harpalus griseus* (n = 93), P - *Amara consularis* (n = 84), R - *Harpalus rufibarbis* (n = 68).

abundant while other species underwent their population minima. The distribution of maximum and minimum annual catches of different species between the years was not even. In 24 abundant species (> 10 individuals caught) the distribution of extreme catches were as follows:

| No of species with: | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 |
|---------------------|------|------|------|------|------|------|------|
| maximum catch | 0 | 3 | 3 | 7 | 2 | 2 | 7 |
| minimum catch | 6 | 5 | 1 | 6 | 4 | 9 | 6 |

Every zero annual catch (in rare species there were more than 1 such catches) was counted as minimum. Thus the number of minimum catches does not correspond to the number of maximum ones.

The maximum occurrence of peak catches was observed in 1976 and 1979. In 1976, a year with warm and dry spring and early summer, mostly the xerophilic and riparian species (which flew from greater distances) had their maxima (e.g. *Chlaenius vestitus*, *Bembidion varium*). In 1979 several field species had their maxima (e.g. *T. quadristriatus*).

We observed no consistent long-time trends, either in general abundance of carabids or in abundance of different species. The abundance of species is apparently regulated by weather conditions prevailing in a given year.

4. Sex ratio

In 5 abundant species the ratio of sexes was ascertained at the time of maximum flight activity of the species. In only one species, *A. gracilipes*, the presence of sexes departed significantly from the assumed 1:1 ratio. The results were as follows:

| | N | % of males | departure from 1:1 ratio |
|-------------------------------|-----|------------|---------------------------|
| <i>Amara apricaria</i> | 100 | 34.0 | not significant |
| <i>Amara majuscula</i> | 100 | 48.0 | n.s. |
| <i>Harpalus rufipes</i> | 134 | 51.5 | n.s. |
| <i>Trechus quadristriatus</i> | 100 | 58.0 | n.s. |
| <i>Agonum gracilipes</i> | 123 | 75.6 | significant at $p < 0.05$ |

DISCUSSION

Our results concern some interesting topics. We will discuss them mainly on the basis of results with abundant species.

1. The characteristics of flight activity in carabids sampled by the light trap

In most species the flight activity takes place in only a small period of the adult life span, which, in some species at least, may perhaps extend over 1—2 years. *H. rufipes* was the only species, whose terrestrial and flight activity we were able to compare on the basis of data from Czechoslovakia (Fig. 3). The data concerning terrestrial activity were taken from pitfall trapping of Skuhřavý and Novák (1957), Skuhřavý (1959), Skuhřavý et al. (1959), and Orbtel (1968). The species has a distinct autumnal peak of terrestrial activity (and perhaps abundance) and an usually less distinct vernal one. The period of flight activity falls approximately into the valley between the two peaks of terrestrial activity. In *T. quadristriatus* the peak of flight activity perhaps also precede the peak of terrestrial activity, which (in England) extends from late Aug. to Oct. (Baker and Dunning, 1975).

This flight activity does presumably belong to the migratory type. In general, mainly young adults in the pre-reproductive period tend to disperse by migration (Meijer, 1974). In *Amara plebeja* there exist spring migrations from hibernation sites to the habitats of summer breeding, and reciprocal migrations in the autumn (van Huizen, 1977). The end of migratory period is usually accompanied by degeneration of flight muscles. Tietze (1967) found in a randomly collected samples of several fully winged carabid species only a small fraction of individuals with developed flight muscles. Thus in *H. rufipes* he found developed flight muscles in only 2 males (captured in June and Aug) and 2 females (captured in Aug.) out of 62 individuals examined. This may indicate that the period, in which an individual is capable of flight is rather short.

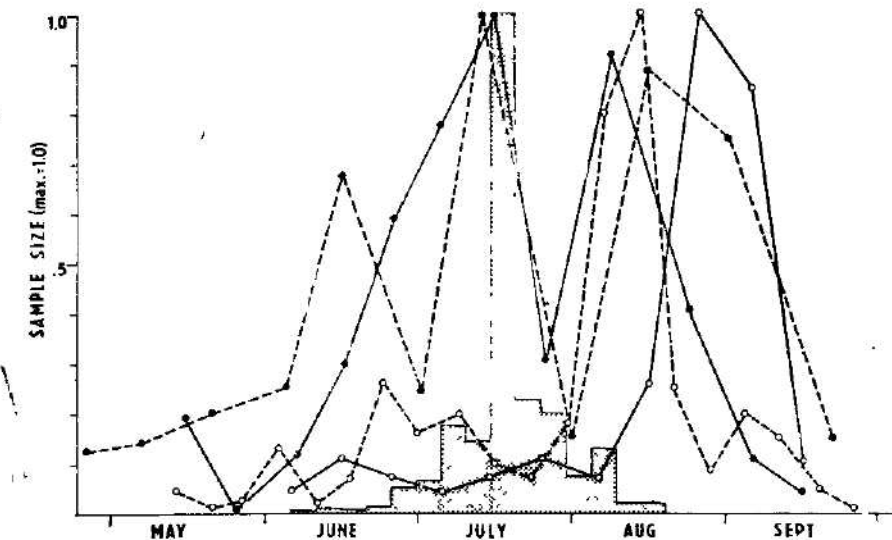


Fig 3. The comparison of terrestrial activity of *Harpalus rufipes* as revealed by pitfall traps (according to ○—○ Skuhravý and Novák, 1957; ○---○ Skuhravý, 1959; ●—● Skuhravý et al., 1959; ●---● Obrtel, 1968), with the flight activity as revealed by light trap at Praha-Ruzyně (pentad sums of pooled 1973—1979 material).

Several environmental factors including the availability of food may influence the reproduction and migration (cf. Thiele, 1977; Solbreck, 1978). Inappropriate conditions, mainly perhaps the lack of food, stimulate both the migratory flight (Meijer, 1974) and terrestrial activity (Baars, 1979b). By contrast, under appropriate photoperiodic conditions, ample food promotes the reproductive maturation. With the onset of reproduction, flight muscles histolyze. It is possible that some individuals may find appropriate conditions at the habitats where they have developed and do not migrate at all. Thus the proportion of migrating individuals may perhaps vary with environmental conditions.

2. The relation between the composition of light trap samples and composition of carabid population in the surroundings

The percent similarity of our sample with carabid populations of field habitats of Czechoslovakia (Obrtel, 1968; Skuhřavý et al., 1959), and Germany (Basedow et al., 1976), and populations from urban habitats in Poland (Czechowski, 1980a, b) is very low. The values of similarity index are $Re = 2.8-6.3\%$, $Re = 0.3-4.4\%$, and $Re = 0.1-6.4\%$ for Czechoslovak, German, and Polish populations respectively. This is mainly due to the fact that most species abundant in pitfall traps (which were used in above studies) are brachypters. But there are also other causes of differences. We suppose that pitfall traps selectively sample larger carabid beetles, while population density of small species appears underestimated (cf. Greenslade, 1964). On the other hand, small species belong to most important fliers captured by our light trap (*T. quadristriatus* is about 4 mm long). Thus if the proportion of small species in terrestrial populations is greater than indicated by pitfall traps, the similarity of terrestrial and aerial populations of carabids in field and urban habitats may be slightly greater.

By contrast the similarity of aerial populations of carabids may be sometimes larger, even in distant geographic areas. Basedow and Dickler (1981) sampled carabids with a light trap in an orchard near Heidelberg (West Germany). Twenty one of 29 species in their sample were present also in our sample and the dominant species in both samples were identical, with exception of *Harpalus diffinis* and *Trechus secalis*. Haeck (1971) sampled the carabids by means of window traps in the Netherlands. The window trap collects the beetles during day and night; and his traps were placed in a habitat quite different from the surroundings of our trap (near and within the newly built polder). Despite these differences in trap function, geographic position and surrounding environment, the similarity of Haeck's samples to samples from our light trap was much greater ($Re = 35.5\%$) than the similarity of our samples to terrestrial carabid populations of Czechoslovakia.

3. The effect of sampling method on variability of annual catches

When the trap is run continuously throughout the season, the variation in total year-catches of different species appears a good relative measure of the amount of annual change in absolute population size of these species (Wolda, 1978). Of course, the weather seriously affects the catches in individual nights but the migration is probably a programmed event in the life-cycle of an animal, which become realized at the nearest period of appropriate weather (cf. Baars, 1979a). This compensation of bad catches in nights of inclement weather by abundant catches in favourable nights nullifies the effect of changing weather.

The comparison of the data on variation of year-catches from light traps with results gained by other sampling methods in different geographic areas revealed interesting dependence of annual population fluctuations on the degree of aridity of the climate (Wolda, 1978). In comparing such results one must assume that the data are not substantially influenced by the type of collecting procedure (and in a number of cases it is perhaps so).

We compared the amount of variation of year-catches (in species where > 10 ex. were caught in 1973—1979) in our light trap with results of two pitfall sampling programs in England (Jones, 1979) and in the Netherlands (den Boer, 1977) (Fig. 4). The standard deviations of $\log_{10} n+1$ (where n is the year-catch of a given species) were used for comparison of annual variation of sample size (Williamson, 1972). The pitfall sampling has been demonstrated to produce good estimation of population density of certain species (Baars, 1979a; Ericson, 1979). The pitfall samples, however, tend to have greater annual variation than the light trap samples. The difference between

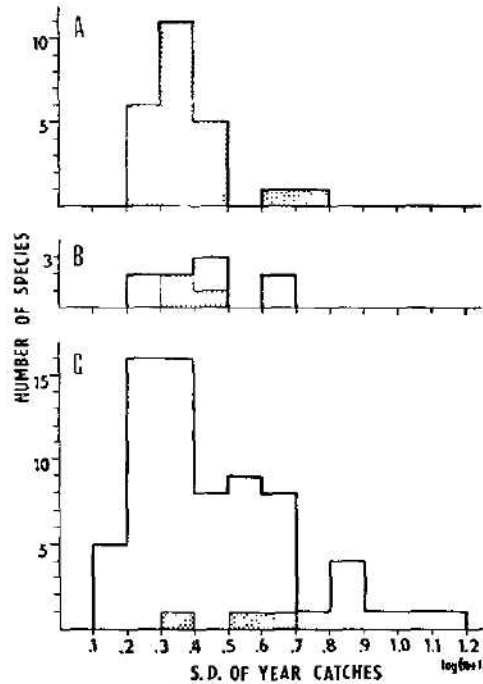


Fig. 4. The distribution of variation of annual catches of carabid species in three different sampling programs: A — light trap, Praha-Ruzyně (species captured in > 10 ex.); B — pitfall trap, England (Jones, 1979); C — pitfall trap, the Netherlands (den Boer, 1977). Shaded areas — species shared in common with Praha-Ruzyně trap.

our and Boer's samples was statistically significant (Kolmogorov—Smirnov test). The results may reflect the different ecological situations of the areas studied; or the fact that some terrestrial species not included in our samples may have greater variation of population size than regular fliers. Another explanation may be that the "populations" sampled by pitfall traps are more local and hence more severely influenced by local environmental changes of catastrophic nature (e.g. agricultural practices) than aerial populations, which recruit from leiger areas. Thus in Carabidae the variability of year-catches may be perhaps influenced by the type of sampling procedure.

Acknowledgement

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**NOTES ON VARIABILITY OF MACROTHRIX HIRSUTICORNIS
(CRUSTACEA, CLADOCERA)**

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Abstract: The author describes the variability, biology and distribution of *Macrothrix hirsuticornis* Norman et Brady, 1867 in Slovakia. The study is centred on the comparison of *Macrothrix hirsuticornis* and *Macrothrix groenlandica*. We concluded that *H. groenlandica* cannot be an independent species regarding the variability of *M. hirsuticornis*. *M. hirsuticornis* occurs in our samples most often with *Daphnia magna* and *Moina brachiata* and was never dominant.

INTRODUCTION

This species is not very frequent in Slovakia. Despite the rarity of *Macrothrix hirsuticornis*, we observed remarkable variability in form of the head shield, the shape of the shell valves and number of hooked spines on each segment. We observed individuals like *Macrothrix hirsuticornis* s. str., *Macrothrix hirsuticornis* var. *arctica*, and *Macrothrix groenlandica* (according to Smirnov, 1976). The remarkable variability of *Macrothrix hirsuticornis* is the reason of differences in the determination of this species.

A survey of the distribution and characters of *Macrothrix hirsuticornis* var. *groenlandica* is given by Fox (1962). In var. *groenlandica* he also includes *Macrothrix arctica* from Italy (Parensan, 1931) and *Macrothrix arctica* var. *carpatica* (Orghidan et Negrea, 1959) from Romania.

Lilljeborg (1900) considers *Macrothrix arctica* Sars, 1890 from Norway only as a variety of *Macrothrix hirsuticornis*.

Macrothrix hirsuticornis is known from Palearctic, Nearctic and Australian region. It occurs throughout Europe.

The geographical distribution of *Macrothrix hirsuticornis* var. *groenlandica* is not sufficiently known. In Europe it was found in: Iceland, Norway, northern Sweden, Italian Alps, Romania — in the Carpathian mountains (Meijering, 1961, Hrbáček, 1978), Czechoslovakia — in the High Tatras mountains (Minkiewicz, 1916), Bulgaria — in the Rila and Pirin mountains (Flössner, 1967). Then it was found in: Greenland, Caucasus, Pamir (Behning, 1941) and according to Smirnov (1976) in Argentina as well.

MATERIAL AND METHODS

List of samples from Slovakia (Fig. 1): Dolný Bar, shallow pool, May 8, 1956; Topoľníky, pool near a village, April 5, 1955; Palárikovo, ditch near a village (periodic water), April 17, 1956; Tvrdošovce, fish pond, April 22, 1969; Palárikovo, shallow pool, April 22, 1969; Búč, pool near a village with sandy bottom, April 22, 1969; Patince, pool with plant (*Carex* sp.) July 26, 1969; Iža — Komárno, ditch in a field, July

26, 1969; Velká Mača, large pool in a village, April 20, 1970; Jenkovce, shallow pool in a field with *Typha* and *Carex*, April 26, 1970; Palárikovo — Selice, large shallow pool in a field, May 13, 1970; Jatov, pool, May 17, 1970; Kameničná, shallow pool, May 14, 1970; Zlatná na Ostrove, small shallow pool, May 14, 1970; Salka, shallow pool, May 17, 1970; Bielovce, large shallow pool in a field, May 17, 1970; Bunkovce, shallow pool May 31, 1970; Hurbanovo, shallow pool near a village, April 14, 1967; Vajnory, shallow pool, March 30, 1971; Salka, small plantless shallow pool in a village, May 25, 1972; Komárno, small pool in a field, May 27, 1972; Búč, small shallow pool on a field, September 26, 1972; Nové Zámky, large plantless pool, May 29, 1973; High Tatras — Velické pleso, tarn, October 14, 1973.

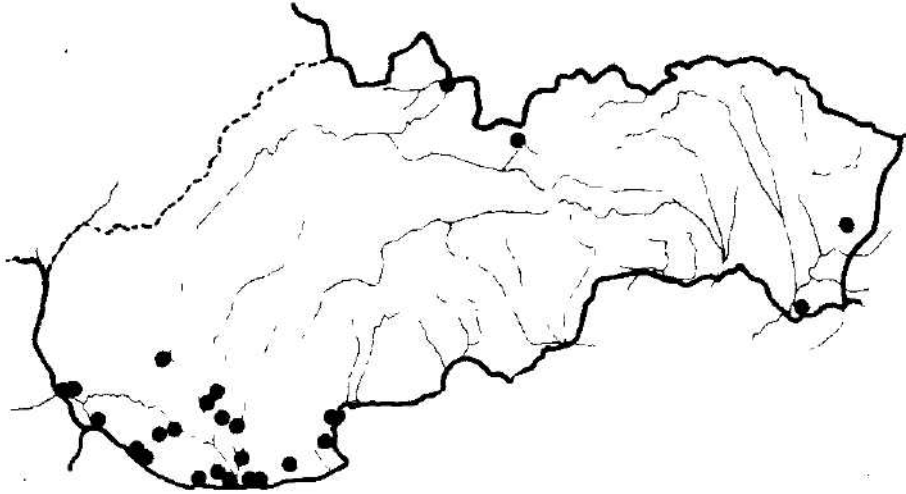


Fig. 1. Distribution of *Macrothrix hirsuticornis* in Slovakia.

Material from the following localities was analysed in more detail:
 828 Jatov, May 13, 1970: small shallow pool with plants near a road. About 200 m altitude. Collected individuals suggested the presence of *Macrothrix hirsuticornis* s. str. and *Macrothrix hirsuticornis* var. *groenlandica* (25 females and 6 males).
 1849 The High Tatras, tarn — Velické pleso, October 14, 1973, at 1663 m altitude, maximum depth 4.5 m. Individuals like *Macrothrix hirsuticornis* s. str. and *Macrothrix hirsuticornis* var. *groenlandica* (21 females, 4 males).
 789 Jenkovce, April 26, 1970, shallow pool on a field with plants (*Typha* sp. and *Carex* sp.). 5 females.

The study of the variability is based on body dimension measured according to Šrámek — Hušek (1962).

Permanent mounts of comparative material are deposited in the National history Museum in Bojnice in Czechoslovakia Nr. VII a — 3344 and in my collection.

RESULTS AND DISCUSSION

The description of *Macrothrix hirsuticornis* is not given it agrees with the literature (Behning, 1941, Flössner, 1972, Smirnov, 1976, Šrámek — Hušek, 1962).

Head shield — in typical individuals it is equally vaulted and dorsal fold is characteristic for *Macrothrix groenlandica*. According to the literature *M. hirsuticornis* var. *groenlandica* (Fox, 1962, Behning, 1941, Smirnov 1976) is found in higher latitudes or, in southern geographical regions, it is in high-

her altitudes (Carpathian, Alps, Caucasus, Pamir mountains). The individuals found in the tarn Velické pleso fits the second case. This is not the case of Jatov (about 200 m altitude). In both samples we found typical females as well as *groenlandica*-like individuals. In one case, one female from the tarn Velické pleso has double fold of head shield like *Macrothrix montana* (Birge). We consider it an anomaly of *Macrothrix hirsuticornis* (Fig. 3).

Valves are thin, in summer females slightly reticulated. We found distinct reticulation only in some individuals from the tarn Velické pleso and in ephippial females (Fig. 2).

The shape and size of dorsal ridge is very variable. The summer females with thin shell have a poorly developed dorsal ridge (Fig. 9). This character is not a rule and changes from case to case. It is usually smooth but we found individuals from Jenkovce (Fig. 11) with an extremely developed dorsal ridge an irregularly humped backline.

The marginal setae of valves are neither equally long nor equally distributed. In proximal part of the ventral margin are 2 long and 1 short seta, in the middle part 2 long and 2 short ones and in distal part 1 long and 1 short seta alternate (Fig. 2a, 9a). Some females had also fine bristles on some setae on ventral margin. The fine bristles were also found in the males (Fig. 4a).

Antennules — their spinulation varied and we were not able to distinguish between typical antennules of *Macrothrix hirsuticornis* and its varieties (Fig. 5, 6).

Antennae — a detail description of antennae of *Macrothrix hirsuticornis* var. *groenlandica* is given by Fox (1962). Smirnov (1976) singled out this variety as an independent species (*M. grönländica*). Differential diagnosis is based on the number of hooked spines on segments of antennae constant 0—2—1 / 0—0—1. We found that the number of hooked spines is not constant and is not typical only for var. *groenlandica*, but also for *M. hirsuticornis* s. str. According to our observation the number of hooked spines varies: 0—(1—3)—1 / (0—1) —0—1. (Fig. 12a, b).

Postabdomen — a terminal claw with fine bristles on the ventral margin and 4—5 small spines of the dorsal margin is characteristic for all the populations in Slovakia (Fig. 8, 13).

Ephippium — the var. *groenlandica* has only 1 egg. *M. hirsuticornis* may have in its ephippium 1—3 eggs. Ephippium primitive, not good different from the valves. Near backline fine polygonal reticulated, than are only fine and short lines or points. Permanent eggs are in chitinised and reticulated cover (Fig. 7). It is probably that permanent eggs may be free in the water without cover of the valves.

Size of females — *M. hirsuticornis* s. str. 0.6—2.2 mm, *M. h.* var. *groenlandica* up to 1 mm.

Size of males — up to 0.6 mm.

Bionomy — individuals collected from the territory of Slovakia were mostly found in temporary shallow pools. They were rarely collected from permanent water such a tarn, small fish ponds etc. The occurrence from the end of March till the middle of October.

Macrothrix hirsuticornis cooccured most often with the species *Daphnia magna* and *Moina brachiata*. More rarely with the following species: *Daphnia atkinsoni*, *Daphnia longispina*, *Ceriodaphnia reticulata*, *Simocephalus expinosus*, *Wlassicsia pannonica* and *Chydorus phaericus*. *Macrothrix hirsuticornis*

was never dominant in our samples. It lives on the bottom, or on waterplants. Sometimes it swims in free water, but only for a short time. We have never found it in peat bogs.

SUMMARY

The study is focused on the variability of *Macrothrix hirsuticornis* and its varieties than were differentially rated by many authors (Behning, 1941, Orghidan et Negrea, 1959, Flössner, 1967, Smirnov, 1976 etc.). The following characters were considered in our examination of populations from Slovakia: the head shield, valves, antennules, antennae, postabdomen and ephippium.

Based on examination of these characters we found a remarkable variability of *Macrothrix hirsuticornis*. Therefore we included the var. *groenlandica* — like population from Slovakia in *Macrothrix hirsuticornis*.

It is interesting that *groenlandica*-like population was found also in lowland which does not agree with data from literature.

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The figures 2—8 and 9—13 will be found at the end of this issue.

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Zoologische Abteilung des Westböhmisches Museums Plzeň

**DIE BEWERTUNG DES VORKOMMENS DER FLEDERMÄUSE (MAMMALIA:
CHIROPTERA) IN WESTBÖHMEN**

Luděk HŮRKA

Eingegangen am 29. Mai 1981

Abstract: The bat coenose of the western part of Bohemia is discussed on the basis of 22 years of research of their occurrence. During this time 11, 687 bats, 16 species in 719 localities were gained. This community is appreciated through the statistical ecological methods — index of equitability, index of ecological dominance, rough density — and by means of the index of rate of density. The hypsometrical frequency of individual species in the course of all the years round occurrence and the nature of the community is demonstrated grafically.

EINLEITUNG

Seit 1959 verfolgen wir systematisch das Vorkommen der Fledermäuse in Westböhmen. Aus diesem Gebiet waren bis dahin nur vereinzelt Funde weniger Arten bekannt und dazu noch nur aus den dreissiger Jahren dieses Jahrhunderts.

Literatur, die das frühere Vorkommen der Fledermäuse auf dem erwähnten Gebiet behandelt, ist in der Arbeit von H ů r k a 1973 angeführt. Nach dieser Zeit festgestellten Lokalitäten einiger Arten sind in den Arbeiten von K r á t k á et K r á t k ý 1976, Č e r v e n ý et H a n á k 1977, Č e r v e n ý 1978, H ů r k a 1974, 1977, 1978, 1979 und Š e d o 1979, 1980 enthalten.

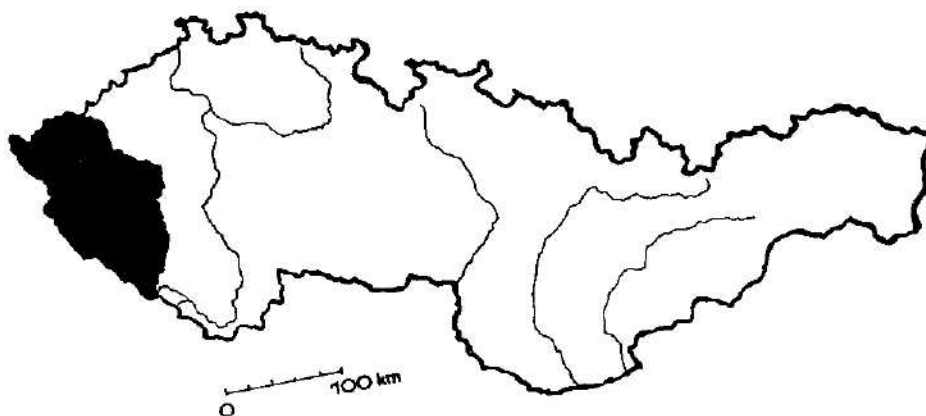
Die Erforschung der Verbreitung von Fledermäusen wird hauptsächlich von den Mitarbeitern der zoologischen Abteilung des Westböhmisches Museums in Plzeň betrieben, aber in den letzten Jahren haben in dieser Richtung in der Umgebung von Sušice und Klatovy Dr. D. Krátká und Dr. J. Krátký aus dem Bezirksmuseum in Sušice mitgewirkt. In demselben Gebiet wurde eine ganze Reihe bedeutender Abfänge von Ing. J. Červený aus Praha verzeichnet. Ungefähr 4 Jahre widmete sich auch Dr. I. Brdička aus dem Bezirksmuseum in Karlovy Vary der Verfolgung des winterlichen Fledermausvorkommens in seinem Wirkungskreis.

Allen hier genannten, sowie meinen Kollegen aus der naturwissenschaftlichen Abteilungen des Westböhmisches Museums in Plzeň und nicht zuletzt auch den Kindern und Jugendlichen, die in der naturwissenschaftlichen Interessengruppe unter Führung des Herrn Vl. Kraus in Rokycany tätig sind, gebührt für ihre opferwillige Mitarbeit und Hilfe bei den anspruchsvollen langjährigen Forschungsarbeiten mein bester Dank.

Dem Herrn Dr. V. Hanák, CSc., aus dem Lehrstuhl der systematischen Zoologie der naturwissenschaftlichen Fakultät der Karlsuniversität in Praha bin ich für die Durchlesung des Manuskriptes und wertvolle Anmerkungen mit Dank verpflichtet.

MATERIAL UND METHODIK

Seit 1959 wurden an 719 Lokalitäten 11 687 Stück Fledermause von 16 Arten (*R. hipposideros*, *M. mystacinus*, *M. brandti*, *M. nattereri*, *M. bechsteini*, *M. myotis*, *M. daubentoni*, *V. murinus*, *E. nilssoni*, *E. serotinus*, *N. leisleri*, *N. noctula*, *P. pipistrellus*, *B. barbastellus*, *P. auritus* und *P. austriacus*) angesammelt. Konkretere Angaben über einzelne Arten werden in der Tabelle I angeführt. Angaben über Beringung der Fledermause werden in besonderer, bereits erschienenen Arbeit erwähnt und bearbeitet.



Karte 1. Gebiet Westböhmens.

Im Text wurden einige Methoden der statistisch-ökologischen Bewertung angewandt, die eine genauere Klärung der Beziehung einzelner Populationen zur gesamten Biozönose der Fledermause in Westböhmen ermöglichen sollen:

a) Index der ökologischen Dominanz, der nach der Formel

$$c = (n_i/N)^2 \quad (\text{Odum 1977})$$

berechnet wurde und wo die Summe nach der Zusammenfassung der Bedeutung der jeweiligen Art den Endwert der Zonosekomposition anzeigt, nach welchem man feststellen kann, ob die Gemeinschaft natürlich oder z. B. durch abiotische Faktoren bereits gestört ist.

b) Index der Äquitabilität, der die verhältnismässige Aufteilung der Individuen unter die Arten anzeigt, die nach der Formel

$$e = \frac{-\sum \left(\frac{n_i}{N}\right) \log \left(\frac{n_i}{N}\right)}{\log S} \quad (\text{Odum 1977})$$

berechnet wurde.

c) grobe Populationsdichte (Odum 1977), die Anzahl der festgestellten Individuen einer Art oder der gesamten Biozönose auf eine Raumeinheit des verfolgten Gebiets, in unserem Fall auf 1 km² oder ha, darstellt.

d) Index der relativen Häufigkeit, der zwecks der leichteren Bewertung der Beziehung jeder Art zur gesamten Gemeinschaft berechnet und benutzt wird und zwar nicht nur auf Grund der zahlenmässigen Grosse der Population (Index der Äquitabilität) sondern auch auf Grund der Anzahl der Lokalitäten, die von einer bestimmten Art besetzt sind, welche durch Prozentanteil an der Gesamtanzahl bisher festgestellter Lokalitäten auf dem verfolgten Gebiet und in der verfolgten Zeitspanne ausgedrückt wird.

In der Formel $p = e \cdot l$

bedeutet e der Index der Äquitabilität (siehe ad b), l die Anzahl der vor einer bestimmten Art besetzten Lokalitäten, die durch $\frac{0}{0}$ von allen festgestellten Fundplätzen ausgedrückt wird.

In diesem Beitrag sind absichtlich alle in den Jahren 1959 bis 1980 festgestellten Lokalitäten des ganzjährigen Vorkommens der Fledermäuse in Betracht gezogen worden, weil es sich hier um Bewertung der gesamten im Verlauf von 22 Jahren verfolgten Zonosen handelt.

Es ist begreiflich, dass der Index der relativen Häufigkeit auch bei der „Einreihung“ der ökologischen Werte der Gemeinschaft nur in der Sommer- oder nur in Winterperiode verwendbar ist, je nach dem Typus der Verstecke einzelner Arten, oder auch zur Bewertung eines oder mehrerer Typen dieser Verstecke usw.; Voraussetzung dazu bildet aber ausreichendes Material.

Zur Ergänzung der eigentlichen Werte des Indexes der relativen Häufigkeit und ihrer Massgeblichkeit kann man die graphische Darstellung der Gemeinschaft der Fledermäuse in Westböhmen (Graph 2) benützen.

- a) die graphische Darstellung der hypsometrischen Frequenz einzelner Arten der Fledermäuse im Verlauf der Sommer- und Winterperiode und des Vorkommens der Wochenstuben auf dem Gebiet Westböhmens, das die Seehöhen von 250 bis 1369 m aufweist.

FESTGESTELLTEN ARTEN

Von den 24 Fledermausarten, die in der ČSSR festgestellt wurden, sind bisher in Westböhmen (d. h. auf dem Gebiet des heutigen Westböhmisches Bezirkes – Karte 1) 18 Arten (66,7%) angetroffen worden. Diese Zahl erscheint nach den bisherigen Erfahrungen als Maximum dessen, was man im westlichen Teil unseres Staates in dieser Hinsicht erwarten kann.

Rhinolophus hipposideros

Diese Art ist an 10 Lokalitäten im Sommer- und an 7 in der Winterperiode angetroffen worden. 8 Wochenstuben mit 3–36 Stück wurden an Böden der Schlösser (62%) am Dachboden der Kirchen (12,5%), in einem Schlosstürmlein (12,5%) und unter einem Schlossfussboden (12,5%) In der Winterperiode wurden Einzelstücke der Kleinen Hufeisennase in Stollen, Grotten und Kellern der Wohnhäuser bei Temperaturen 5–8°C gefunden.

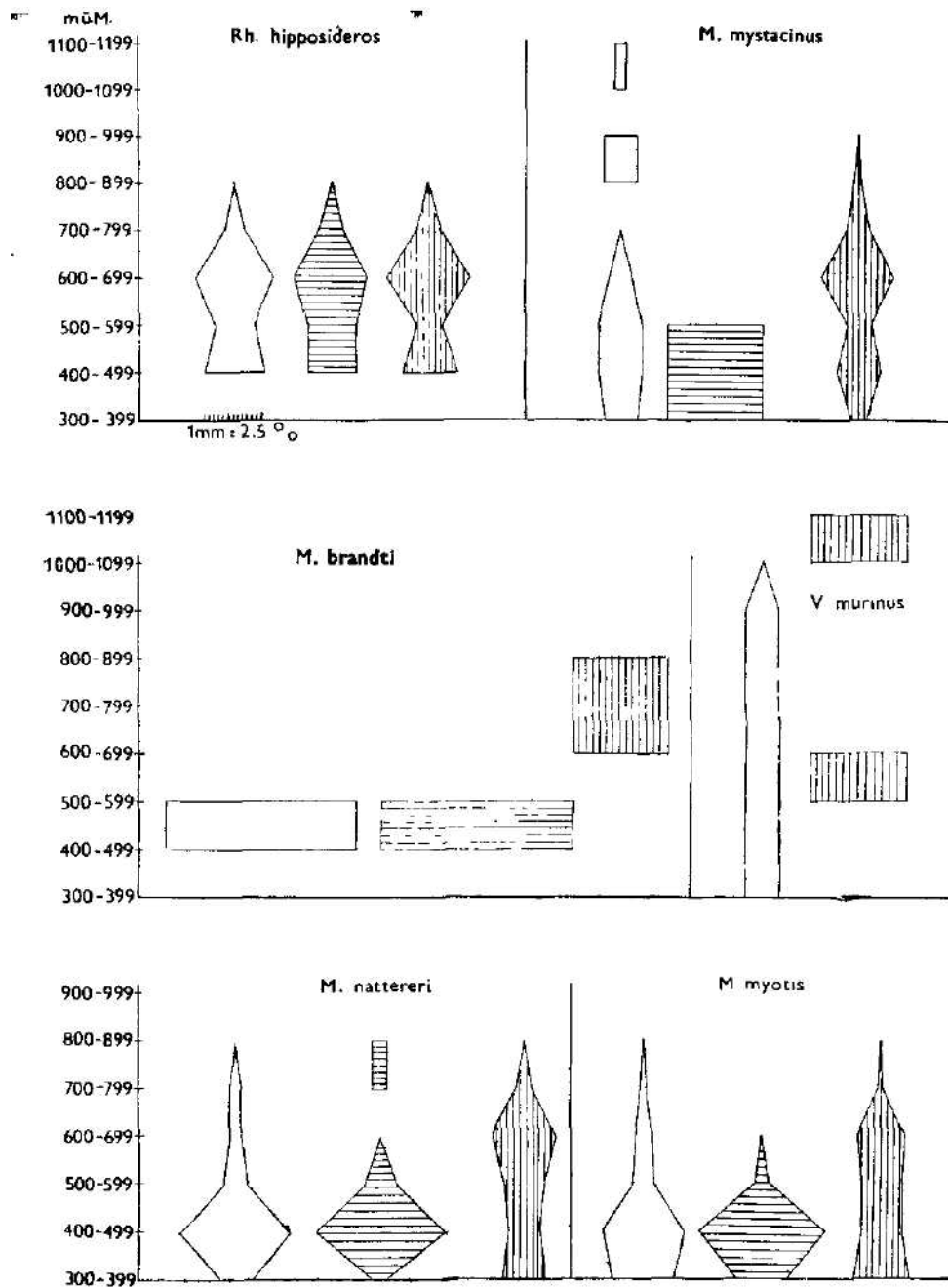
Die ganze Anzahl der in Westböhmen in der Zeitspanne von 1959–1980 festgestellten Exemplare dieser Art beträgt 161 Stück. Sie ist nur im südöstlichen Teil des verfolgten Gebietes, d. h. im Kreis Klatovy in der Umgebung von Sušice (Hůrka 1973, Krátká et Krátký 1973, 1976, Cervený et Hanák 1977) verbreitet. Hypsometrisch fand man die meisten Lokalitäten in der Zone 600–699 m ü. M. (Graph 1) und zwar im Verlauf des ganzen Jahres (41%). Auch die meisten Wochenstuben wurden in diesen Höhen gefunden.

Der Wert des Indexes der relativen Häufigkeit (weiter nur IRH) 0,24 stellt *Rh. hipposideros* nur an 12. Stelle der Artenhäufigkeit der Fledermäuse in Westböhmen und daher wird diese Art hier als weniger häufig bezeichnet. Grobe Populationsdichte beträgt 1 Individuum auf 67,6 km².

Von der Tendenz zum Sinken des Bestandes der Population von *Rh. hipposideros* in Westböhmen zeugt der Umstand, dass seit 1972 in der Winterperiode nur 1 Stück jährlich angetroffen wurde. Zuletzt (wieder nur 1 Stück) am 19. 2. 1976 in einem Stollen bei Kašperské Hory.

Myotis mystacinus

Diese Art wurde bisher an 5,4% aller bekannten Lokalitäten vorgefunden (17 Stück im Sommer, 22 im Winter), Wochenstube nur zweimal mit 40–70 Indi-



Graph 1 A. Die hypsometrische Frequenz der gefundenen Fledermäuse.

viduen. In der Überwinterungsperiode wurden 88 % solitär versteckte Bartfledermäuse in Stollen und Höhlen und 12 % in Burg- und Schlosskellern bei der Temperatur von 5–8°C gefunden.

Die Bartfledermaus ist in Westböhmen die Art mit breitester hypsometrischer Frequenz. Fundplätze des Sommervorkommens fand man in Höhen von 300–1199 m. ü. M., des Wintervorkommens in 300–999 m (Graph 1).

Der Wert des IRH beträgt hier 0,60, was diese Art an 10. Stelle der Artenhäufigkeit einreicht. Die Summe von 181 insgesamt vorgefundenen Individuen (33 Männchen und 148 Weibchen) ergibt grobe Populationsdichte 1 Individuum auf 60 km².

Bartfledermaus kommt sporadisch im ganzen verfolgten Gebiet vor und wird mit Rücksicht auf statistische Ermittlungen in Westböhmen als weniger häufige Art klassifiziert.

Myotis brandti

Wurde nur auf 5 Lokalitäten gefunden und zwar in einer Wochenstube und 4 Winterverstecken. Die Anzahl der Individuen in der Wochenstube schwankte von Jahr zu Jahr zwischen 40 bis 60 Stück. In die Wochenstube kehrten jedes Jahr die vorjährigen Jungen zurück, deren Anzahl 10–15 % betrug.

In der Winterperiode wurden einzelne Stücke solitär und lose an der Wand des Stollens angehängt gefunden (600–899 m ü. M.), bei Temperaturen von 4–6 °C.

Grobe Populationsdichte bei *M. brandti* betrug 1 Individuum auf 65 km², IRH aber nur 0,07. Diese Art wurde bis jetzt nur im östlichen und südöstlichen Teil unseres Gebiets gefunden und mit Rücksicht auf kleine Anzahl der Fundplätze und verhältnismässig auch der Individuen wird sie mit Recht als weniger häufige bezeichnet.

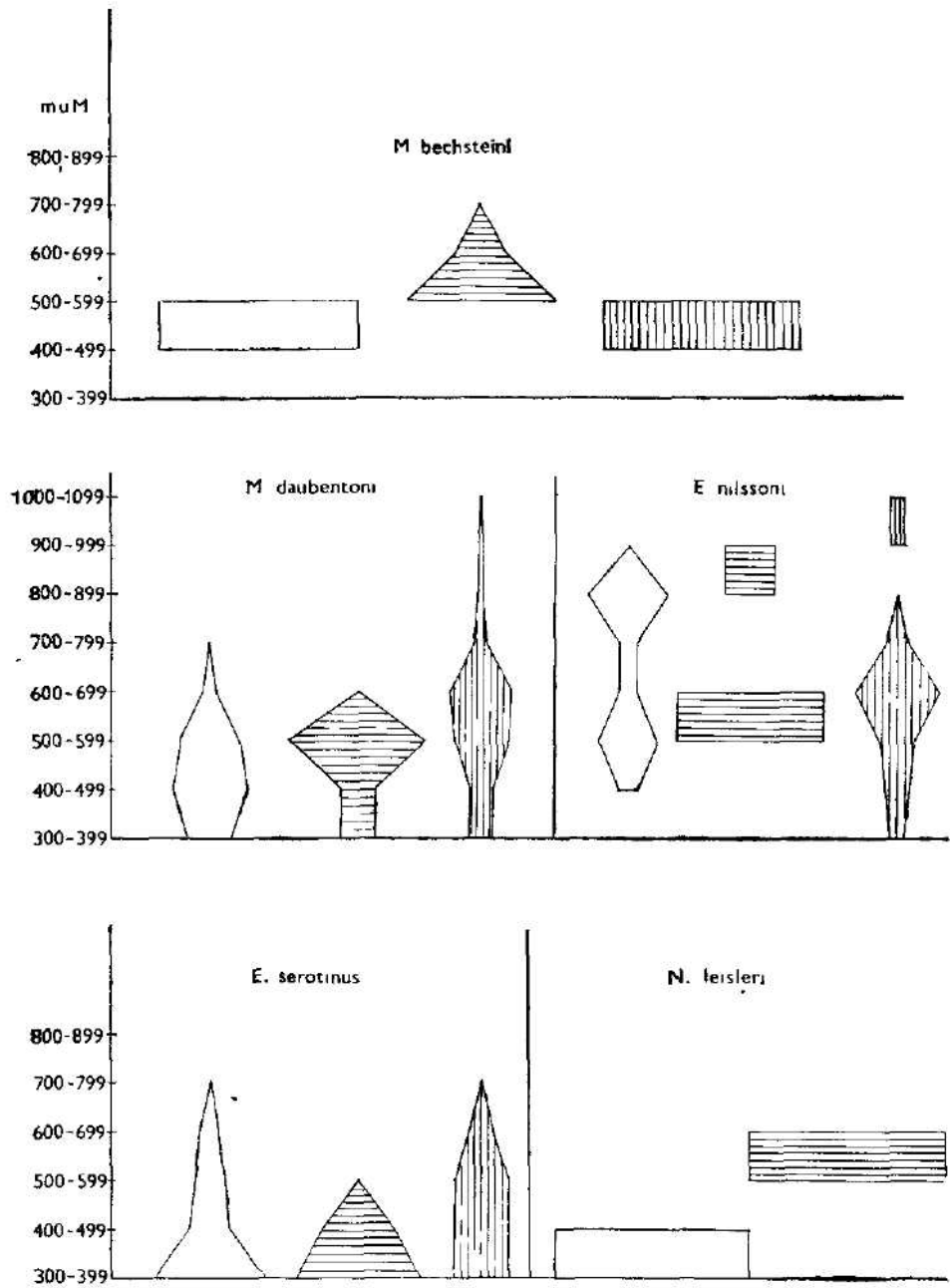
Myotis nattereri

Volle 7 % aller festgestellten Fledermauslokalitäten waren von Fransfledermaus besetzt. An 17 Fundplätzen des Sommervorkommens wurden insgesamt 261 Exemplare gefunden, von denen die Mehrzahl den 12 Wochenstuben angehörte. Zweimal wurde Wochenstube in Baumhöhle (Ahorn – Červený 1978, im zweiten Fall Linde – Krátká et Krátký 1973). Die Anzahl der Angehörigen der Wochenstube schwankte zwischen 5 bis 50 Stück. In der Sommerperiode fand man solitäre Exemplare sowie Wochenstuben meistens in der Zone von 400–599 m u. M. In der Winterperiode fand man Angehörige dieser Art einzeln und tief eingezogen in Spalten der Stollenwände oder Decken. Auf dem Gebiet Westböhmens wurde auch eine Winterkolonie mit 7 Weibchen versteckt in der Spalte einer Karsthöhle gefunden (Červený 1978). Im Verlauf der Überwinterung beobachtete man Verschiebung der Höchstzahl der Lokalitäten von *M. nattereri* in höhere Lagen (500–799 m ü. M.). Temperaturen der Verstecke schwankten zwischen 2–8°C.

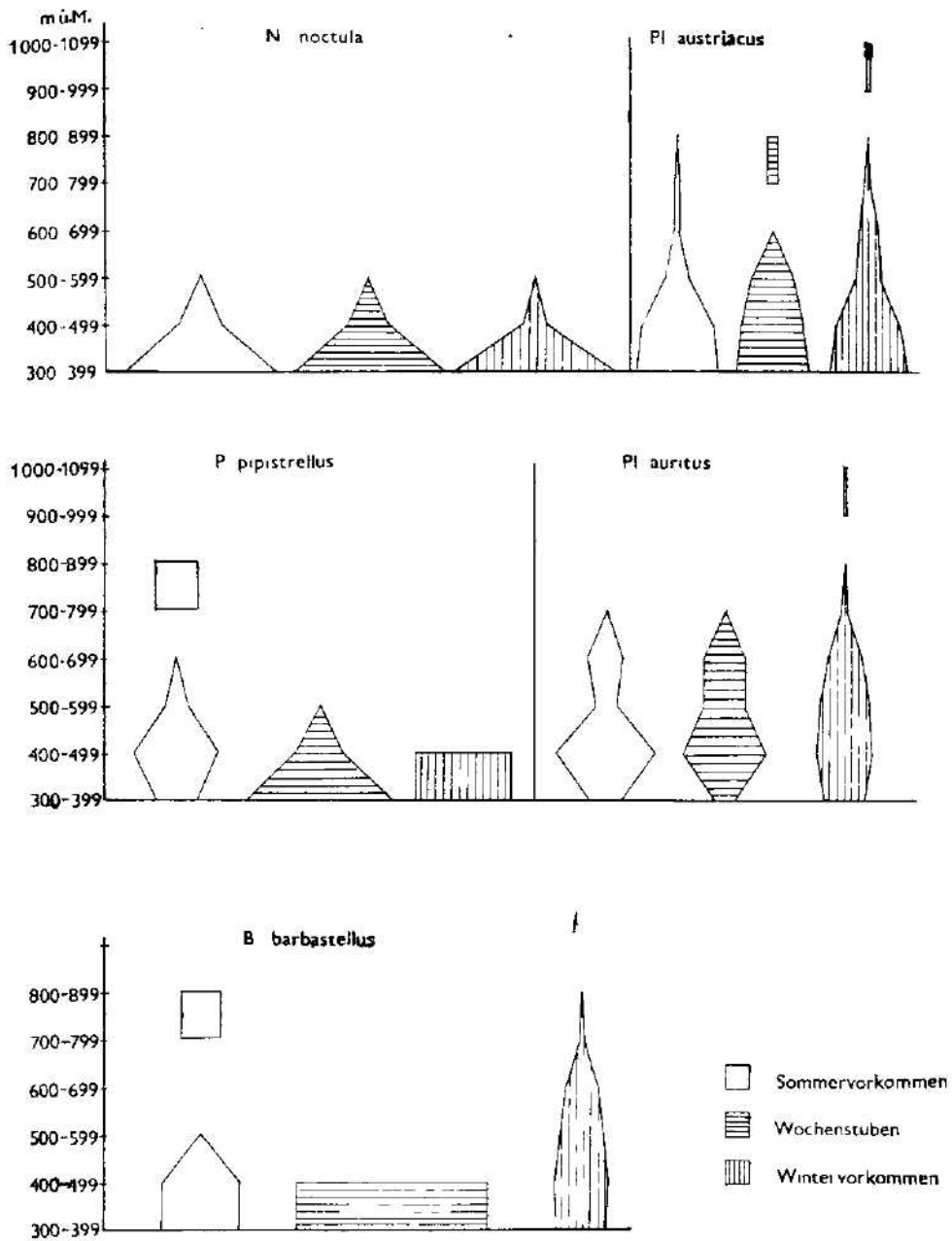
Insgesamt wurden 320 Exemplare in niederen und mittleren Lagen (500–899 m ü. M.) gefunden. Grobe Dichte beträgt 1 Individuum auf 34 km², IRH = 1,19. Man kann daher diese Art in Westböhmen als häufig bezeichnen.

Myotis bechsteini

Ist in Westböhmen in einer Wochenstube (Birkenhöhle, Červený 1978) und an 4 Winterfundplätzen gefunden worden. Alle Winterfunde stammen aus



Graph 1 B Die hypsometrische Frequenz der gefundenen Fledermäuse.



Graph 1 C Die hypsometrische Frequenz der gefundenen Fledermause.

Stollen und einer Grotte. Alle Lokalitäten liegen in der hypsometrischen Zone von 400–799 m ü. M. Die 17 insgesamt angetroffenen Exemplare ergeben grobe Dichtheit 1 Individuum auf 639 km² und nach dem IRH = 0,01 steht diese Fledermaus erst an 14. Stelle der Häufigkeitsliste. Man kann daher sagen, dass die Bechsteinsche Fledermaus in Westböhmen eine seltene Art darstellt, die nach bisherigen Erfahrungen nur inselartig verbreitet ist.

Myotis myotis

Wurde an 66 Lokalitäten im Sommer und 53 im Winter festgestellt. 26 Wochenstuben und 3 Winterkolonien zeugen ebenfalls vom sehr häufigen Vorkommen. Die Zahl der Individuen in den Wochenstuben schwankte zwischen 15–400. Einige Stellen der Wochenstuben sind bereits mehr als 100 Jahre bekannt, z. B. in Domažlice (Hůrka 1978). Es ist aber interessant, dass man im Verlauf der letzten 5 Jahre bei der kleineren Wochenstuben von *M. myotis* sehr oft Übersiedlung oder gänzliches Verschwinden vom ursprünglichen Ort und seiner Umgebung beobachten konnte. Höchste Zahl der Wochenstuben (65,4^{0/0}) ist in der Zone 400–599 m gefunden worden, ebenso wie das solitäre Vorkommen. Im Winter fand man einzelne Exemplare am häufigsten in der Zone von 300–499 m ü. M. In diesen Verstecken, gleichgültig ob in Stollen, Grotten oder Kellern der Burgen und Wohnhäuser, wurde Temperatur von 2–9,5⁰ C gemessen.

Grobe Populationsdichte dieser Art beträgt im hier verfolgten Gebiet 1 Stück auf 2,9 km² und IRH = 10,47, was sie an 1. Stelle der Häufigkeitsliste einreicht. Im Verlauf der Jahre 1959–1980 wurden insgesamt 3722 Exemplare an 119 Lokalitäten gefunden, welche Zahlen zugleich mit den hohen Werten der statistisch-ökologischen Indexe *M. myotis* in Westböhmen zweifellos als sehr häufig erscheinen lassen.

Myotis daubentoni

Im verfolgten Gebiet Westböhmens wurden 42 Lokalitäten dieser Art gefunden. Davon 5 Sommerkolonien der Männchen und 1 Wochenstube. Die Individuenzahl in Männchenkolonien betrug 4 bis 20 Stück, in Wochenstube um 200 Ex. Einzelne Exemplare wurden im Sommer durch Netzabfang meistens in Wassernähe (Červený 1978) oder durch Abschuss dortselbst gewonnen. Wie aus dem Graph 1B erscheint, ist die hypsometrische Frequenz im Sommer am höchsten in der Zone von 400–699 m konzentriert. In der Winterperiode wird die hypsometrische Frequenz bedeutend breiter (300–1099 m ü. M.), meistens kommt aber die Wasserfledermaus nur in der Zone von 500–799 m vor. Sie überwintert bei Temperatur 2–9,5⁰ C.

Grobe Populationsdichte dieser Art ist 1 Stück auf 25 km², so dass von 431 Stück auf einer ziemlich hoher Anzahl der Lokalitäten sie an 6. Stelle der Häufigkeitsliste steht. Die Erwerbung erlaubt die Einreihung der Wasserfledermaus in Westböhmen in häufige Arten. Ihre Verbreitung ist aber nicht gleichmässig. Öfteres Vorkommen wurde nur im mittleren und südlichen Teil Westböhmens festgestellt, in nördlichen Gegenden wurde sie nur sporadisch und bloss im Winter gefunden.

Vespertilio murinus

Diese Art wurde nur einzeln, aber im Verlauf des ganzen Jahres angetroffen. Die Wochenstuben sind bis jetzt nicht gefunden worden. Sechs bekannte Som-

merfundplätze sind auf der ganzen hypsometrischen Breite des Gebiets (in 309—1099 m ü. M.) angeteilt, winterliche Funde dann in den Zonen von 500 bis 699 und von 1000—1199 m. Insgesamt wurden 12 Stück erbeutet, davon 9 Männchen und 3 Weibchen. Das ergibt auch niedrige grobe Populationsdichte — 1 Stück auf 906 km². Nach dem IRH wird *V. murinus* auf vorletzte 15. Stelle der Häufigkeitsliste eingereiht und im verfolgten Gebiet mit Recht als seltene Art bezeichnet. Ihre bis jetzt bekannte Verbreitung nimmt den südlichen und südwestlichen Teil unseres Gebietes ein, zweite Insel liegt in der Mitte, in der Umgebung von Plzeň.

Eptesicus nilssoni

In der letzten Zeit festgestellte 10 Fundplätze des Sommervorkommens (darin 4 Wochenstuben) und 16 Winterlokalitäten reihen diese Fledermaus unter die Arten mit ganzjährigem regelmässigem Vorkommen. Hauptteil der Sommerfunde, einschliesslich der Wochenstuben, fällt in die Zone von 500 bis 699 m. In der Wochenstuben wurden 7—60 Individuen gefunden. Im Winter werden einzelne Exemplare in 89⁰/₀ der Fälle in Bergstollen bei Temperaturen von 1—7,5⁰ C gefunden. Hypsometrische Frequenz in der Winterperiode ist breit, sie nimmt die Zonen von 300—1099 m ein, aber die höchste Konzentration findet man in der Zone von 600—799 m ü. M.

In den Jahren 1959—1980 hat man im verfolgten Gebiet insgesamt 384 Individuen dieser Art gefunden. Grobe Populationsdichte beträgt 1 Stück auf 28 km², nach dem IRH gehört *E. nilssoni* auf 9. Stelle der Häufigkeitsliste und unter häufige Arten, die im ganzen Gebiet verbreitet sind.

Eptesicus serotinus

Eptesicus serotinus wurde an 20 Fundplätzen in der Sommerperiode und nur in 7 Winterquartieren angetroffen. Acht Wochenstuben mit 4—25 Exemplaren hat man in mittleren Lagen von 300 bis 599 m gefunden. Dasselbe gilt auch für solitäre Stücke, deren Funde in gleichen Höhen am zahlreichsten waren. Die Wochenstuben dieser Art sind an Dachböden der Kirchen oder Wohnhäuser untergebracht. Bei sporadischen Funden von *E. serotinus* im Winter handelte sich immer um Exemplare, die tief in Mauerspalten grösserer Gebäude versteckt waren. Bloss in einem Fall wurde *E. serotinus* in einem Stollen gefunden.

Auf dem Gebiet des Westböhmisches Bezirks wurden insgesamt 384 Exemplare von *E. serotinus* an 27 Fundplätzen festgestellt, was diese Art auf 11. Stelle in der Häufigkeitsliste einreicht. Grobe Populationsdichte beträgt bei dieser Art 1 Stück auf 48 km².

Mit Rücksicht auf obige Zahlen wird diese Fledermausart unter die weniger häufigen Arten eingereiht. Bis jetzt wurde sie in mittleren Lagen des südlichen und mittleren Teils des verfolgten Gebiets angetroffen.

Nyctalus leisleri

Diese Fledermaus ist bei uns bis jetzt nur einmal in einer Wochenstube und einmal in der Übergangsperiode festgestellt worden. Beide Fundplätze waren Baumhöhlen — im Fall der Wochenstube in einer hohen Eiche, bei solitärem Weibchen in einem Akazienbaum. In der Winterperiode wurde diese Art nirgends gefunden.

Diese Art steht in der Häufigkeitsliste bei uns an der letzten 16. Stelle. Grobe

Populationsdichte beträgt bei ihr 1 Stück auf 906 km². Sie wird mit Recht als selten bezeichnet und bis jetzt nur im südlichen und südöstlichen Teil des Gebiets gefunden worden.

Nyctalus noctula

Insgesamt wurden 28 Lokalitäten ihres Vorkommens festgestellt (21 im Sommer, 7 im Winter). 12 Wochenstuben waren in Baumhöhlen untergebracht (in der Kiefer, Eiche, Erle und Linde) meistens in der Zone 300—499 m und zählten 6 bis 60 Stück. Weitere zwei Kolonien, die im engen Raum zwischen zwei Häusern und unter dem Fensterrahmen eines Hauses untergebracht waren, sind ganzjährig.

Die 376 bis jetzt auf dem verfolgten Gebiet festgestellten Exemplare von *N. noctula* (IRH = 0,73) reihen diese Art bei uns auf 8. Stelle der Häufigkeitsliste, grobe Populationsdichte beträgt bei ihr 1 Stück auf 29 km². Der Abendsegler gehört unter häufige Arten, ist aber nach bisherigen Feststellungen nur im südlichen und mittleren Teil des hier verfolgten Gebiets verbreitet.

Pipistrellus pipistrellus

Im Verlauf mehrjähriger Forschungen in Westböhmen wurden insgesamt 9 Fundplätze des Sommervorkommens, 6 Lokalitäten des Wintervorkommens und 20 Stellen der vorübergehenden Zwischenquartiere von Zwergfledermaus festgestellt. Davon waren nur Wochenstuben mit 30—40 Stück und 2 Winterkolonien mit 6 bis 700 Stück. Ausser den Zwischenquartieren (Hůrka 1966) wurden Angehörige dieser Art einzeln im Sommer in verschiedenen Verstecken in Häusern, im Winter in Kellern grösserer Objekte gefunden. Die grössten Mengen dieser Fledermaus (933 Männchen und 1003 Weibchen) wurden bei den sog. Invasionen in der zweiten Hälfte August, wo Zwergfledermäuse durch Fenster sogar in Wohnräume eindringen.

Das Sommervorkommen dieser Art wurde in Höhen 300—899 m verzeichnet, im Winter bloss bis 599 m ü. M. Ähnlicherweise wurden auch die Winterkolonien dieser Art nur in Lagen bis 599 m beobachtet.

Auf Grund hoher Anzahl der vorgefundenen Exemplare (3411 Stück) und verhältnismässig hoher Anzahl festgestellter Lokalitäten (IRH = 3,03) wird Zwergfledermaus auf 4. Stelle der Häufigkeitsliste und ihre grobe Populationsdichte beträgt 1 Stück auf 3,2 km². Sie gehört daher in Westböhmen zu sehr häufigen Arten, wennauch ihre Verbreitung sich nur auf den mittleren und südlichen Teil des verfolgten Gebiets beschränkt.

Barbastella barbastellus

Bei dieser „Winterart“ kennen wir bis jetzt in Westböhmen nur 5 Lokalitäten des Sommervorkommens, dafür aber 59 Stellen, wo überwinterte Exemplare gefunden worden sind. Ausser der ersten Wochenstube (Hůrka 1973) wurde 1980 eine weitere mit 12 Weibchen gefunden (Volduchy, Kreis Rokycany). In der Winterperiode werden einzelne Mopsfledermäuse in Kellern und Stollen, meist in Seehöhen von 300—499 m (28,8%) und 400—599 m (28,8%) angetroffen, wo sie bei Temperaturen 0—7° C überwintern.

Grobe Populationsdichte beträgt bei dieser Fledermaus 1 Stück auf 21,5 km², was sie mit dem IRH = 2,10 auf 5. Stelle der Artenhäufigkeit einreicht. Mopsfledermaus gehört daher zu häufigen Arten und ist auf dem ganzen Gebiet Westböhmens verbreitet.

Tabelle 1 -- Die Fledermäuse in Westböhmen in den Jahren 1959--1980

| Art | Lokalitätenzahl | | | | | | Stückzahl | | | Kolonenstand | | Dominanz | Äqui- tabilität |
|---------------------|-----------------|----------|----------|----------|----------|----------|-----------|-----------|----------|--------------|-------|----------|--------------------|
| | Sommer | | Winter | | insg. | | Sommer | | Winter | | insg. | | |
| | Übergang | Übergang | Übergang | Übergang | Übergang | Übergang | Übergang | Übergang | Übergang | | | | |
| <i>Rh. hippi.</i> | 10 | 7 | 17 | 122 | 39 | 161 | 8 | 0,0001897 | 0,1026 | | | | |
| <i>M. mystac.</i> | 17 | 22 | 39 | 145 | 36 | 181 | 2 | 0,0002398 | 0,1121 | | | | |
| <i>M. brandi</i> | 1 | 4 | 5 | 164 | 3 | 167 | 0 | 1,0002041 | 0,1056 | | | | |
| <i>M. valet.</i> | 17 | 33 | 50 | 261 | 59 | 320 | 14 | 0,0007497 | 0,1711 | | | | |
| <i>M. bechst.</i> | 1 | 4 | 5 | 10 | 7 | 17 | 1 | 0,0000021 | 0,0165 | | | | |
| <i>M. myotis</i> | 66 | 53 | 119 | 3 185 | 537 | 3 722 | 26 | 0,1014253 | 0,6330 | | | | |
| <i>M. daubeni.</i> | 13 | 29 | 42 | 301 | 139 | 431 | 6 | 0,00136 | 0,2114 | | | | |
| <i>V. murinus</i> | 6 | 2 | 8 | 10 | 2 | 12 | 4 | 0,0000001 | 0,0012 | | | | |
| <i>E. nilssonii</i> | 10 | 16 | 26 | 316 | 08 | 384 | 4 | 0,0010795 | 0,1949 | | | | |
| <i>E. serot.</i> | 20 | 7 | 27 | 219 | 8 | 227 | 8 | 0,0003772 | 0,1329 | | | | |
| <i>N. leisleri</i> | 1 | 1 | 2 | 11 | 1 | 12 | 1 | 0,0000001 | 0,0012 | | | | |
| <i>N. noctula</i> | 21 | 7 | 28 | 302 | 65 | 367 | 12 | 0,0009861 | 0,1888 | | | | |
| <i>P. pipistr.</i> | 9 | 6 | 35 | 97 | 1 378 | 3 411 | 2 | 0,0831838 | 0,6243 | | | | |
| <i>B. barbast.</i> | 5 | 59 | 64 | 27 | 477 | 504 | 2 | 0,0018597 | 0,2355 | | | | |
| <i>Pl. aurif.</i> | 27 | 84 | 111 | 200 | 493 | 693 | 9 | 0,003516 | 0,2911 | | | | |
| <i>Pl. anstr.</i> | 49 | 92 | 141 | 298 | 780 | 1 078 | 18 | 0,008508 | 0,3619 | | | | |
| insgesamt | 273 | 21 | 425 | 5 668 | 1 937 | 11 687 | 120 | 8 | 0,205683 | | | | |

Plecotus auritus

Eine Art mit breiter hypsometrischen Frequenz, in der Sommerperiode wurde sie an 27 Lokalitäten in Zonen von 300—799 m ü. M., im Winter an 84 Stellen 300—1099 m angetroffen. 9 Wochenstuben (5—20 Ex.) befanden sich in Lagen bis zu 799 m. Die Ergebnisse der ökologischen Beobachtungen an Lokalitäten dieser und nächstfolgender Art *Plecotus austriacus* sind in der Arbeit von H ú r k a 1971 enthalten.

Insgesamt wurden 693 Exemplare an 111 Fundplätzen gefunden, IRH = 4,49, was das Langohr an 3. Stelle der Artenhäufigkeitsliste stellt. Grobe Populationsdichte beträgt 1 Stück auf 15,6 km² und mit Rücksicht auf diese Zahlen wird *Pl. auritus* als sehr häufige Art bezeichnet, die im ganzen verfolgten Gebiet verbreitet ist.

Plecotus austriacus

Von allen bisher in Westböhmen festgestellten Fledermausfundplätzen entfallen auf diese Art 19,6%. Es sind 49 Orte des Sommervorkommens und 92 Lokalitäten des Winteraufenthalts. An 18 Orten wurden Wochenstuben mit 3 bis 25 Stück gefunden. Ähnlich wie die vorhergenannte Art ist auch diese in verschiedenen Höhenlagen angetroffen und zwar im Sommer von 300 bis 899 m und im Winter von 300—1099 m ü. M. Die meisten Wochenstuben befanden sich aber in Lagen bis zu 499 m (38,9%), in höheren Lagen sinkt die Zahl deutlich — bis 599 m 33%, bis 699 m 22% usw.

Nach dem IRH = 7,49 nimmt *Pl. austriacus* die zweite Stelle in der Artenhäufigkeitsliste ein. Grobe Populationsdichte ist 1 Stück auf 10 km². Alle diese Daten zeugen davon, dass es sich um sehr häufige Art handelt, die im ganzen Gebiet Westböhmens verbreitet ist.

AUSWERTUNG

Ich habe mich bemüht konkrete Angaben über die Verbreitung der Fledermäuse in Westböhmen, die mit Hilfe einer ganzen Reihe der Mitarbeiter gesammelt wurden, mit statistisch ökologischen Methoden auszuwerten (siehe Absatz Material und Methodik). Ziel dieser Bewertung war eine wenigstens annähernde Übersicht über qualitatives sowie quantitatives Vorkommen der Fledermäuse in Westböhmen zu gewinnen.

In mehreren Nachbarstaaten werden Fledermäuse an der „Roten Liste“ der bedrohten oder sogar aussterbenden Tiere angeführt. In der Zeit der fortschreitenden Intensivierung der landwirtschaftlichen Produktion und Industrialisierung erscheint die Festsetzung eines bestimmten Wertes als notwendig, der als Ausgangspunkt für weitere Beobachtungen der Faunenentwicklung dienen könnte, besonders der Arten, welche als Bioindikatoren verwendet werden können. Und das sind die Fledermäuse ohne Zweifel.

Die Fledermausgemeinschaft Westböhmens besteht aus 16 Arten. Diese Zahl ist, mit Rücksicht auf Verbreitungsareale dieser Tiere, ökologische Bedingungen die durch Lage, Seehöhe und Klima gegeben sind und bei dem Studium ihrer Lebensweise gesammelt wurden, angemessen.

Nach dem Index der ökologischen Dominanz 0,20 ist es eine Biozönose mit mehreren dominanten Arten, d. h. eine Gemeinschaft, die in nicht allzusehr veränderten Naturbedingungen lebt. Davon zeugt auch die verhältnismässige Aufteilung von 11 687 Individuen auf 16 Arten (Äquitabilität):

| sehr häufig | | häufig | | weniger häufig | | selten | |
|--------------------|------|-----------------|------|------------------|------|-----------------|-------|
| <i>M. myotis</i> | 0,63 | <i>B. barb.</i> | 0,23 | <i>E. serot.</i> | 0,13 | <i>M. bech.</i> | 0,01 |
| <i>P. pipistr.</i> | 0,62 | <i>M. daub.</i> | 0,21 | <i>M. myst.</i> | 0,11 | <i>V. mur.</i> | 0,001 |
| <i>Pl. austr.</i> | 0,38 | <i>E. nils.</i> | 0,19 | <i>M. bran.</i> | 0,10 | <i>N. leis.</i> | 0,001 |
| <i>Pl. aurit.</i> | 0,29 | <i>N. noct.</i> | 0,18 | <i>Rh. hip.</i> | 0,10 | | |
| | | <i>M. natt.</i> | 0,17 | | | | |

Die Werte des Indexes der relativen Häufigkeit (siehe Absatz Methodik), die graphisch dargestellt sind (Grafik 2), bestätigen durch den Verlauf der Kurve den allgemein gültigen Grundsatz für eine natürliche Zonose (O d u m 1977). Nach der relativen Häufigkeit zusammengesetzte Rangliste zeigt den ökologischen Wert jeder von 16 Arten:

| | | | |
|---------------------------|-------|-----------------------------|--------|
| 1. <i>M. myotis</i> | 10,47 | 9. <i>E. nilssoni</i> | 0,70 |
| 2. <i>Pl. austriacus</i> | 7,49 | 10. <i>M. mystacinus</i> | 0,60 |
| 3. <i>Pl. auritus</i> | 4,49 | 11. <i>E. serotinus</i> | 0,50 |
| 4. <i>P. pipistrellus</i> | 3,03 | 12. <i>Rh. hipposideros</i> | 0,24 |
| 5. <i>B. barbastellus</i> | 2,10 | 13. <i>M. brandti</i> | 0,07 |
| 6. <i>M. daubentoni</i> | 1,23 | 14. <i>M. bechsteini</i> | 0,01 |
| 7. <i>M. nattereri</i> | 1,19 | 15. <i>V. murinus</i> | 0,001 |
| 8. <i>N. noctula</i> | 0,73 | 16. <i>N. leisleri</i> | 0,0003 |

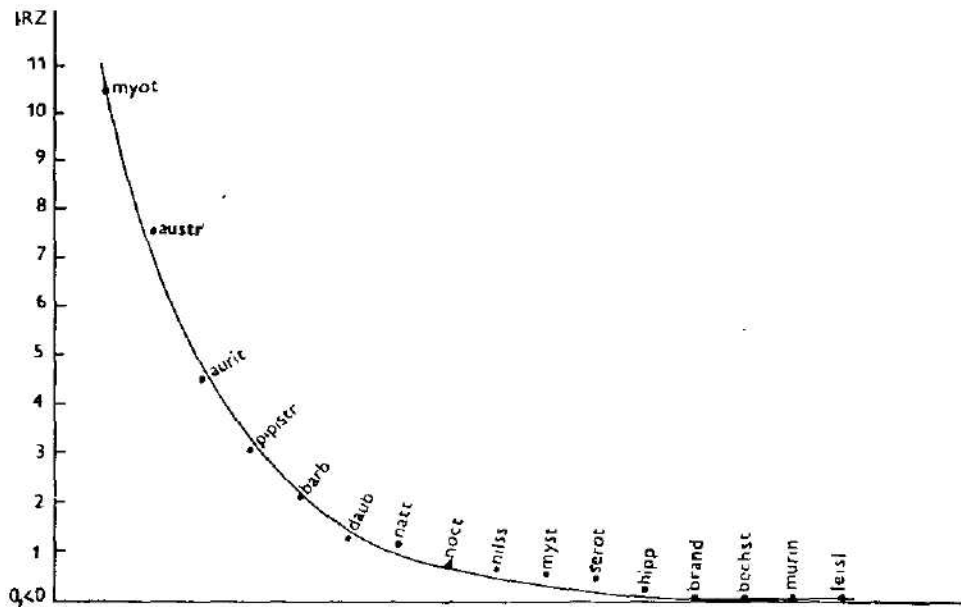
Auch die Werte der groben Populationsdichte berechtigen die Einreihung der Arten an bestimmte Stelle der Häufigkeitsliste und Aufteilung auf sehr häufige, häufige, weniger häufige und seltene Arten:

| | | |
|-------------------------------------|---------------------|---------------------------------------------|
| <i>M. myotis</i> — 1 Individuum auf | 2,9 km ² | durchschnittlich bei sehr häufigen Arten |
| <i>P. pipistrellus</i> | 3,2 | 1 Individuum auf 1,2 km ² |
| <i>Pl. austriacus</i> | 10,0 | |
| <i>Pl. auritus</i> | 15,6 | |
| <i>B. barbastellus</i> | 21,5 | |
| <i>M. daubentoni</i> | 25,0 | durchschnittlich bei häufigen Arten |
| <i>E. nilssoni</i> | 28,0 | 1 Individuum auf 5,4 km ² |
| <i>N. noctula</i> | 29,0 | |
| <i>M. nattereri</i> | 34,0 | |
| <i>E. serotinus</i> | 48,0 | |
| <i>M. mystacinus</i> | 60,0 | durchschnittlich bei weniger häufigen Arten |
| <i>M. brandti</i> | 65,0 | 1 Individuum auf 14,7 km ² |
| <i>Rh. hipposideros</i> | 67,6 | |
| <i>M. bechsteini</i> | 639,0 | durchschnittlich bei seltenen Arten |
| <i>V. murinus</i> | 639,0 | 1 Individuum auf 265 km ² |

Grobe Populationsdichte der Fledermauszönose Westböhmens beträgt mit Rücksicht auf die Fläche von 1 087 100 ha und 11 687 festgestellte Fledermausindividuen 0,01 Exemplare auf 1 ha.

ZUSAMMENFASSUNG

Die Fledermausgemeinschaft in Westböhmen, die in den Jahren 1959–1980 verfolgt und nach Feststellung von 719 Fundplätzen und zu 16 Arten gehörenden 11 687 Individuen bewertet wurde (*R. hipposideros*, *M. mystacinus*, *M. brandti*, *M. nattereri*, *M. bechsteini*, *M. myotis*, *M. daubentoni*, *V. murinus*, *E. nilssoni*, *E. serotinus*, *N. leisleri*, *N. noctula*, *P. pipistrellus*, *B. barbastellus*, *P. auritus* und *P. austriacus*) ist eine natürliche Zönose. Die hier angetroffenen Arten wurden nach ihrer Häufigkeit und Verbreitung auf sehr häufige (*M. myotis*, *P. pipistrellus*, *P. austriacus*, *P. auritus*), häufige (*B. barbastellus*, *M. daubentoni*, *E. nilssoni*, *N. noctula*, *M. nattereri*), weniger häufige (*E. serotinus*, *M. mystacinus*, *M. brandti*, *Rh. hipposideros*) und seltene Arten (*M. bechsteini*, *V. murinus*, *N. leisleri*) aufgeteilt.



Graph 2. Die Chiropterozönose Westböhmens (1959–1980) nach IRZ.

Die Fledermäuse werden auf dem ganzen Gebiet Westböhmens angetroffen.

Hypsometrische Frequenz ihres Vorkommens (Graph 1) bewegt sich von 300–1199 m ü. M. Häufigstes Vorkommen ihrer Wochenstuben wurde in der Zone 300 bis 599 m ü. M. festgestellt (75%), des ganzen Sommervorkommens in Lagen von 300–699 m ü. M. (84%) und der Überwinterung in niederen und mittleren Lagen von 300–799 m ü. M. (93%).

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ACERENTULUS CONDEI SP. N. A NEW PROTURAN SPECIES OF "CONFINIS" GROUP

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Abstract: The new species *Acerentulus condei* sp. n. is characterized with presence of p_1' and missing of p_1' , a_1 and a_2 on terg. VII, as well as by a' reaching to b' , and by relatively short foretarsus (TR = 3.4, BS = 0.3) and stern. XI with 4 setae.

Acerentulus condei sp. n.

Figs A – E

Holotype ♀ and allotype ♂, from Sardinia, Strada Orientale Sarda km 158, dry walnut-tree, moss, April 5, 1978 Dr. R. Dallai leg. Holotype and allotype mounted in Swan's medium kept in Muséum d'Histoire naturelle de Genève. One paratype kept in Istituto di Zoologia Università di Siena, and some paratypes kept in author's collection.

Description. Length of body 100 μm , foretarsus without claw 84 μm .

Head. Sensillae of maxillary palpi seta-like, sensilla of labial palpi sausage-like. Preudoculus broader than long. Canal of maxillary gland with long proximal part, proximally tripartite (Fig. A).

Foretarsus (Figs B, C) with extremely long, in the first third broadened sensilla a overreaching γ_3 . Sensilla b is shorter than c . a' reaching to the base of b' . The ratio of sensillae on exterior side of foretarsus $a : b : c : d : e : f : g$ as 48 : 41 : 43 : 40 : 45 : 44 : 40, on interior side $a' : b' : c'$ as 32 : 41 : 39. Sensilla t_1 is claviform placed below a' , t_2 setiform and t_3 shaped like a willow leaf. TR = 3.4, BS = 0.3. EU = 0.18.

Abdomen. Comb VIII with 10 teeth. Setae a_1 and p_1' missing on terg. VII as in *Acerentulus gisini* Condé, 1952 (Fig. D).

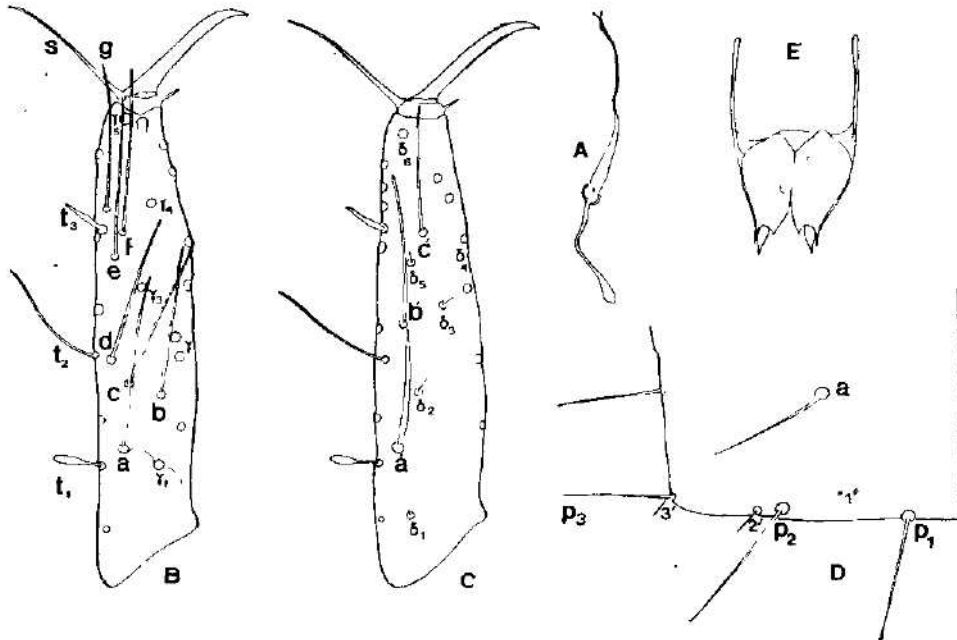
The outer genitalia. Female squama genitalis with strong, pointed acrostyli (Fig. E).

Survey of chaetotaxy in Tuxen's system:

| | I | II–III | IV–V | VI | VII | VIII | IX–X | XI | XII |
|--------|----|--------|------|----|-----|------|------|----|-----|
| terg. | 6 | 8 | 8 | 8 | 6* | 6 | 12 | 6 | 9 |
| | 10 | 12 | 12 | 14 | 16* | 16 | | | |
| | 3 | 3 | 3 | 3 | 3 | 4 | | | |
| stern. | | | | | | | 4 | 4 | 6 |
| | 4 | 5 | 8 | 8 | 8 | 2 | | | |

x a_1 , a_3 and p_1' missing.

Distribution and ecology. Sardinia and Corsica, Sardinia: Strada Orientale Sarda km 158, dry walnut-tree, mos, April 5, 1978 m ♂, 4 ♀, 1 praemago ♂ Dr. R. Dallai leg. Corsica: The species mentioned from Corsica belongs probably to this taxon, foretarsus of Corsican specimens: 80–93 μm sternite XI also with four setae (Condé, 1980).



Figs. A—E. *Acerentulus condei* sp. n.: A. Canal of maxillary gland. — B. Foretarsus in exterior view. — C. Foretarsus in interior view. — D. Chaetotaxy of the left half of terg. VII. — E. Female squama genitalis.

Differential diagnosis. The new species *Acerentulus condei* sp. n. is related to *Acerentulus confinis* var. *exiguus* Condé, 1944, *Acerentulus gisini* Condé, 1952 or *Acerentulus alpinus* Gisin, 1945 respectively. It differs from *A. confinis* var. *exiguus* Cdé in shorter foretarsus, BS, longer a' , in presence of p_3' and missing of p_1' on terg. VII. a_1 and p_1' are missing on terg. VII also in *A. gisini* Cdé and *A. alpinus* Gis. (*A. gisini* Cdé: TR = 4.1 — 4.3, BS = 0.35, EU = 0.14, sensilla a' do not reaching the sensilla b' . *A. alpinus* Gis.: TR = 3.6, BS = 0.37, acrostyli of female squama genitalis are long pointed).

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ON ALBINOTIC CLARIAS BATRACHUS (PISCES, CLARIIDAE)

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Received April 27, 1981

Abstract. Five specimens of the albinotic form of the catfish of the genus *Clarias* were examined with regard to their correct species determination. These specimens were found belong to *Clarias batrachus* (Linnaeus, 1758).

MATERIAL AND METHODS

Five specimens of catfish were kept in the aquaria of the Dept. Syst. Zool., Charles University and the Aquarium Exhibition "Tatra" in Prague. After perishing they were conserved in 4% formalin, later they were transferred into spirit. Body proportions were measured by means of dividers with the accuracy ± 0.5 mm. Counting of meristic characters was made using the binocular microscope.

RESULTS AND DISCUSSION

Description of albinotic specimens: Specimens of 153.0, 197.0, 300.0, 300.5 and 495.0 mm of the total length conserved in formalin and later in spirit have a whitish to pinkish body colour. Translucent bones on the head are yellowish, eye is reddish. Living specimens kept in aquaria were whitish to pink with typical red eyes. Pectoral fins extend nearly to the vertical from the base of the dorsal fin origin. The ventral fin extends a little beyond the origin of the anal one. Nasal barbels reach nearly to the gill opening, their length being 100 (88—115) % of the length of mental barbels. Those on the maxillary reach nearly to the centre of the pectoral fin; their length is 118 (109—134) % of the length of mandibular barbels. The occipital process is more rounded in bigger specimens (Figs. 1—5). Intermaxillary teeth form the band which is as broad in the centre as the vomerine band (Fig. 6). The body depth 13 (11—15) % of the total length, the head length 16 (15—17) % of the total length, the head length up to the end of the occipital process 22 (20—23) % of the total length, maximum head width 96 (91—99) % of the head length measured to the gill opening and 70 (66—75) % of the head length measured to the end of the occipital process, the length of the occipital fontanel 38 (35—46) % of the length of the frontal one, the eye diameter 9 (8—12) % of the head length measured to the gill opening, the interorbital width 108 (100—116) % of the mouth opening width, 56 (54—58) % of the head length to the gill opening and 41 (40—44) % of the head length to the end of the occipital process; the length of the ventral fin 69 (60—74) % of the length of the pectoral fin, the length of the pectoral fin 105 (98—118) % of the head length to the gill opening (without snout), the length of the pectoral spine 106 (85—130) % of the length of the postorbital part of the head measured to the gill opening.

Albinotic Clariids were imported into Europe from Thailand (Siam) by

Table 1. Selected meristic characters and body proportions of albinotic *Clariids* compared with literary data of *Clarias batrachus* and *Clarias macrocephalus*

| | <i>Clarias batrachus</i> | | | | <i>Clarias macrocephalus</i> | | | |
|------------------------------------------------------------------------------|--------------------------|------------------------------|----------------|--------------|------------------------------|----------------|--------------|--------------|
| | own data | Weber and De Beaufort (1913) | Günther (1864) | Smith (1945) | Day (1958) | Günther (1864) | Smith (1945) | Smith (1945) |
| Rays in dorsal fin | 66 (61-72) | 60-76 | 64-70 | 60-76 | 62-76 | 70 | 70 | 70 |
| Rays in anal fin | 49 (40-51) | 47-58 | 50-53 | 47-58 | 45-58 | 50 | 50 | 50 |
| Rays in pectoral fin | I/10 6 | I/8-11 6 | I/8 | — | I/8-11 6 | I/8 | — | — |
| Rays in ventral fin | 19* | 16-19 | — | — | — | — | — | more than 20 |
| Height of occipital process as % of its base | 66 (44-86) | about 50 | — | about 50 | rather less than 50 | — | — | 20-33 |
| Distance between dorsal fin origin and occipital process as % of head length | 26 (23-31) | 18-22 | — | 18-25 | — | — | — | 14-20 |
| Length of pectoral spine as % of length of pectoral fin | 85 (74-94) | 100 and more | 75 | — | — | — | — | 75 |

*) only one specimen

Andreas Werner (Meinken, 1961). Meinken (l. c.) supposed that this albinotic catfish belong to *Clarias macrocephalus* or *Clarias batrachus*. Following Weber and De Beaufort (1913) *Clarias batrachus* have "sometimes transverse rows of light spots along the sides of body and tail". "Albinism is fairly common in this species" (Smith, 1945). Smith (l. c.) reports three albinotic specimens of *Clarias batrachus* from the Meping near Chiangmai (Thailand). Weber and De Beaufort (1913) reported a milky white specimens with a little reddish coloration (probably the albinotic form) from Pajakomboh, Sumatra determined as *Clarias macrocephalus* Günther, 1848, which according to them, is however rather a doubtful species. These specimens are distinct from *Clarias batrachus* according to mentioned authors "by their long and strong pectoral spine which is of pectorals or farther" — compare Table 1. According to Smith (1945) *Clarias macrocephalus* Günther, 1848 is a good species, but specimens in their picture have longer barbels than those shown in the Günther's description (1864) of *Clarias macrocephalus*. Weber's specimens of *Clarias macrocephalus* (see Weber and De Beaufort, 1913) "were subsequently adjudged to represent *Clarias batrachus*" (according to Smith, 1945).

Our specimens have short barbels (see above), similarly as *Clarias macrocephalus*. According to Günther (1864), *Clarias batrachus* (here = *Clarias magur*) has longer barbels. The nasal ones extend to or nearly to the extremity of the pectoral fin. Our specimens agree rather with Smith's (1945) description of *Clarias batrachus* in Weber and De Beaufort (1913) in the between the base of the dorsal fin and the occipital process and due to the shape of the occipital process (Table 1). Our specimens agree with the description of *Clarias batrachus* in Weber and De Beaufort (1913) in the arrangement of the intermaxillary and vomerine teeth. In *Clarias batrachus* the vomerine band of teeth is as broad in the centre, or narrower than the supermaxillary band. Our albinotic catfish must be also classified as *Clarias batrachus* (Linnaeus, 1758). The uncertain determination of Meinken (1961) was therefore solved.

Acknowledgments

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

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**CHANGES IN BODY MEASURES DURING THE GROWTH OF THE NEWTS
TRITURUS VULGARIS, T. ALPESTRIS AND T. CRISTATUS
(AMPHIBIA: URODELA)**

Ivan REHÁK

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Abstract: An analysis was made of 588 specimens of the Smooth newt, *Triturus vulgaris* (L., 1758), 336 specimens of the Alpine newt, *Triturus alpestris* (Laur., 1768) and 84 specimens of the Warty newt, *Triturus cristatus* (Laur., 1768), in order to disclose relative changes during growth in tail length, width and length of the head, distance between anterior and posterior extremity with respect to body length and relative growth in head length with respect to its width. In total, growth in species investigated is allometric. The suitability of individual biometrical indexes for taxonomy is discussed.

INTRODUCTION

In the studies on the taxonomy of the newts, bodily measures are among the criteria frequently used in the comparison of population samples of unequal size frequency and age spectrum. In these cases, the suitability of the individual bodily measures which undergo changes during the growth of the animal has to be tested. There is little information on these changes available in the pertinent literature. In the Smooth newt, the problem has been treated by Lá c (1963) and K e l a r o v á (1977), who both evaluated collectively material composed of several population samples and therefore, their results might have been distorted by the interpopulation variability of body measures. E r n s t (1952) and R o č e k (1974) assessed relative growth of individual body dimensions for the Alpine newt. The former author evaluated growth changes collectively for several population samples. The latter author evaluated these changes separately for the individual population samples, but pointed out himself that his results might have been disfigured by a small number of animals in his population samples. Relative changes in body measures during growth of the Warty newt have been studied by Lá c (1957) on 242 specimens of *T. cristatus dobrogicus* from Slovakia. I have analyzed separately each population sample in order to avoid any confusion possibly brought about by interpopulation variability.

MATERIALS AND METHODS

Specimens of the newts examined in this study were collected from Bohemian localities. *T. vulgaris*: Praha – Libeň (121♂♂, 63♀♀), Karlštejn – district Beroun (46♂♂, 49♀♀), Bahna – district Rokycany (48♂♂, 37♀♀), Smečno – district Kladno (51♂♂), Polom – district Chrudim (38♀♀). *T. alpestris*: Křivoklát – district Rakovník (51♂♂, 94♀♀), Česká Třebová – district Ústí nad Orlicí (45♂♂, 60♀♀), Soumarský most – district Prachatice (50♂♂, 36♀♀). *T. cristatus*: Božec – district Kolín (18♂♂,

19 ♀♀, 16 juv.), Křivoklát — district Rakovník (12 ♂♂, 16 ♀♀, 3 juv.). In addition, I determined relationships of head length/width in Smooth newt for a population sample from the Bulgarian locality Momchilgrad (17 ♂♂, 24 ♀♀). My graduation thesis contains detailed descriptions of these localities (Rehák 1979). All specimens were collected from water and preserved uniformly in 4% formalin. Each population sample (males and females apart) were divided in size classes at an interval of 3 mm in the Smooth and Alpine newt, respectively 5 mm in the Warty newt. The comparison of the individual size classes provided evidence for a relative growth with regard to body length (L) in these dimensions: length of the tail (Lcd), width of the head (Ltc), distance between extremities (LiE), length of anterior extremity (Pa), length of posterior extremity (Pp) and length of head (Lc). In addition, I examined relationships of Ltc and Lc during growth. In the Smooth newt and Warty newt I used a standard measuring method employed by a number of authors (Terentyev and Chernov 1949, Fuhn 1960, Lác 1968, Opatrný 1973, Bannikov et al. 1977). In the Alpine newt most measurements were made with a method employed by Ernst (1952) and Roček (1974) except the length of the anterior and posterior extremity which I measured with a method used in the Smooth and Warty newt.

Explanation of figures

Notes: Graphs in the study are for selected population samples, those for all population samples and all relationships investigated are available in Rehák (1979). Vertical line — variation amplitude of the given index in the pertinent size class
Horizontal line — sample mean
Rectangular frame on vertical line — 95% confidence interval for the mean
Straight line — the equations of straight lines have been calculated separately for each population sample to facilitate the reading of the graph
Numerals on vertical lines — number of specimens in pertinent size classes.

Acknowledgement

My sincere thanks are due to Associate Professor Dr. Ota Oliva, CSc. for a careful reading of my manuscript.

RESULTS

a) Relative Growth of the Tail Length (Lcd)

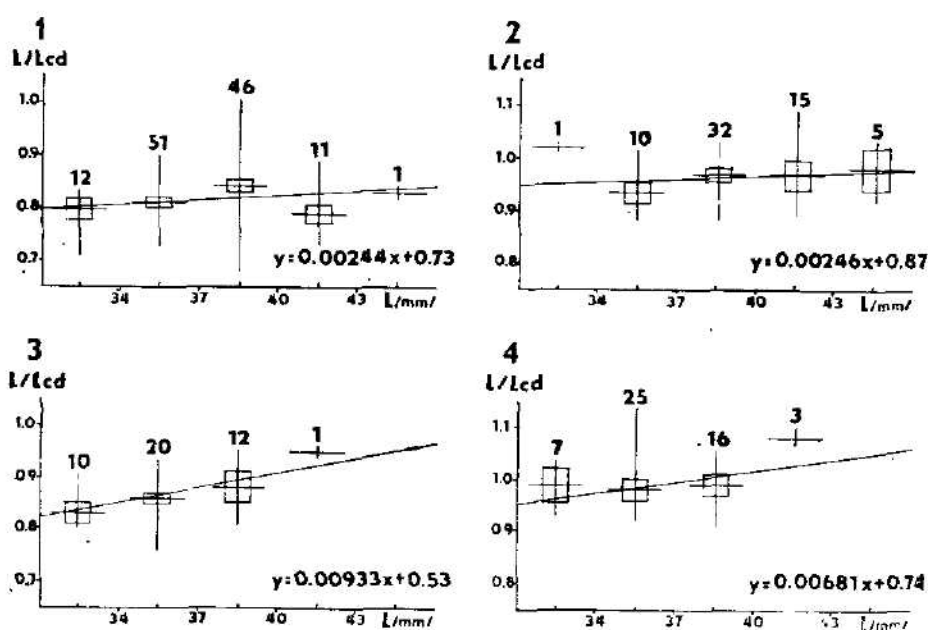
Triturus vulgaris

Males: In males from the locality Karlštejn, the growth of the tail was generally isometric. Although a moderately positive allometric growth of the tail was indicated by a comparison between the first and the last size class, the number of animals in the two marginal classes was too limited to enable an assessment of a statistical significance of the difference. Evidence of a clearly negative allometric growth of the tail was obtained for males from the localities Bahna and mainly Hředle (Fig. 3). Considerable differences were found among the individual size classes of males in population samples from Libeň (Fig. 1) and Smečno. In the former, the differences were highly significant and outside the scope of a simple linear relation. In males from Libeň, the growth of the tail was at first negative allometric, later positive allometric, in males from Smečno, there was first a positive allometric growth, which changed to a negative allometry.

Females: The growth of the tail of females from all samples displayed a moderately negative allometric growth. This tendency was the least marked in the sample from Libeň (Fig. 2), more distinct in samples from Karlštejn and Polom, the most distinct in the sample from Hředle (Fig. 4). In the last two samples, the more marked tendency towards this growth was influenced primarily by a relatively much shorter tail of the largest females. It was difficult

to interpret the growth of the tail of females from the locality Bahna, because the general tendency was influenced by the small number of animals in the marginal groups, where the general picture was affected most significantly by each animal. However, a comparison of the three size classes between the two marginal classes suggested a positive allometric growth of the tail.

A major deterrent to an understanding of the longitudinal growth of the tail are mainly seasonal changes in its length. Particularly in the male, the crest developing on the tail during the aquatic life increases considerably the length of the tail, not to mention the thread-like filament developing on the tail of a certain number of males from several populations. In my opinion the degree to which these changes develop in the male appears to be proportionate to the degree of sexual maturity of the individual. This view is supported by a relatively long tail in males of the last but one size class of the Libeň sample (Fig. 10). In males of the population sample from Křivoklát, a relative increase in tail length has shown to be positive allometric, but it should be remembered that these samples were collected at a time when all these characters were fully developed. Therefore, the presence of a larger number of males in the samples might explain the slightly positive allometry observed in the



Figs. 1-4. *T. vulgaris*. Changes in L/Lcd during growth. 1 = Libeň - males; 2 = Libeň - females; 3 = Hředle - males; 4 = Hředle - females.

growth of the tail which however, might be illusory. In support of this concept is the situation observed in a population sample from the locality Bahna collected at the close of the reproduction period at which there is evidence already of a negative allometric growth of the tail. On the other hand, this hypothesis does not hold for the population sample from Hředle (Fig. 3) where males were still in their full display outfit, and where there was already an

obvious tendency toward a distinct decrease in relative tail length at a simultaneous increase in body length. In the male, the degree of development of the tail crest might greatly complicate the interpretation of the actual growth of the tail. For the female, we have reliable evidence of a negative allometric growth of the tail which increases minimally in length during the reproduction period. Among the individual populations, there are small differences in the rate of tail growth. In general, a decrease in relative tail length is small and, frequently, differences among neighbouring size classes are statistically insignificant. This applies mainly to the marginal size classes in which the number of animals is low. With regard to a considerable variability of this and all other characters under study, the small number of animals in marginal classes might greatly complicate the interpretation of the situation established. It is therefore difficult to decide whether deviation disclosed for females from the locality Bahna are or are not of importance.

Triturus alpestris

Males: In the population sample from the locality Česká Třebová, the relative growth in tail length was roughly identical in all size classes. By contrast, I disclosed considerable differences in relative tail length among the individual size classes from the localities Křivoklát and Soumarský most. In the population sample from Křivoklát, tail growth changed from a negative to a positive allometry, in males from Soumarský most, this trend was reversed. In total, the trend of tail growth in length was isometric in males from both populations.

Females: In the population sample from Soumarský most, growth of the female tail was negative allometric. In females of the population sample from the locality Česká Třebová, there was almost isometric growth in tail length. In females from the population sample Křivoklát, a relative decrease in tail length was recorded for the first three size classes; it increased in length in size class 4. The total trend indicated a faintly negative allometric growth.

Triturus cristatus

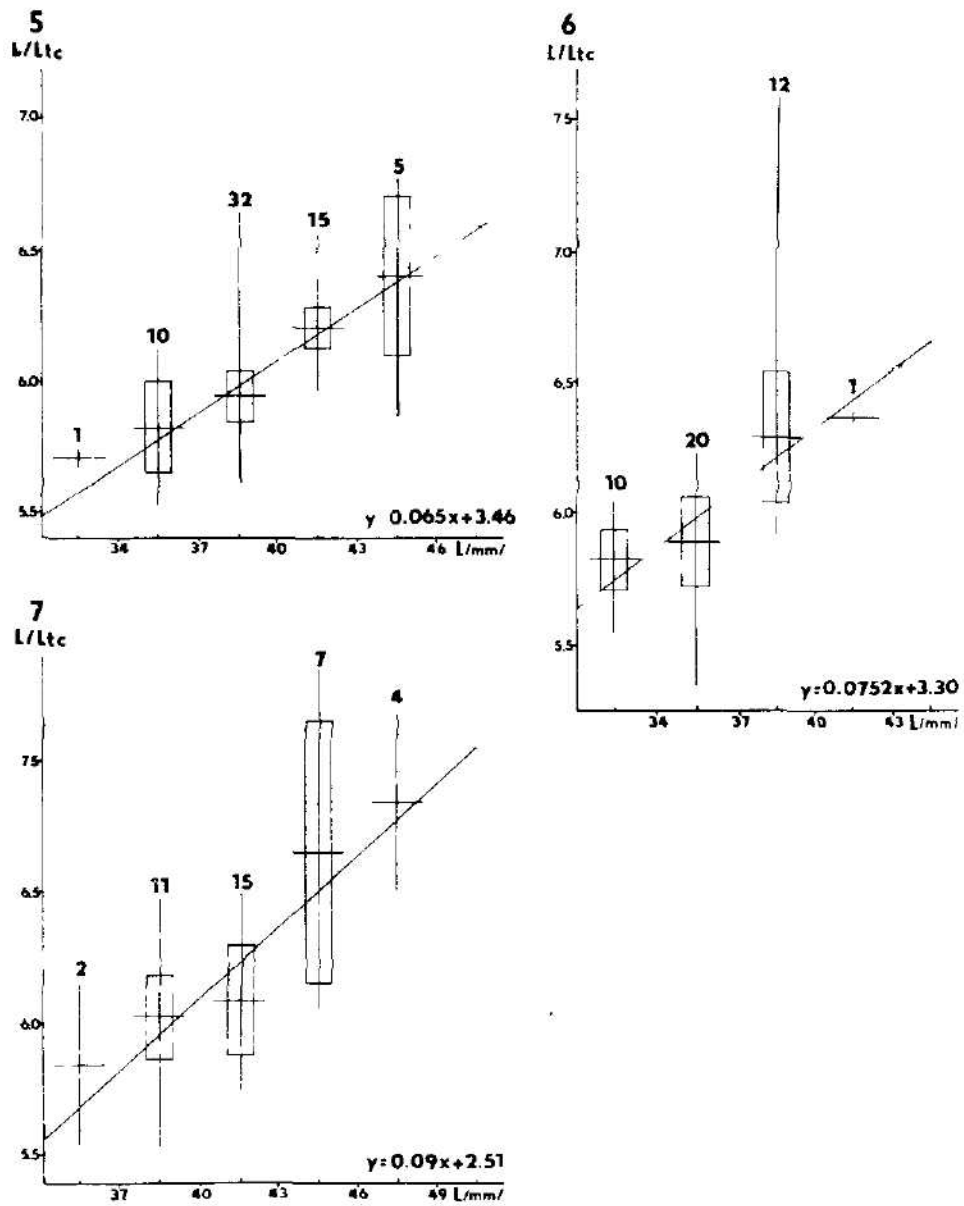
Growth in tail length appears to be weakly negative allometric in both sexes of the population sample from the locality Božec. Taking into account the small number of animals in the first two size classes of the population sample from the locality Křivoklát, I observed a negative allometric trend in the growth of the tail of the male, an isometric growth in the tail of the female. A high variability of L/Lcd values among the individual size classes impedes a more accurate interpretation.

b) Relative Growth in the Width of the Head (Ltc)

Triturus vulgaris

In all population samples examined, negative allometry is involved in growth of this dimension with respect to the body (Figs. 5–7). Thereby, considerable differences both among individual populations and the sexes were found in the degree of the relative reduction. In population samples from all localities, the relative reduction in the width of the head during the growth of the body was more marked in the female than in the male. An exception from this rule was the population sample from Hředle, where this situation was reversed,

i. e., the reduction in this dimension was more marked in the male than in the female.



Figs. 5--7. *T. vulgaris*. Changes in L/Ltc during growth. 5 = Libeň - females; 6 = Hředle - males; 7 = Bahna - females.

Triturus alpestris

In both sexes of all population samples examined, the relative growth of the head in relation to the body was found to be negative allometric. Numerous irregularities were observed among the individual size classes.

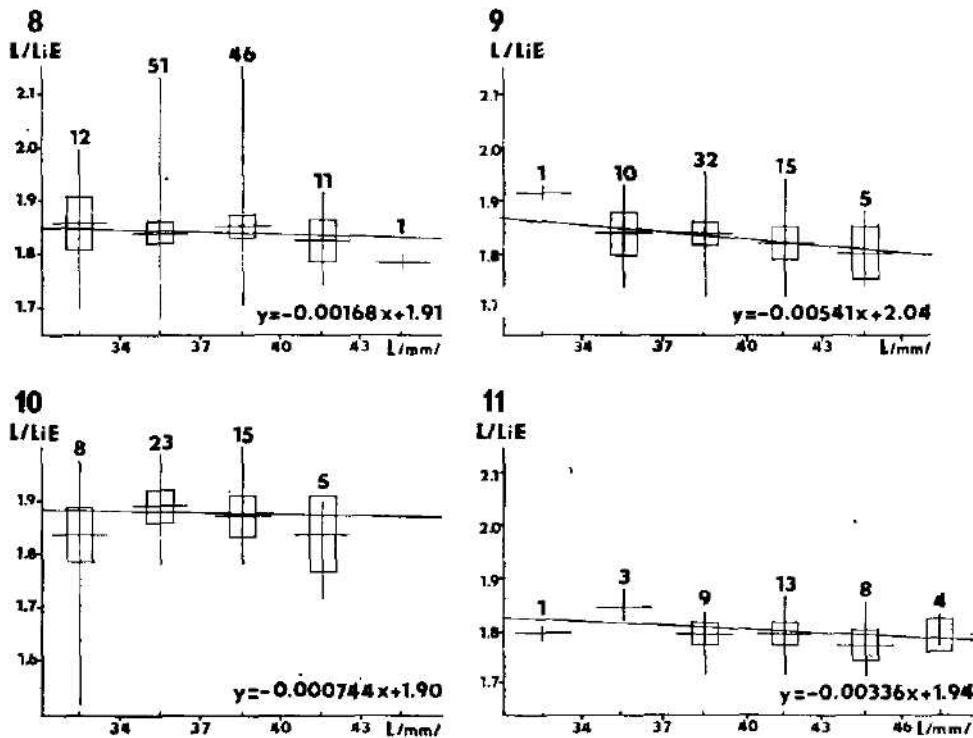
Triturus cristatus

I observed a marked, relative decrease of the head width with respect to the growing body in all cases examined.

c) Relative Growth in the Distance between the Anterior and the Posterior Extremity (LiE)

Triturus vulgaris

Males: In males from the localities Libeň (Fig. 8), Karlštejn and Smečno (Fig. 10), the growth in LiE was positive allometric. A positive allometric growth of LiE was indistinct in males from Libeň (Fig. 8), but generally more marked in males from Karlštejn. However, the more distinct allometric growth in the latter population sample should be ascribed to the small number of animals in marginal size classes distorting the general picture, and might, in fact, be less distinct. The relative growth of LiE in males from Smečno (Fig.



Figs. 8-11. *T. vulgaris*. Changes in L/LiE during growth. 8 = Libeň - males; 9 = Libeň - females; 10 = Smečno - males; 11 = Polom - females.

10) cannot be characterized as a distinct linear regression mainly for an abnormal variation amplitude in the first size class. Conclusive evidence for a positive allometric growth of LiE has been given by the remaining size classes. On the other hand, changes in LiE during the growth of males from the locality Bahna have been found to be irregular, with a tendency toward a moderately negative allometric growth. A completely irregular relative growth of LiE in males from the locality Hředle should be ascribed mainly to the conditions in the second size class.

Females: In spite of numerous irregularities among the individual size classes, a moderately positive allometric growth of LiE has been observed for females from the localities Libeň (Fig. 9) and Bahna. This was indistinct in females from the locality Polom (Fig. 11). On the other hand, LiE growth was isometric in females from the locality Karlštejn, negative allometric in females from the locality Hředle. In the latter case, the negative allometric growth should be ascribed mainly to the situation in the first size class.

Triturus alpestris

Growth of LiE displays trends towards a moderate positive allometry. An exception was the isometric to faintly negative allometric growth of LiE in females from the locality Soumarský most. Males of size class 3 (the most numerous size class) of the population sample from Křivoklát displayed a significant deviation from the generally positive allometric trend.

Triturus cristatus

The estimate of the significance of considerable differences in subsequent size classes was impeded by the small number of animals in the individual size classes. I observed an evidently positive allometric trend in LiE growth in both population samples and both sexes with a slightly more marked trend toward this type of growth in the female than in the male.

d) Relative Growth in Length of the Anterior Extremity (Pa)

Triturus vulgaris

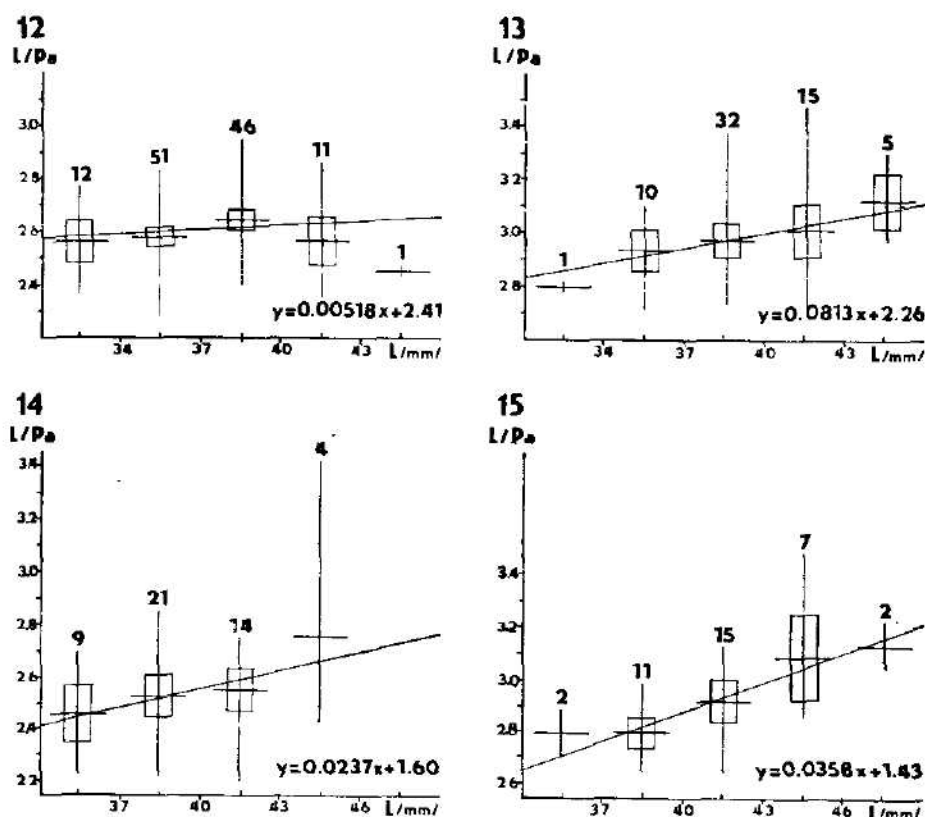
Males: There was a considerable irregularity in the growth of this dimension among males of the individual size classes from all localities except those from the population sample from Karlštejn where Pa growth was primarily isometric with an indistinct negative allometric tendency. In spite of the considerable irregularity in Pa growth, it can generally be regarded as either indistinctly, or slightly more negative allometric (the latter applies mainly to males from the locality Bahna – Fig. 14).

Females: In females from the localities Libeň (Fig. 13), Karlštejn and Bahna (Fig. 15), I observed a distinct relative decrease in the length of Pa as the body increased in length. By contrast, in females from Hředle, Pa displayed a positive allometric growth, and in females from the locality Polom, Pa growth was highly irregular, but generally negative allometric.

Triturus alpestris

Males: Growth of Pa was roughly isometric in males from the locality Soumarský most, moderately negative allometric in males from the locality Česká

Třebová. A remarkable relative decrease in Pa observed mainly in males from the locality Křivoklát might be ascribed to a relative shortness of the anterior legs of males belonging to the last size class.



Figs. 12-15. *T. vulgaris*. Changes in L/Pa during growth. 12 = Libeň - males; 13 = Libeň - females; 14 = Bahna - males; 15 = Bahna - females.

Females: A relative decrease in Pa with respect to body length has been found in females from Křivoklát. In the remaining localities, there is a reduction in the length of the anterior leg in size classes 2, 3, 4, but in both cases this trend is disturbed by the presence of small and relatively "short-legged" females in size class 1 so that growth of Pa appears to be isometric. In females from Soumarský most, a deviation from the general trend observed in size class 1 should evidently be ascribed to the presence of an abnormally short-legged female as clearly indicated by an abnormal variation amplitude.

Triturus cristatus

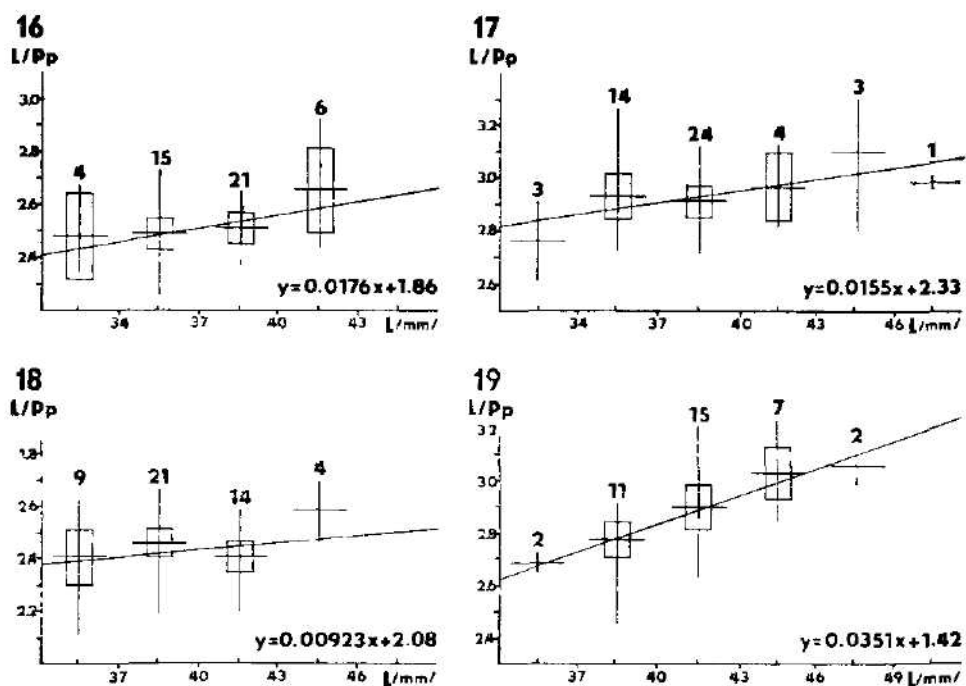
In the female, I observed a decrease in the anterior extremity during growth in population samples from both localities. The actual importance of relatively short-legged, large males in the population sample from the locality Bo-

žec was difficult to assess. Therefore, I can only suggest that the relative size of the anterior extremity did not change during growth. When considering adult males only (last four size classes) from the locality Křivoklát, growth of their anterior extremity showed trends toward a positive allometry, but the comparison with the three juvenile specimens in the sample indicated trends toward a generally negative allometric growth.

e) Relative Growth in Length of the Posterior Extremity (Pp)

Triturus vulgaris

The growth of Pp was negative allometric in both sexes. This negative allometry was more distinct in females from the locality Bahna (Fig. 19), indistinct in males from the locality Libeň. An exception were females from the locality Hředle with a slightly positive allometric growth of Pp, and males from the locality Smečno where Pp growth appeared to be slightly positive allometric in the first size classes.



Figs. 16-19. *T. vulgaris*. Changes in L/Pp during growth. 16 = Karlštejn - males; 17 = Karlštejn - females; 18 = Bahna - males; 19 = Bahna - females.

Triturus alpestris

In both sexes of population samples from the localities Křivoklát and Soumarský most, there is a negative allometric growth of Pp. In general, growth of Pp of both sexes of the population sample from the locality Česká Třebová

indicates that it is slightly positive allometric which should be ascribed mainly to an exceptional situation in size class 1.

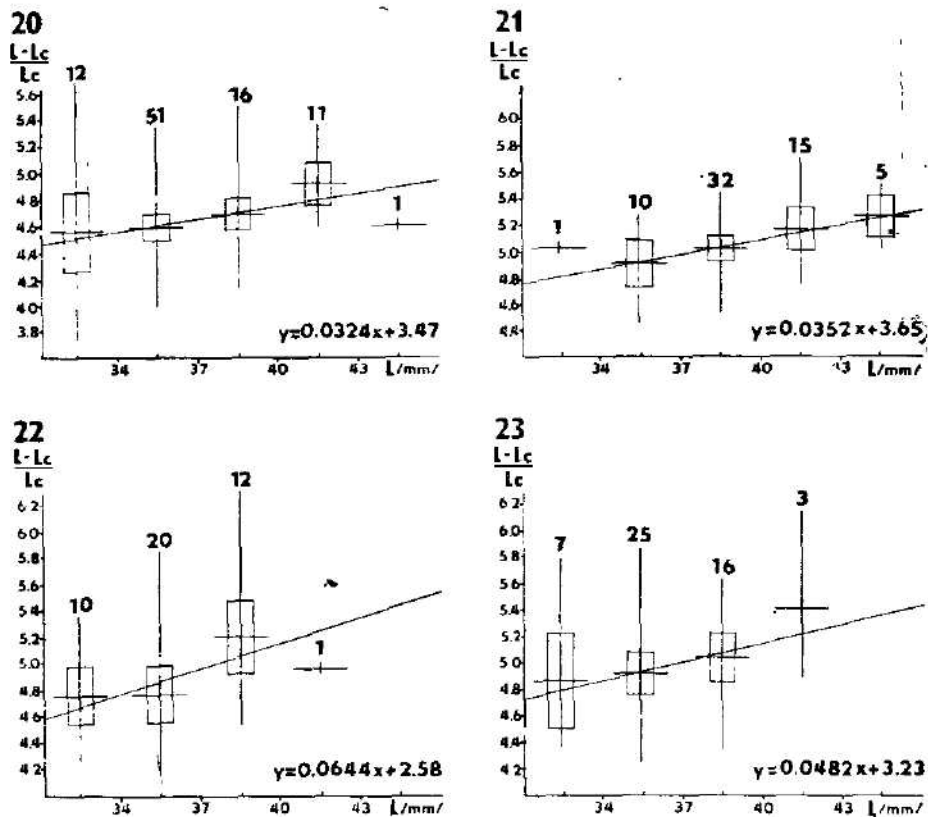
Triturus cristatus

The posterior extremity increased in males from both localities. By contrast growth of Pp in females from the two localities was negative allometric. A comparison of the pertinent size classes indicated that there was a considerable agreement between the anterior and posterior extremity during growth.

f) Relative Growth in Head Length (Lc)

Triturus vulgaris

Although the growth of head is negative allometric in length, the degree of this allometry and also its association with the sex vary among the individual populations. While in several population samples (e. g. Libeň), the degree of the allometry is roughly identical in both sexes (Figs. 20–21), a more marked allometric growth has been observed in females from a population sample from Karlštejn. On the other hand, in population samples from Hředle (Figs. 22–23) and Bahna, allometric growth was more marked in the male.



Figs. 20–23. *T. vulgaris*. Changes in $(L-L_c)/L_c$ during growth. 20 = Libeň - males; 21 = Libeň - females; 22 = Hředle - males; 23 = Hředle - females.

Triturus alpestris

Growth of L_c is negative allometric in all population samples and both sexes. There are small differences in the degree of this allometry among the individual population samples and among the two sexes. A slight deviation from this type of growth has been observed in females of size classes 2, 3 and 4 from the locality Soumarský most.

Triturus cristatus

With respect to the body, relative growth of the head in length is negative allometric.

Table 1. *T. vulgaris*. Equations of straight lines for individual relationships

| Relationship | Population sample | Males | | Females | |
|----------------------------|-------------------|-----------------|------------|-----------------|------------|
| $L/Lc_d = f(L)$ | Libeň | $y = 0.00244$ | $x + 0.73$ | $y = 0.00246$ | $x + 0.87$ |
| | Hředle | $y = 0.00933$ | $x + 0.53$ | $y = 0.00681$ | $x + 0.74$ |
| | Karlštejn | $y = -0.0016$ | $x + 0.91$ | $y = 0.0035$ | $x + 0.86$ |
| | Bahna | $y = 0.00623$ | $x + 0.66$ | $y = 0.00136$ | $x + 0.95$ |
| | Smečno | $y = 0.00173$ | $x + 0.96$ | — | — |
| | Polom | — | — | $y = 0.00402$ | $x + 0.81$ |
| $L/Ltc = f(L)$ | Libeň | $y = 0.0284$ | $x + 4.92$ | $y = 0.065$ | $x + 3.46$ |
| | Hředle | $y = 0.0752$ | $x + 3.30$ | $y = 0.0494$ | $x + 4.20$ |
| | Karlštejn | $y = 0.0348$ | $x + 4.74$ | $y = 0.0492$ | $x + 4.53$ |
| | Bahna | $y = 0.0469$ | $x + 4.14$ | $y = 0.09$ | $x + 2.51$ |
| | Smečno | $y = 0.0492$ | $x + 4.40$ | — | — |
| | Polom | — | — | $y = 0.0512$ | $x + 4.33$ |
| $L/LiE = f(L)$ | Libeň | $y = -0.00168$ | $x + 1.91$ | $y = -0.00541$ | $x + 2.04$ |
| | Hředle | $y = -0.00046$ | $x + 1.92$ | $y = 0.00296$ | $x + 1.73$ |
| | Karlštejn | $y = -0.00514$ | $x + 2.06$ | $y = -0.000381$ | $x + 1.81$ |
| | Bahna | $y = 0.00335$ | $x + 1.71$ | $y = -0.00946$ | $x + 2.22$ |
| | Smečno | $y = -0.000744$ | $x + 1.90$ | — | — |
| | Polom | — | — | $y = -0.00336$ | $x + 1.94$ |
| $L/Pa = f(L)$ | Libeň | $y = 0.00518$ | $x + 2.41$ | $y = 0.0813$ | $x + 2.26$ |
| | Hředle | $y = 0.0073$ | $x + 2.40$ | $y = -0.0164$ | $x + 3.62$ |
| | Karlštejn | $y = 0.00263$ | $x + 2.52$ | $y = 0.00911$ | $x + 2.60$ |
| | Bahna | $y = 0.0237$ | $x + 1.60$ | $y = 0.0358$ | $x + 1.43$ |
| | Smečno | $y = 0.00137$ | $x + 2.51$ | — | — |
| | Polom | — | — | $y = 0.0183$ | $x + 2.29$ |
| $L/Pp = f(L)$ | Libeň | $y = 0.00264$ | $x + 2.37$ | $y = 0.014$ | $x + 2.39$ |
| | Hředle | $y = 0.0116$ | $x + 2.14$ | $y = -0.00335$ | $x + 3.08$ |
| | Karlštejn | $y = 0.0176$ | $x + 1.86$ | $y = 0.0155$ | $x + 2.33$ |
| | Bahna | $y = 0.00923$ | $x + 2.08$ | $y = 0.0351$ | $x + 1.42$ |
| | Smečno | $y = -0.000714$ | $x + 2.49$ | — | — |
| | Polom | — | — | $y = 0.00582$ | $x + 2.73$ |
| $\frac{L - Lc}{Lc} = f(L)$ | Libeň | $y = 0.0324$ | $x + 3.47$ | $y = 0.0352$ | $x + 3.65$ |
| | Hředle | $y = 0.0644$ | $x + 2.58$ | $y = 0.0482$ | $x + 3.23$ |
| | Karlštejn | $y = 0.0141$ | $x + 4.14$ | $y = 0.057$ | $x + 2.94$ |
| | Bahna | $y = 0.0665$ | $x + 2.06$ | $y = 0.0227$ | $x + 4.08$ |
| | Smečno | $y = 0.0345$ | $x + 3.57$ | — | — |
| | Polom | — | — | $y = 0.0214$ | $x + 4.30$ |

Table 2. *T. alpestris*. Equations of straight lines for individual relationships

| Relationship | Population sample | Males | | Females | |
|----------------------------|-------------------|-----------------|------------|-----------------|------------|
| $L/Led = f(L)$ | Křivoklát | $y = 0.0000319$ | $x + 1.34$ | $y = 0.00303$ | $x + 1.16$ |
| | Česká Třebová | $y = 0.002$ | $x + 1.23$ | $y = -0.000976$ | $x + 1.29$ |
| | Soumarský most | $y = 0.000689$ | $x + 1.27$ | $y = 0.00756$ | $x + 0.85$ |
| $L/Ltc = f(L)$ | Křivoklát | $y = 0.035$ | $x + 4.08$ | $y = 0.0216$ | $x - 4.64$ |
| | Česká Třebová | $y = 0.0207$ | $x + 4.71$ | $y = 0.0169$ | $x + 5.05$ |
| | Soumarský most | $y = 0.0154$ | $x + 5.10$ | $y = 0.0289$ | $x - 4.59$ |
| $L/LtE = f(L)$ | Křivoklát | $y = -0.0024$ | $x + 2.19$ | $y = -0.00272$ | $x + 2.07$ |
| | Česká Třebová | $y = -0.00534$ | $x + 2.31$ | $y = -0.00801$ | $x + 2.27$ |
| | Soumarský most | $y = -0.00262$ | $x + 2.22$ | $y = 0.00263$ | $x + 1.83$ |
| $L/Pa = f(L)$ | Křivoklát | $y = 0.0181$ | $x + 2.08$ | $y = 0.0124$ | $x + 2.34$ |
| | Česká Třebová | $y = 0.0733$ | $x + 2.56$ | $y = 0.0178$ | $x + 3.01$ |
| | Soumarský most | $y = -0.00546$ | $x + 3.17$ | $y = 0.00345$ | $x + 2.88$ |
| $L/Pp = f(L)$ | Křivoklát | $y = 0.0189$ | $x + 2.00$ | $y = 0.0102$ | $x + 2.44$ |
| | Česká Třebová | $y = -0.00135$ | $x + 2.89$ | $y = -0.00383$ | $x + 3.25$ |
| | Soumarský most | $y = 0.00333$ | $x - 2.68$ | $y = 0.0062$ | $x + 2.69$ |
| $\frac{L - Lc}{Lc} = f(L)$ | Křivoklát | $y = 0.0222$ | $x + 2.40$ | $y = 0.0338$ | $x + 1.82$ |
| | Česká Třebová | $y = 0.016$ | $x + 2.57$ | $y = 0.0255$ | $x + 2.15$ |
| | Soumarský most | $y = 0.0268$ | $x + 2.12$ | $y = 0.0183$ | $x + 2.57$ |

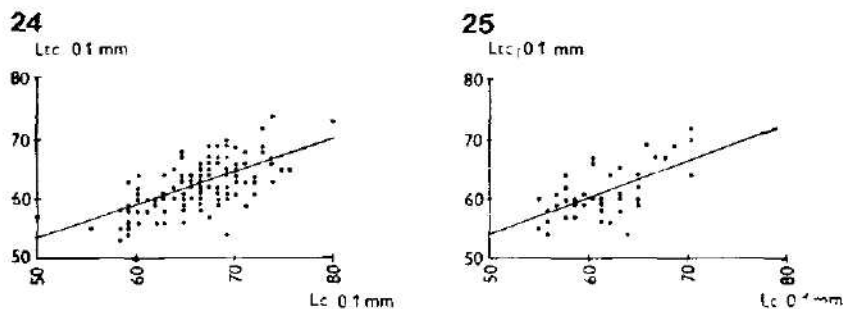
g) Lc/Ltc Relations During Growth*Triturus vulgaris*

In an attempt to determine Ltc/Lc relations, I computerized my data. Using the multiple correlation coefficient, I examined whether the character of this relations was linear (isometry), or could be better described by a parabolic or cubic curve, which would mean that the growth of Ltc and Lc is not isometric. I determined the width: length ratio of the head, separately for each sex, for

Table 3. *T. cristatus*. Equations of straight lines for individual relationships

| Relationship | Population sample | Males + juv. | | Females + juv. | |
|----------------------------|-------------------|----------------|------------|----------------|------------|
| $L/Led = f(L)$ | Božec | $y = 0.000458$ | $x - 1.10$ | $y = 0.00134$ | $x + 1.07$ |
| | Křivoklát | $y = 0.00346$ | $x + 1.01$ | $y = -0.00172$ | $x + 1.17$ |
| $L/Ltc = f(L)$ | Božec | $y = 0.0749$ | $x + 1.91$ | $y = 0.0666$ | $x - 2.24$ |
| | Křivoklát | $y = 0.0385$ | $x - 3.72$ | $y = 0.0355$ | $x - 3.85$ |
| $L/LtE = f(L)$ | Božec | $y = -0.00221$ | $x + 1.92$ | $y = -0.00314$ | $x + 1.94$ |
| | Křivoklát | $y = -0.00495$ | $x + 2.12$ | $y = -0.00697$ | $x + 2.17$ |
| $L/Pa = f(L)$ | Božec | $y = 0.00103$ | $x + 2.92$ | $y = 0.0221$ | $x + 2.03$ |
| | Křivoklát | $y = 0.00957$ | $x + 2.44$ | $y = 0.0137$ | $x + 2.31$ |
| $L/Pp = f(L)$ | Božec | $y = -0.00811$ | $x - 3.07$ | $y = 0.00934$ | $x + 2.38$ |
| | Křivoklát | $y = -0.00305$ | $x - 2.76$ | $y = 0.00682$ | $x + 2.45$ |
| $\frac{L - Lc}{Lc} = f(L)$ | Božec | $y = 0.0554$ | $x + 1.78$ | $y = 0.0509$ | $x - 1.93$ |
| | Křivoklát | $y = 0.0348$ | $x + 3.02$ | $y = 0.0315$ | $x + 3.17$ |

4 population samples from Libeň, Hředle, Karlštejn and Momčilgrad. According to my results, the head is growing isometrically in relation of width to length. An exception are females from Karlštejn (Fig. 25) where it appears that in large females an increase of the head in width is quicker than that in length. A similar situation has been found to occur in females from Momčilgrad, but there, the head of small females increased more rapidly in width than in length. However, with regard to a considerable spread of points indicating relations in length to width of the head for the individual specimens, no significance can be ascribed to these deviations. It can be concluded that, in general, in relation to each other, the growth of Ltc and Lc is isometric, and negative allometric with respect to body length. This means that the value $Lc:Ltc$ remains constant during the growth period. However, its utilization in the evaluation of the interpopulation and geographical variability is complicated by a high, individual variability.



Figs. 24—25. *T. vulgaris*. Relationship among Ltc and Lc. 24 = Libeň — males; 25 = Karlštejn — females.

Triturus alpestris

There exists a considerable individual variability in the relation of Lc to Ltc. With respect to each other, growth of the two dimensions is always isometric. An exception are big females from the locality Krivoklát in which there is a slight tendency towards a positive allometric growth of the head in width in relation to its length. For males from the locality Soumarský most, a parabolic curve describes this relations far better than a straight line, because growth of head width is positive allometric with respect to its growth in length. In most cases, the shape of the head as regards width and length changes minimally during growth of the Alpine newt, although in several populations, the head grows relatively faster in width than in length, but this applies mainly to large specimens. As a whole, growth of the head is negative allometric with respect to the body.

Triturus cristatus

I have studied this relations on both males and females of the population sample from the locality Božec. In relation to each other, growth of the two head dimensions is isometric. Therefore, the shape of the head does not change during growth whereby its growth is negative allometric with respect to the body.

DISCUSSION

The method employed in this study is based on the presupposition that the size of the individual parts of the body depends only on body length and not on the age of the animal because an approximate estimate of the age of the newt can only be made according to the size (Smirina and Roček 1976, Hagström 1977, 1980). Another factor not considered by this method is a possible modifying effect of greatly different seasonal, climatic and nutritive conditions on the growth of the body during the development of the individual generations. A major deterrent to a correct interpretation of the character of growth changes is a considerable individual variability particularly in size classes in which the number of animals is small. I have tried to do away with at least some deficiencies of the method in that I have analyzed the most abundant population samples available. I have not included population samples whose correct evaluation has been impeded by the aforementioned deficiencies of the method in my general conclusions.

The comparison of my present results indicates that growth in width and length of the head with respect to the body is negative allometric in the three species of the genus *Triturus* examined in my studies. According to Lee (1975) this is a common phenomenon in vertebrates, associated with a concentration of sense organs and nerve tissue in this area. It might also be the result of an adaptation to a relatively large-size prey on which the newt feeds from its earliest youth. Growth in head length with respect to that in width is isometric. A feature observed to occur in all *Triturus* species examined, and generally more marked in the female, is a slight increase in the distance between the anterior and posterior extremity with respect to the body. Relative growth in tail length is isometric to slightly negative allometric with respect to the body. The slightly negative allometric trend is more marked in the female (this might possibly be due to the influence of seasonal changes in tail length of the male). An observation made for all three newt species examined is a relative shortening of extremities with respect to the body (more marked in the females). An exception are males of *Triturus cristatus* in which growth of the posterior extremity is positive allometric, that of the anterior extremity faintly positive allometric to isometric. It might well be that this exceptional character of growth changes in the extremities of the males *T. cristatus* might be associated with the etology of reproduction — the displaying male erects its body raising it maximally in its posterior part (for details see Reháček 1979, 1981). This pose does not occur in the display of the Smooth newt and the Alpine newt. If, in fact, relatively longer hind legs in the male increase the probability of a successful pick-up of the spermatophore by the female, this might be an explanation of the development of this specific character of the leg growth in the males of *T. cristatus* during the evolution of this species.

My results for the Smooth newt are in complete agreement with those obtained by Kelárová (1977) from a collective evaluation of a set of animals from Bohemia (173 specimens). With respect to body length, this author reported a negatively allometric growth for the extremities, width of head and for the tail. Several of the values given by Láč (1963) for L/Lcd , L/Ltc , L/Pa and L/Pp are in agreement with the negative allometric growth of the pertinent dimensions, others are not. Gislén and Kauri (1959) did not confirm a negative allometric growth of the tail and extremities, but these authors

evaluated a material composed of immature specimens, larvae and a few adults. Kelárová (1977) although stating in the text of her paper that the anterior extremity of the female grows more quickly than the posterior extremity, demonstrates the opposite in the graphical illustration appended to the text. I have tried to avoid confusion caused by the interpopulation variability in body size, relative body dimensions and in the character of growth changes in that I have evaluated each population sample separately. According to my results, it is sometimes the anterior extremity that grows more quickly than the posterior extremity, and that in both sexes alike, while in other populations, the situation is reversed. Several of the dimensions which I have examined for their relative growth have not been studied by the authors mentioned.

Several dimensions of the Alpine newt have been investigated by Ernst (1952) and Roček (1974). Roček (1974) maintains that growth of the tail is isometric but his figures indicate mainly the intrapopulation variability in relative tail length. Moreover, his figures lack data on the number of animals in the individual size classes and, therefore, there might exist a different interpretation of several curves. According to Ernst (1952), growth of the tail is negative isometric. My own results are some kind of "compromise", because I observed an isometry in the male, and a negative allometry in the female. My finding of a negative allometric growth of the anterior extremity is in agreement with Ernst, but in contradiction to that made by Roček who maintains that this growth is isometric. As regards changes in other body dimensions, Roček regards growth of the distance between the extremities to be isometric, my results indicate that this growth is slightly positive allometric. I agree with Roček in that growth of both extremities is in an approximate agreement with one another. Roček reports considerable differences in growth of the two head dimensions which do not exclude the possibility that their growth is negative allometric. My results are in favour of a negative allometry both in the width and the length of the head. I agree with Roček in that both dimensions grow mostly isometrically in respect to each other. In agreement with Roček is my observation of an exceptional relative enlargement of the head during growth, but I failed to observe an exceptional elongation of the head reported by him. In my opinion, slight differences in our results might have been brought about by the small number of animals in the sample analyzed by Roček. In this case, each individual deviation, particularly in marginal size classes, changes significantly the definite picture. Roček himself pointed out this possibility. In addition, both authors measured the length of extremities with a method (different from that employed by me) which, in my opinion, does not influence the assessed character of growth as has been also indicated by disagreements in the results obtained by Roček and Ernst.

A detailed study on the variability and growth of the mentioned characters was made by Lác (1957) for the subspecies *T. c. dobrogicus* from Slovakia. The author, evaluating collectively a material consisting of several population samples, maintained that growth of the tail of adult specimens was isometric, while I observed a slightly negative allometric growth in tail length in my material. Whether this difference in our results should be ascribed to the specificity of the individual subspecies or to a considerable variability in the material is difficult to assess. As regards growth in other body dimensions,

Lac, similar to myself, examined these in both juveniles and adults. Although Lac maintained that leg growth was negatively allometric, he stated simultaneously that relationships of absolute leg length to body length could be expressed by linear equations. This, however, suggests an isometric growth.

The figure in his paper illustrating changes in $\frac{Pa}{LiE} \cdot 100$ and $\frac{Pp}{LiE} \cdot 100$

indicates a decrease in this value during growth (and that without reservation in the female only), but the author failed to consider the fact that this might just as well mean a negative allometric growth of extremities as a positive allometric growth of LiE or the result of both. Therefore, no comparison could be made of my results on changes in these taxonomically important dimensions with the data obtained by Lac (1957). Our results are in agreement as regards the negative allometric growth in head width and head length.

In studies on the taxonomy of the newts, biometrical indexes L/Lcd, L/Ltc,

$$L/LiE, L/Pa, L/Pp, \quad \frac{L - Lc}{Lc}, \frac{Pa \cdot 100}{LiE}, \frac{Pp \cdot 100}{LiE},$$

Pa/Pp are among the criteria frequently used in a comparison of population samples of an unequal size frequency and unknown age spectrum. However, because these indexes are based on body dimensions having allometric growth with regard to body, their suitability for taxonomical studies is problematic.

Especially indexes L/Ltc, $\frac{L - Lc}{Lc}$,

showing considerable changes during the growth, are not suitable. Also comparisons based on the indexes L/Pa, L/Pp can lead to wrong results. Lcd and LiE have only slightly allometric growth with regard to body and therefore the indexes L/Lcd and L/LiE are relatively suitable for comparative studies if the population samples are sufficiently numerous. Considering that Pa generally shows negative allometry and LiE slightly positive allometry, resulting changes during growth in indexes

$$\frac{Pa \cdot 100}{LiE} \text{ and } \frac{Pp \cdot 100}{LiE}$$

are not considerable. During the growth values of Pa/Pp and Lc/Ltc remain generally constant. However, their utilization is complicated by a very high individual variability.

SUMMARY

In total, growth of the Smooth newt, the Alpine newt and the Warty newt is allometric. With respect to body length, growth of Ltc and Lc is negative allometric. In relation to each other, these two dimensions are growing isometrically. Growth of distance between anterior and posterior extremity is moderately positive allometric. Growth in tail length is slightly negative allometric (particularly distinct in the females) to isometric with respect to the body. Growth of the anterior and posterior extremities is negative allometric with respect to body length. An exception are males of the Warty newt, in which growth in extremities is isometric to slightly positive allometric (posterior extremity). These differences might be associated with the courtship behaviour in males of the Warty newt.

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**ÜBER DIE VARIABILITÄT UND SYNONYMIK DER TAXONE AUS DEM
UMKREIS VON ACANTHOCYCLOPS VENUSTUS (COPEPODA, CYCLOPOIDA)**

Jaroslav ROSOL & Otakar ŠTÉRBA

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Abstract. After an analysis of the morphometrical characteristics gained both from literature and from the authors research of their own material, the authors have reached the conclusion that the group of *Acanthocyclops venustus*, *A. crinitus*, *Ac. stammeri*, *Ac. stammeri westfalicus*, *Ac. troglophilus* and *Ac. phreaticus* constitute a single species with the joint denomination of *Acanthocyclops venustus* (Norman and Scott).

EINLEITUNG

Im Jahre 1906 wurde durch Norman und Scott die Art *Acanthocyclops venustus* aus den Moorgewässern von England beschrieben, die schrittweise in weiteren Ländern (z. B. Irland — Gurney 1933, Schweden — Lindberg 1948, Wollingstersee in Norddeutschland — Klie 1928) gefunden war. Ursprünglich wurde die Art als acidophil angesehen, aber schon der Fund von Klie (1928) deutete an, dass sie eine grössere ökologische Valenz hat. Im Jahre 1910 beschreibt Graeter aus der schweizer Höhle Hölloch im Mnotatal die Art *Cyclops crinitus*, die der Art *Ac. venustus* auffallend ähnlich war, sowie *Cyclops phreaticus*, der durch Chappuis (1928) aus den rumänischen Untergrundwässern beschrieben wurde. Im Jahre 1930 beschreibt Kiefer aus der italienischen Höhle von St. Canzian eine weitere ähnliche Art *Ac. stammeri* und im Jahre 1931 bestimmt derselbe Autor eine Subspecies dieser Art *Ac. stammeri westfalicus* aus Westfalen. Schliesslich im Jahre 1932 beschreibt Kiefer aus dem bekannten Karstgebiet Popovo polje in Jugoslawien *Ac. troglophilus* (aus dieser Lokalität stammen auch 2 Weibchen, die hier im Jahre 1972 durch den ersten der beiden Autoren dieses Beitrages gefunden worden sind).

Von *Ac. venustus* sollen sich die erwähnten Taxone durch folgende Merkmale unterscheiden:

Ac. crinitus: Im allgemeinen durch grössere Ausmasse des Körpers (2,0–2,3 mm), längere mittlere apikale Furkalborste. Absenz von Dörnchen an der Oberfläche des Cephalothorax (?).

Ac. phreaticus: Vielleicht die gesamte Körpergrösse?

Ac. stammeri: Längere Furkaläste, schlankeres letztes Glied Enp₄ an der äusseren Seite dieses Gliedes ist keine Borste sondern ein Dorn, es fehlen die Haare an der Innenseite der Furka.

Ac. stammeri westfalicus: Von der Nominatform sondert sie sich durch eine kürzere Furka und einen kürzeren 3. Glied Enp₄ ab.

Ac. troglophilus: Längere Furkaläste und längeres 3. Glied Enp₄.

Aus den einzelnen Beschreibungen ergibt sich klar, dass es sich dabei um auffallend ähnliche Formen handelt. Dieser Tatsache war sich schon Kiefer (1937) bewusst, der neben des eigenen Materials auch Sammlungen von Karaman,

Chappuis, Remy und Viets bearbeitet hatte. Er kommt zur Ansicht, dass es sich dabei im Grunde um eine einzige euryplastische Art handelt, erwähnt aber *Ac. phreaticus* und *Ac. crinitus* nicht. Er führt die Unterarten *Ac. venustus stammeri* und *Ac. venustus troglophilus* ein, die südlich der Alpen leben sollen, dagegen *Ac. venustus* s. str. nördlich der Alpen. Weiter macht er darauf aufmerksam, dass sich in der südlichen Richtung die Furka und das 3. Glied Enp_4 verlängert, sodass die Unterscheidung dieser Taxone nach Kiefer 1937 wie folgt ist:

Ac. venustus venustus: F_{ind} 3,6—4,2, Enp_{4ind} 2,1—2,3.

Ac. venustus stammeri: F_{ind} 3,0—3,5, Enp_{4ind} 1,7—2,0.

Ac. venustus troglophilus: F_{ind} 5,1—6,1, Enp_{4ind} 2,4—2,7.

Rylov (1948) hält *Ac. troglophilus* für Synonymum zu *Ac. stammeri*. Die diskutierten Taxone wurden schrittweise durch verschiedene Autoren in vielen Lokalitäten in verschiedenen europäischen Ländern gefunden, jedoch immer in einer kleinen Zahl.

Beachten wir nun das Indikationsgewicht der einzelnen angewendeten Merkmale. Die Zahl der Glieder und ihre Grundbeborstung sind bei allen diskutierten Taxonen gleich. Sehr häufig angewendete Merkmale sind der Furkalindex und der Index des 3. Gliedes Enp_4 , die bei manchen Arten (besonders der ausschliesslich ober-

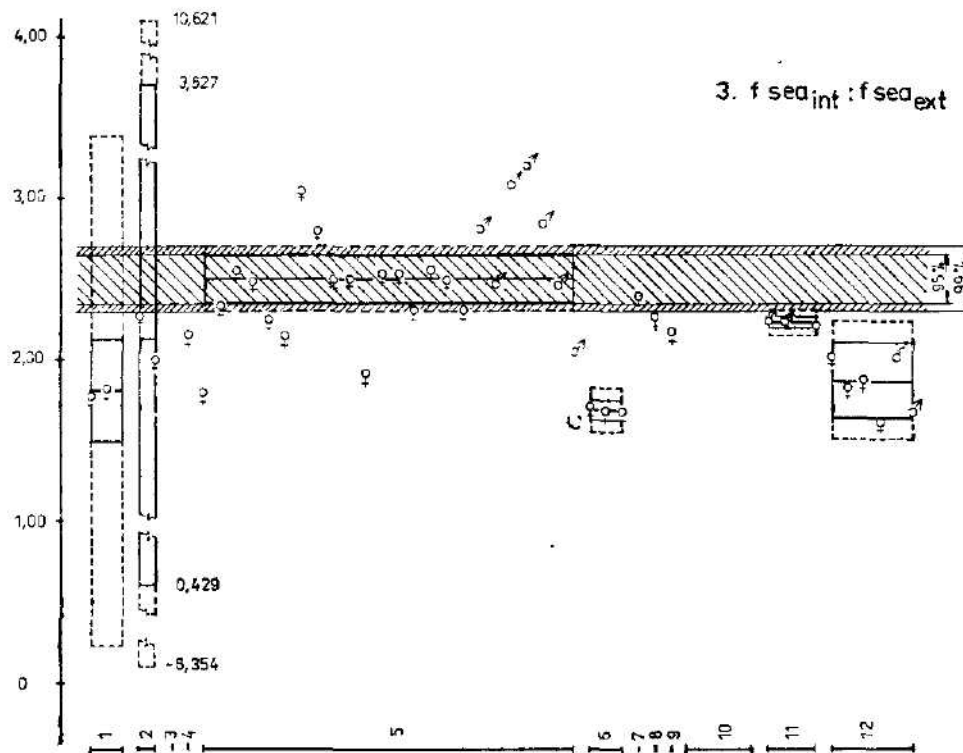


Abb. 1. Die Variabilität des Furkalindexes (1 = Popovo Polje 1933, 2 = Pop. Polje 1972, 3 = St. Ganzian, 4 = Wien, 5 = Bratislava 1975—1976, 6 = Mladeč-Cerlinka, 7 = Schweiz, 8 = Westfalen, 9 = Oberrhein, 10 = Bonn, 11 = Belgien, 12 = Britanien).

Tab. 1. Übersicht

| | Wien, Kiefer 1963 <i>Ac. venustus</i> | Oberriem, Kiefer 1957 <i>Ac. venustus</i> | Bonn, Haime 1946 <i>Ac. venustus</i> <i>v. westfalicus</i> | Schweiz, Traeter 1968 <i>Ac. crinitus</i> | Westfalen, Kiefer 1931 <i>Ac. stammeri</i> <i>v. westfalicus</i> | Belgien, Kiefer 1936 <i>Ac. stammeri</i> <i>v. westfalicus</i> |
|-----------------------|------------------------------------------|-------------------------------------------------|------------------------------------------------------------------|----------------------------------------------|---------------------------------------------------------------------------|----------------------------------------------------------------------|
| 1 ♀ | 1 ♀ | 3 ♀, ♂ | 1 ♀ | 1 ♀ | 1 ♀ | 1 ♀ |
| l | 1,100 | 1,140 | 1,165 | 2,100—2,300 | 1,000 | 1,000 |
| l (a + f) | 0,400 | 0,465 | ? | 0,819 | 0,400 | ? |
| f ind | 3,400 | 3,100 | 3,250 | 4,000 | 3,100 | 2,940 |
| f seam _{int} | 0,679 | 0,720 | 0,660 | 0,880—0,920 | 0,600 | 0,720 |
| f seam _{ext} | 0,395 | 0,425 | 0,327 | 0,528 | 0,300 | 0,480 |
| f sea _{int} | 0,190 | 0,185 | ? | 0,192 | 0,168 | 0,195 |
| f sea _{ext} | 0,088 | 0,085 | ? | 0,080 | 0,074 | 0,088 |
| f lat | 0,038 | 0,048 | ? | 0,050 | 0,038 | 0,052 |
| f dors | 0,127 | 0,170 | ? | 0,169 | 0,133 | 0,138 |
| e ₄ ind | 1,900 | 2,000 | 1,906 | ? | 1,850 | 1,670 |
| spae ₄ int | 0,056 | 0,053 | 0,049 | ? | 0,053 | 0,043 |
| spae ₄ ext | 0,058 | 0,061 | 0,055 | ? | 0,047 | 0,051 |
| ile | 69 | 62 | 70 | 70 | 68 | 69 |
| I. | + | + | + | + | ? | + |
| II. | ? | (+) | o | ? | ? | ? |
| III. | ? | (+) | + | + | (+) | + |
| IV. | ? | ? | ? | + | ? | ? |
| V. | + | o | (+) | ? | + | o |

flächigen) wirklich relativ konstant sind. In anderen Fällen können jedoch beide Indexe sehr variabel sein, was vor allem für Arten, die so in oberflächlichen wie in Untergrundwässern leben. Bei dem Übergang der mehr oder weniger natanten Populationen in die interstitialen Gewässer der Sandkiessablagerungen kommt es regelmässig zu einer überraschend schnellen und ausgeprägten Reduktion der Länge der Furka und der Schwimmorgane (z. B. *Acanthocyclops languidoides*, *Ac. languidus*, *Ac. crassicaudis*, *Eucyclops serrulatus* oder *Paracyclops fimbriatus*). Versuchsweise wurde bewiesen, dass bereits die ersten Filialgenerationen der Art *Paracyclops fimbriatus*, gezüchtet im Millieu von gewässertem Sande, signifikant so die Furka wie die 3. Glieder Eap₄ verkürzen (Štěrba, Schmidt 1982).

Ähnlich ist es mit der Körpergrösse, die bei den einzelnen Populationen und Exemplaren sehr schwankt. Ein weiteres Merkmal sind die Furkalborsten und deren Längenverhältnisse, für die Unterscheidung der inkriminierten Taxone sind sie jedoch nicht verwendbar, da beweiskräftige Differenzen nicht festgestellt wurden. Dasselbe gilt für die Insertion der lateralen Furkalborste. Bei der ganzen Gruppe *Ac. venustus* sind als charakteristisch kreisförmige „Einsenkungen“ unter der Kutikula, ausgeschnittene Lamellen an den Hinterrändern der Körpersegmente und weiter die lamellaren Skulpturen und feine Dörnchen an der Oberfläche des Körpers angeführt. Ihre Verwendung ist aber zweifelhaft, da es sich um ein ganz ungewöhnliches Merkmal handelt. Ein unserer Ansicht nach gleich unverwendbares Merkmal ist die Präsenz oder Absenz von feinen Haaren an der Innenseite der Furka, die erst bei einer 100malen und höheren Vergrösserung sichtbar sind. Auch der Dorn an der In-

der Hauptmerkmale

| Butanmen, Gurney 1933 <i>C. venustus</i> | St. Ganzian, Krieger 1930 <i>A. stammeri</i> | Popovo polje, Krieger 1933 <i>A. stammeri</i> <i>troglophilus</i> | Popovo polje, Rosol 1972 <i>A. venustus</i> | Mladeč - Čerlinka, Štěrba 1956, 1975 <i>Ac. venustus</i> | Bratislava Rosol 1975, 1976 <i>Ac. venustus</i> , 17 ♀ | |
|------------------------------------------------|----------------------------------------------------|----------------------------------------------------------------------------|---------------------------------------------------|----------------------------------------------------------------|--------------------------------------------------------------|------------------|
| 4 ♀, \bar{x} | 4 ♀ | 2 ♀, \bar{x} | 2 ♀, \bar{x} | 3 ♀, \bar{x} | \bar{x} | $\Sigma \bar{x}$ |
| 1,133 | = 1,200 | 1,660 | 1,520 | 1,220 | 1,281 | 0,046 |
| 0,400 | ? | 0,530 | 0,540 | 0,467 | 0,494 | 0,020 |
| 3,518 | 4,00 - 4,40 | 5,330 | 4,100 | 3,400 | 3,653 | 0,091 |
| 0,660 | = 0,900 | ? | 0,990 | 0,673 | 0,695 | 0,012 |
| 0,453 | = 0,500 | ? | 0,635 | 0,470 | 0,440 | 0,019 |
| 0,098 | ? | 0,174 | 0,182 | 0,133 | 0,213 | 0,006 |
| 0,054 | ? | 0,097 | 0,085 | 0,079 | 0,088 | 0,002 |
| 0,071 | ? | 0,054 | 0,046 | 0,046 | 0,047 | 0,002 |
| 0,095 | ? | 0,156 | 0,149 | 0,153 | 0,162 | 0,006 |
| 1,863 | 2,00 - 2,20 | 2,590 | 2,200 | 2,143 | 2,237 | 0,039 |
| ? | ? | 0,100 | 0,100 | 0,039 | 0,036 | 0,001 |
| ? | ? | 0,103 | 0,098 | 0,040 | 0,060 | 0,002 |
| = 70 | = 68 | 74 | 71,5 | 69,667 | 69,941 | 0,303 |
| + | + | + | + | + | + | |
| + | ? | ? | + | + | + | |
| + | (+) | + | + | + | (+) | |
| + | ? | ? | + | + | + | |
| o | + | + | + | o | o | |

nenseite des 3. Gliedes Enp_4 , der ausnahmsweise die Borste vertritt, ist ein zweifelhaftes Merkmal.

DAS MATERIAL UND DIE VERARBEITUNGSWEISE

Aus dem obenangeführten ist klar, dass es sich um eine Gruppe von ausserordentlich morphologisch plastischen Taxonen handelt. Zur Lösung ihrer systematischen Stellung tragen wir bei mit der Bewertung von Merkmalen, die wir aus zugänglicher Literatur gewonnen oder abgeleitet haben, und weiter durch die Bearbeitung vom verhältnismässig reichen Material aus der Tschechoslowakei, der aus zwei Gebieten gewonnen wurde. Erstens waren es Karstgewässer aus Mittelmähren (Höhle „Mladeč“, Štěrba 1956) und einer Wasserbohrung aus dem begrabenen Karst „Čerlinka“ (ca 4 km von der ersten Lokalität), die Mehrzahl des Materials stammt aber aus den Hydrobohrungen auf dem „Žitný ostrov“ (östlicher Vorstadtteil von Bratislava am linken Donauufer, leg. Rosol 1976-77).

Wichtige morphologische Parameter wurden in die Tafel I zusammengestellt, die eine Ausgangsbasis für die folgende mathematisch-statistische Bewertung bedeutet, die die drei wichtigsten Merkmale betreffen (Furkalindex, Index des 3. Gliedes Enp_4 , das Verhältnis der Länge der inneren und äusseren apikalen Furkalborste). Die anderen Merkmale halten wir für die Charakteristik der Taxone in diesem Falle nicht als wesentlich. In der Tafel I ist die Zusammenstellung der Merkmale der Art *Ac. phreaticus* (Chappuis) nicht einbegriffen, den wir hätten die ursprünglichen Fassung nicht zur Disposition. Die Werte dieser Art waren aus der Arbeit von Damian George-cu (1963) abgeleitet und laut dieser soll die Art wie folgt charakterisiert werden: $l = 0,850$, $l(a - f) = 0,370$, $f_{ind} = 3,50$, $f_{seam_{int}} = 0,600$, $f_{seam_{ext}} = 0,324$, $f_{sea_{int}} = 0,162$, $f_{sea_{ext}} = 0,085$, $f_{lat} = 0,035$, $f_{dors} = 0,085$, $Enp_{4ind} = 2,10$, $spae_{4int} = 0,036$, $spae_{4ext} = 0,036$, $nb = 69 \%$.

Tab. 2. Die statistischen Hauptparameter der analysierten Gesamtheiten für die beobachteten Merkmale

| Lokalität f_{ind} | n_i | \bar{x} | S_i | S_x | m | t_0 | $t_{m,\alpha}$ | | | |
|-----------------------------|-------|-----------|-------|-------|--------|----------|----------------|--------|--------|---------|
| | | | | | | | α | 0,10 | 0,05 | 0,01 |
| Bratislava | 24 | 3,638 | 0,328 | 0,067 | — | — | — | — | — | — |
| Mladeč | 3 | 3,400 | 0,100 | 0,058 | 9,481 | 2,693 | 1,823 | 2,246 | 3,211 | 3,638 |
| Popovo polje 1933 | 3 | 5,347 | 0,042 | 0,024 | 24,604 | — 24,050 | 1,709 | 2,061 | 2,791 | 3,083 |
| Popovo polje 1972 | 2 | 4,100 | 0,283 | 0,200 | 1,235 | — 2,191 | 5,516 | 10,731 | 51,030 | 100,710 |
| Bonn | 5 | 3,108 | 0,467 | 0,209 | 4,852 | 2,415 | 2,601 | 2,601 | 4,117 | 4,895 |
| Belgien | 3 | 2,920 | 0,044 | 0,025 | 24,357 | 10,050 | 1,710 | 2,062 | 2,794 | 3,086 |
| Britannien | 6 | 3,528 | 0,325 | 0,133 | 7,754 | 0,738 | 1,868 | 2,320 | 3,391 | 3 881 |
| $e4_{ind}$ | | | | | | | | | | |
| Bratislava | 24 | 2,225 | 0,147 | 0,030 | — | — | — | — | — | — |
| Mladeč | 3 | 2,143 | 0,086 | 0,003 | 23,530 | 2,694 | 1,712 | 2,066 | 2,802 | 3,097 |
| Popovo polje 1933 | 3 | 2,627 | 0,072 | 0,042 | 4,487 | — 7,821 | 2,075 | 2,676 | 4,326 | 5,196 |
| Popovo polje 1972 | 2 | 2,200 | 0,283 | 0,200 | 1,045 | 0,122 | 6,161 | 12,328 | 61,239 | 122,230 |
| Bonn | 5 | 1,938 | 0,207 | 0,093 | 4,874 | 2,946 | 2,030 | 2,597 | 4,104 | 4,877 |
| Belgien | 4 | 1,750 | 0,063 | 0,031 | 9,908 | 10,940 | 1,814 | 2,231 | 3,177 | 3,591 |
| Britannien | 6 | 1,975 | 0,231 | 0,094 | 6,045 | 2,519 | 1,941 | 2,443 | 3,698 | 4,304 |
| $f_{sea,int} : f_{sea,ext}$ | | | | | | | | | | |
| Bratislava | 24 | 2,499 | 0,346 | 0,071 | — | — | — | — | — | — |
| Mladeč | 3 | 1,689 | 0,024 | 0,014 | 24,383 | 11,270 | 1,710 | 2,062 | 2,793 | 3,086 |
| Popovo polje 1933 | 2 | 1,808 | 0,035 | 0,025 | 21,520 | 9,246 | 1,719 | 2,077 | 2,825 | 3,127 |
| Popovo polje 1972 | 2 | 2,133 | 0,189 | 0,133 | 1,637 | 2,434 | 4,152 | 7,353 | 29,430 | 55,192 |
| Bonn | — | — | — | — | — | — | — | — | — | — |
| Belgien | 3 | 2,232 | 0,014 | 0,008 | 23,561 | 3,765 | 1,712 | 2,066 | 2,801 | 3,096 |
| Britannien | 6 | 1,873 | 0,221 | 0,090 | 12,014 | 5,469 | 1,782 | 2,179 | 3,054 | 3,428 |

Erklärung der benutzten Verkürzungen

(Alle absoluten Masse sind in mm angegeben); l = Gesamtlänge des Exemplars; $l(a + f)$ = Abdomen + Furka (Summe der Längen); f_{ind} = Furkalindex; $f_{seam,int}$ = Seta apicalis media interna (Länge); $f_{seam,ext}$ = Seta apicalis media externa (Länge); $f_{sea,int}$ = Seta apicalis interna (Länge); $f_{sea,ext}$ = Seta apicalis externa (Länge); f_{lat} = Seta lateralis (Länge); f_{dors} = Seta dorsalis (Länge); $e4_{ind}$ = Index des Endopodits 4; $spae 4_{int}$ = Spina apicalis interna e4 (Länge); $spae 4_{ext}$ = Spina apicalis externa e4 (Länge); ilb = Insertion der f_{lat} von der Wurzel (Länge); + = Merkmal ist präsent; — = Merkmal ist nicht präsent; (+) = Merkmal ist präsent aber kaum merklich; ? = der Wert nicht messbar oder die Angabe fehlt.

NUMERISCHE BEARBEITUNG

Im wesentlichen wurden eine Hypothese nachgeprüft, dass die Werte von gewählten morphometrischen Indexen der einzelnen Auswahlen zur derselben Gesamtheit gehören, vorausgesetzt, dass die zugehörigen Varianzen nicht bekannt und voneinander verschieden sind ($\sigma_{Br} \neq \sigma_i$).

Die erreichbaren Ausgangswerte stellen 8 (ev. 6) ausgewählte Gesamtheiten und 4 Punktwerte dar. Der Vergleich in allen Paarkombinationen für die 3 gewählten Hauptmerkmale wäre sehr langwierig, sogar im Falle, dass nur die Gesamtheiten erwogen werden. Deswegen haben wir die Referenzauswahl „Bratislava“ gewählt und die anderen Auswahlen haben wir nur mit ihr verglichen.

Dies bedeutet, dass die Gültigkeit der Beziehung $\mu_{Br} - \mu_i = \delta_0 = 0$, nachgeprüft wurde, wo μ die erwarteten Werte der zugehörigen Auswahlen sind und δ ein Unterschied der erwarteten Werte der einzelnen Auswahlen ist.

Tab. 3. Übersicht der Übereinstimmungen (resp. der Differenz) für verschiedene Sicherheitschwellen.

+ = die Hypothese für gegebene α kann man nicht ablehnen,
 - = die Hypothese für gegebene α muss man ablehnen

| f_{ind} Lokalitat | α | 0,10 | 0,05 | 0,01 | 0,005 |
|------------------------|----------|------|------|------|-------|
| Mladeč | | - | - | + | + |
| Popovo polje 1933 | | - | - | - | - |
| Popovo polje 1972 | | + | + | + | + |
| Bonn | | - | + | + | + |
| Belgien | | - | - | - | - |
| Britannien | | + | + | + | + |

| e_{ind} Lokalitat | α | 0,10 | 0,05 | 0,01 | 0,005 |
|------------------------|----------|------|------|------|-------|
| Mladeč | | - | - | + | + |
| Popovo polje 1933 | | - | - | - | - |
| Popovo polje 1972 | | + | + | + | + |
| Bonn | | - | - | + | + |
| Belgien | | - | - | - | - |
| Britannien | | - | - | + | + |

| $f_{seaint} : f_{seeext}$ Lokalitat | α | 0,10 | 0,05 | 0,01 | 0,005 |
|----------------------------------------|----------|------|------|------|-------|
| Mladeč | | - | - | - | - |
| Popovo polje 1933 | | - | - | - | - |
| Popovo polje 1972 | | + | + | + | + |
| Bonn | | ? | ? | ? | ? |
| Belgien | | - | - | - | - |
| Britannien | | - | - | - | - |

Die untersuchte Hypothese wird abgelehnt, wenn der Wert t_0 für die gegebene Voraussetzung im Absolutwert die kritische Gruppe $t_{m,\alpha}$ überschreitet ($t_{m,\alpha}$ finden wir für den gewählten Wert α in den Tabellen).
 t_0 rechnen wir aus der Beziehung

$$t_0 = \frac{\bar{x}_1 - \bar{x}_i - \delta}{\sqrt{s_{x_1}^2 + s_{x_i}^2}} \quad (1)$$

$$\text{wo } s_{x_i}^2 = \frac{s_i^2}{n_i} \quad (1a) \text{ ist.}$$

s_x ist die Standardabweichung von Durchschnitt, s_i ist die Standardabweichung der einzelnen Auswahlen, n_i representiert den Umfang der Auswahl. Die Beziehung (1) hat ungefähr t-Verteilung von m Freiheitsgrad.

m ist durch die Beziehung

$$\frac{1}{m} = \frac{1}{n_1 - 1} \left[\frac{s_{x_1}^2}{s_{x_1}^2 + s_{x_i}^2} \right] + \frac{1}{n_i - 1} \left[\frac{s_{x_i}^2}{s_{x_1}^2 + s_{x_i}^2} \right] \quad (2)$$

definiert (für m von nicht ganzen Zahlen ist eine lineare Extrapolation nötig).

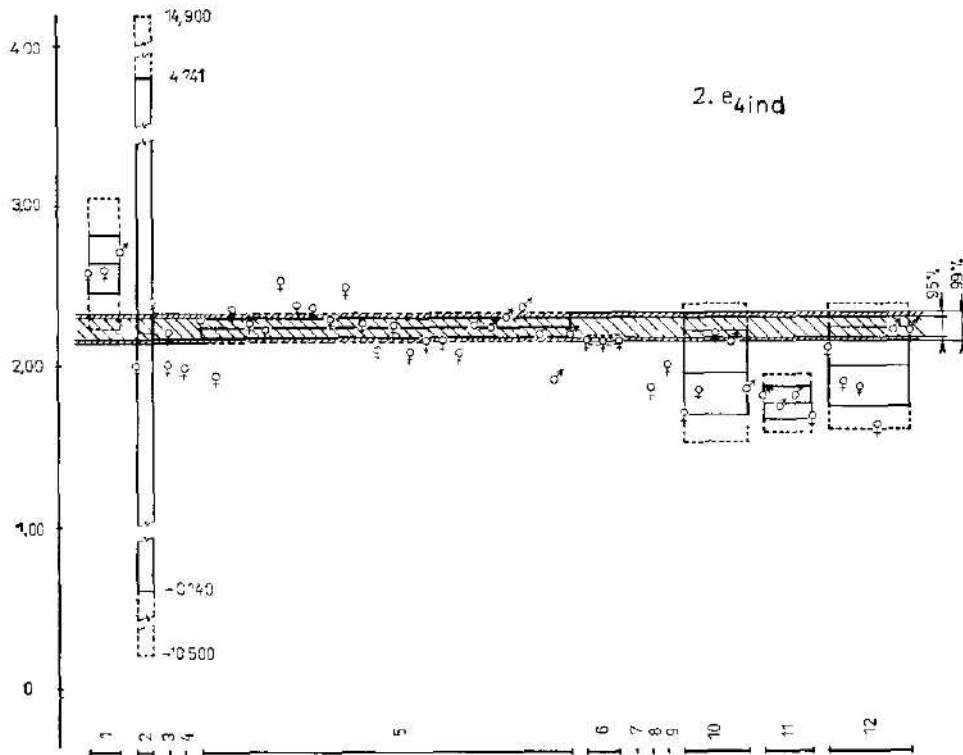


Abb. 2. Die Variabilität des Indexes des 3. Gliedes Enp_4 (Siehe Abb. 1).

Für isolierte Werte (d. h. für Standardabweichungen von Nullwert) wurde nur eine Informationsuntersuchung, ob diese Werte in die Konfidenzintervalle für den erwarteten Wert gehören, durchgeführt (bei der Auswahl „Bratislava“).

Der Konfidenzintervall wurde aus der Beziehung

$$\bar{x} = \frac{t_{n-1, \alpha} \cdot s}{\sqrt{n}} \quad (3)$$

berechnet, wo $t_{n-1, \alpha}$ der tabellierte kritische Wert für $n - 1$ Freiheitsgrade und die Sicherheitsschwelle α nach der Einteilung von Student ist.

Die Ergebnisse sind in den Tab. 2, 3 und 4 enthalten.

DIE GRAPHISCHE VERARBEITUNG DER ERGEBNISSE

Für die ausgewählten morphologischen Indexe sind alle Angaben in der Form eines Punktdiagrammes abgebildet. Die einzelnen Auswahlen sind als Rechtecke dargestellt, die in der Horizontalrichtung durch den Umfang der Auswahl (n) und in der Vertikalrichtung durch die Konfidenzintervalle für $\alpha = 0,01$ und $0,05$ begrenzt sind. In jedem Rechteck ist mit einer vollen Linie der Durchschnittswert der Gesamtheit angeführt. Bei der Auswahl „Bratislava“ sind für die Illustration die Umfänge beider Intervalle in den Grenzen $n_1 \sim n_2$ der verglichenen Werte eingezeichnet.

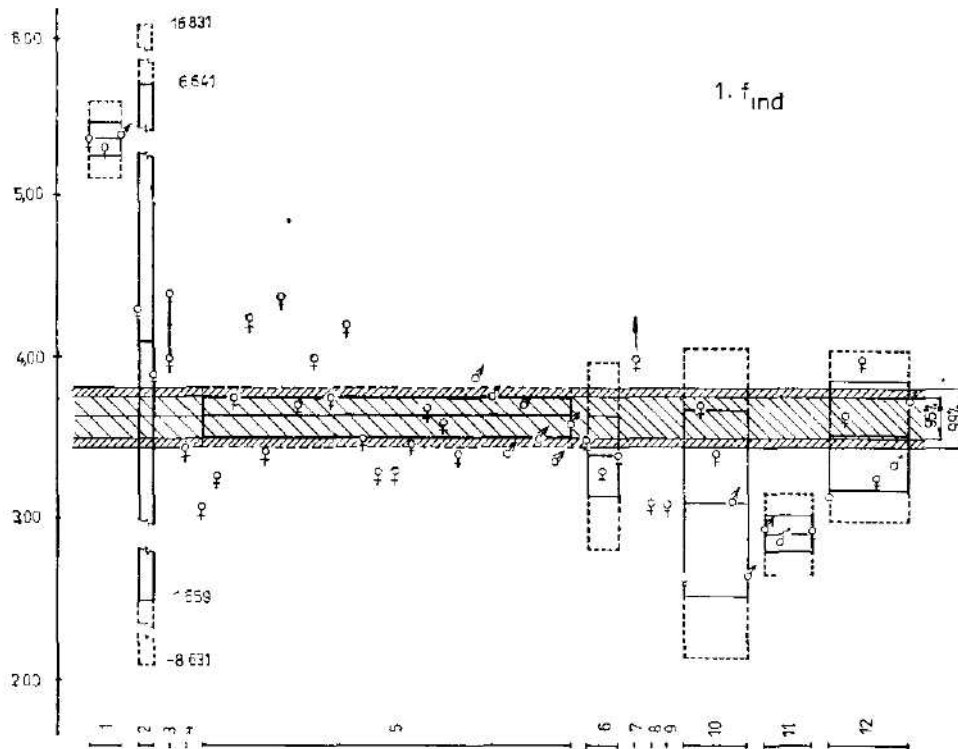


Abb. 3. Die Variabilität des Indexes $f_{sea_{int}}$ und $f_{sea_{ext}}$ (Siehe Abb. 1).

Ausser den Angaben, die die einzelnen Gesamtheiten charakterisieren sind in den Graphen auch die isolierten Punktwerte eingetragen. Die Diagramme sind durch den Tabellenteil ergänzt. Die graphische Abbildung der einzelnen Gesamtheiten auf der Basis der genannten Indexe sind in den Abb. 1, 2 und 3 veranschaulicht.

ZUSAMMENFASSUNG

Auf Grund der Bearbeitung von Literaturangaben und vorliegendem Material kommen wir zu folgenden Schlussfolgerungen:

1. Die Unterscheidungsmerkmale aller diskutierten Taxone knüpfen kontinuierlich einander zu oder sie überdecken sich.
2. Die Grenzen der einzelnen morphologischen Merkmale sind praktisch in der Variationsspanne der tschechoslowakischen Populationen.
3. Eine bestimmte Ausnahme bildet der Furkalindex bei dem Taxon „*troglophilus*“, der die höchsten festgestellten Werte aller anderen übertrifft. Gleichzeitig wurde aber bestätigt, dass der Furkalindex bei der ganzen Gruppe merklich variabel und für die Charakterisierung einer selbstständigen Art nicht genügend ist (eine Erklärung der längeren Furka bei dieser Form kann man in den ökologischen Verhältnissen der Lokalität sehen: es geht um ein Höhlensystem, wo die Raumverhältnisse nicht eingeschränkt sind, wie es dem in den Interstitialgewässer ist — siehe hoher). Dieser Umstand führte schon Kiefer (1937) dazu, dass er seine „Art“ für

Tab. 4. Kritische Werte für $\alpha = 0,01$ (resp. 0,05) und die Werte Konfidenzintervalle für gegebene α

| f_{ind} | Bratislava | Mladec | Popovo polje 1933 | Popovo polje 1972 | Bonn | Belgien | Britanmen |
|-----------------------------|----------------|----------------|-------------------|-------------------|----------------|----------------|----------------|
| n | 24 | 3 | 3 | 2 | 5 | 3 | 6 |
| \bar{x} | 3,638 | 3,400 | 5,347 | 4,100 | 3,108 | 2,920 | 3,528 |
| S_x | 0,067 | 0,058 | 0,024 | 0,200 | 0,209 | 0,025 | 0,133 |
| $t_{n-1, 0,05}$ | 2,069 | 4,303 | 4,303 | 12,706 | 2,776 | 4,303 | 2,571 |
| 95 % | 3,776 3,500 | 3,650 3,150 | 5,450 5,243 | 6,641 1,559 | 3,688 2,528 | 3,028 2,812 | 3,869 3,187 |
| $t_{n-1, 0,01}$ | 2,807 | 9,925 | 9,925 | 63,657 | 4,604 | 9,925 | 4,032 |
| 99 % | 3,826 3,450 | 3,976 2,824 | 5,585 5,108 | 16,831 -8,631 | 4,070 2,146 | 3,170 2,670 | 4,063 2,993 |
| ϕ_{4ind} | | | | | | | |
| n | 24 | 3 | 3 | 2 | 5 | 4 | 6 |
| \bar{x} | 2,225 | 2,143 | 2,627 | 2,200 | 1,938 | 1,750 | 1,975 |
| S_x | 0,030 | 0,003 | 0,042 | 0,200 | 0,093 | 0,031 | 0,094 |
| $t_{n-1, 0,05}$ | 2,069 | 4,303 | 4,303 | 12,706 | 2,776 | 3,183 | 2,571 |
| 95 % | 2,287 2,163 | 2,156 2,130 | 2,806 2,447 | 4,741 -0,314 | 2,195 1,681 | 1,850 1,650 | 2,218 1,732 |
| $t_{n-1, 0,01}$ | 2,807 | 9,925 | 9,925 | 63,651 | 4,604 | 5,841 | 4,032 |
| 99 % | 2,309 2,140 | 2,173 2,113 | 3,041 2,212 | 14,931 -10,531 | 2,364 1,512 | 1,933 1,567 | 2,356 1,594 |
| $f_{sea,int} : f_{sea,ext}$ | | | | | | | |
| n | 24 | 3 | 2 | 2 | ? | 3 | 6 |
| \bar{x} | 2,499 | 1,689 | 1,508 | 2,133 | ? | 2,232 | 1,873 |
| S_x | 0,071 | 0,014 | 0,025 | 0,133 | ? | 0,008 | 0,090 |
| $t_{n-1, 0,05}$ | 2,080 | 4,303 | 12,706 | 12,706 | ? | 4,303 | 2,571 |
| 95 % | 2,646 2,353 | 1,749 1,629 | 2,135 1,492 | 3,827 0,439 | ? ? | 2,266 2,198 | 2,105 1,641 |
| $t_{n-1, 0,01}$ | 2,807 | 9,925 | 53,657 | 63,657 | ? | 9,925 | 4,032 |
| 99 % | 2,699 2,300 | 1,828 1,550 | 3,394 0,222 | 10,621 -6,354 | ? ? | 2,311 2,153 | 2,237 1,509 |

eine Subspecies *Ac. venustus* hält: wir sind jedoch der Ansicht, dass es hier um eine bloße ökologische Form geht, ähnlich wie bei vielen anderen stygophilen Arten.

4. Aus den angeführten Tatsachen geht hervor, dass die diskutierten Taxone eine einzige plastische Art mit einer breiten morphologischen Variabilität darstellen.

5. Der Taxon, ursprünglich als *Ac. troglophilus* Kiefer, 1932 beschrieben, kann man als ökologische Form mit der Bezeichnung *Ac. venustus f. troglophilus* (Kiefer) ansehen.

6. Die Taxone *Acanthocyclops crinitus*, *Ac. stammeri*, *Ac. stammeri westfalicus* und *Ac. phreaticus* haben keine Begründung und in allen Fällen handelt es sich um Synonyma zu *Acanthocyclops venustus* (Normann et Scott).

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REVIEWS — RECENSE

Wolfgang Böhm (ed.): *Handbuch der Reptilien und Amphibien Europas* Volume I, *Echsen* I 520 pp., 91 figs. Akademische Verlagsgesellschaft, Wiesbaden, 1981. Price DM 216

Following the publication of the successful *Handbuch der Vogel Mitteleuropas* (U. Glutz von Blotzheim Editor) and the *Handbuch der Säugetiere Europas* (J. Niethammer and F. Krapp Editors) the Akademische Verlagsgesellschaft has continued its editorial activity by publishing the first volume of the planned *Handbuch der Reptilien und Amphibien Europas*. The significance of this book becomes clear if it is considered that apart from the popular publication *A Field Guide to the Reptiles and Amphibians of Britain and Europe* by E. N. Arnold and J. R. Burton (Collins, 1978) the scientific public does not have at its disposal any summarizing work on European amphibians and reptiles which would contain modern findings. The last book on this topic "*Herpetologia europaea*", by E. Schreiber, was published in 1912. Dr. Wolfgang Böhm, the editor of the present publication, invited a number of significant European herpetologists to collaborate. The first volume comprising the members of the families Gekkonidae, Agamidae, Chamaeleonidae, Anguillidae, Amphisbaenidae, Scincidae and partly also of the family Lacertidae has been elaborated by N. A. Ananjeva, A. Beutler, W. Bischoff, M. Cleylan, I. S. Darewskij, O. G. Dely, U. Gruber, C. J. J. Klaver, F. J. Obst, V. F. Orlova, J.-P. G. Orsini, F. Palacios, O. Rieppel, A. Salvador, N. N. Ščerbak and B. Schneider.

The brief introductory part written by the Editor contains a zoogeographical definition of Europe and also a presentation of the editorial aim as well as a key to the orders and suborders of the European reptiles. The keys to families, genera and species are given in the systematic part.

The chapters devoted to the individual species constitute the basis of the systematic part and are elaborated according to a uniform scheme. An introductory paragraph deals with a diagnosis of the species, further paragraph contains its description. The latter presents data concerning both the absolute size and body proportions, morphological and anatomical characters as well as data on blood proteins and carotenes. This reveals the gaps in our knowledge not only of the latter two characters but also of the osteology of European reptiles. However, a study of anatomical features may sometimes be a more important contribution to the elucidation of problems in systematics than a very detailed study of external features. It is to be considered that the external appearance of the animal often represents a result of adaptation, and may veil real phylogenetic and systematic relations.

The paragraph devoted to distribution is always accompanied by a sketch map. The part dealing with the variability of morphological characters, particularly sexual dimorphism, ontogenetic variability, seasonal variability, ecologically dependent variability and geographical variability is also important. In the latter paragraph a survey of subspecies may be found. In the part on ecology, a characterization of biotopes is given, and food requirements, mating and population dynamics are treated. The concluding paragraphs of the individual chapters devoted to the individual species contain information on the development of young ones and their behaviour. This paragraph also contains notes of day and seasonal activity, ethology of mating and voice. The bibliography is a significant supplement. References are given at the end of each chapter, which consider only the respective species; at the end of each volume are cited references containing data on several species.

With regard to this the whole book offers a good survey, and thus it is possible to find the required data very quickly. It should only be added that in the future it would be useful to omit in similar treatises the artificial boundary between the recent zoology and palaeozoology and to add a survey of the reptiles and amphibians living on the present-day territory of Europe in the geological past. This would help to provide a general idea not only on the present state of the European herpetofauna but also on its historical development.

A further four volumes are intended to be issued roughly at 18-month intervals and are to deal with the remaining representatives of the family Lacertidae, snakes and turtles, tailed amphibians and anurans. Not only will the envisaged work be a comprehensive survey of the European herpetofauna but also — judging from the choice of authors — it will be a truly European work. Without doubt, the whole of the total five volumes will become a much sought-after handbook.

Z. Roček

Gillott C.: *Entomology*. 729 pp., illust., Plenum Press, New York & London, 1980. Price \$ 49.50 (hardcover).

Gillott's text covers hexapod evolution and diversity, anatomy and physiology, reproduction and development, and basic ecology (jointly with essentials of applied entomology). The treatment is lucid, integrative, up-to-date, with an emphasis on principles and common mechanisms rather than on exceptions. Various easy to find omissions and simplifications are unavoidable owing to the generality of treatment, and it would be trifling to criticize them.

The section on diversity starts with a very interesting summary of hypotheses on arthropod and hexapod evolution; stress is laid on the origin of wings and metamorphosis, and the author tends to accept Manton's controversial Uniramian concept. The description of insect skeletal system (eidonomy) is, as in most of the recent textbooks, too short, but clear and instructive. The review of hexapod classification is modern but rather cursory, omitting many odd but cladogenetically critical taxa, and, in the unfortunate tradition of almost all textbooks of entomology, it is too sketchy as far as the diversity of primarily wingless groups is concerned: this is most notable in the case of Collembola whose classification as presented is really out-of-date. Chapters on anatomy and physiology as well as those on reproduction and development are generally very good, and in the manner established by Chapman the hexapod body is viewed as a system of systems; all the structural description are fully integrated with explanations of functions, with an emphasis on the latter. Strangely, some topics are not covered: e. g. there is no comprehensive treatment of sound- and light-producing organs, of intraspecific communication, and the reader will look for vain for some of the now familiar terms such as kairomones and allomones.

The inclusion and exclusion of matters in chapters on ecology always is the most problematic side of integrated entomology textbooks, and it is the easiest target of criticism. I, personally, miss here a review of hexapod "biology" and treatment of insect parasite - warm-blooded host relationships. The annotated lists of basic literature appended to each chapter are up-to-date, not leaving out anything important of what has been published in the U. S. A. and U. K.; however, many basic sources published elsewhere, and almost all written in languages other than English are ignored, how can one assess the phylogeny of insects without Hennig, their eidonomy without *Traité de Zoologie*, and systematics of Strepsiptera without Kinzelbach?

With all the above exceptions, Gillott's textbook is very good and on the whole well balanced; good as a basis for both introductory and advanced courses of entomology and systematic zoology, and good as a source of modern knowledge for researchers not specializing in the particular field concerned. The words of criticism only emphasize the near-impossibility to cover the vast subject of entomology in one single-author volume to the satisfaction of everyone.

P. Štys

Endler J. A. *Geographic Variation, Speciation, and Clines* Monographs in Population Biology, 10. 246 pp., illust. Princeton University Press, Princeton, 1977. Prices: cloth \$ 29.00, paper \$ 12.50.

The major theme of Endler's monograph is the causality of geographic variation and sharp differentiation found in continuously distributed populations of continental species, and evolved despite the absence of barriers to gene flow and in only gradually changing environment. The author poses and affirmatively answers three major questions: May sharp geographic differentiation evolve across spatially and genetically continuous population? Can steep clines give rise to hybrid zones and assortative mating? Is parapatric speciation possible, and, if so, by what mechanism does it operate?

The problem is approached through an excellent summarization of scattered data from field observations, experiments (both largely concerning animals), extensive original model simulations and theoretical integration, mainly from the viewpoint of population genetics. The relationships among gene flow, dispersal, and migration are scrutinized, and properties of clines and hybrid zones subjected to detailed investigation. Professor Endler convincingly demonstrates that steepening of clines

resulting in the formation of hybrid zones is a widespread phenomenon, and that gene flow is not always a strong dedifferentiating factor. The conditions necessary for parapatric speciation are specified, and the resulting geographic patterns of species, subspecies and natural clines are reviewed.

Although the book content is less inclusive and more specialized than its title seems to suggest, not only specialists in population and evolutionary biology but also all evolutionarily minded biogeographers and taxonomists would benefit from reading it, partly because of a deep coverage of an important though little explored evolutionary topic but mainly owing to the author's critical, concise and clear re-examination of basic concepts and terms concerning speciation and phenomena of population differentiation. The book is accompanied by a glossary and an extensive list of references forming a practically complete bibliography of clines and related subjects.

P. Stys

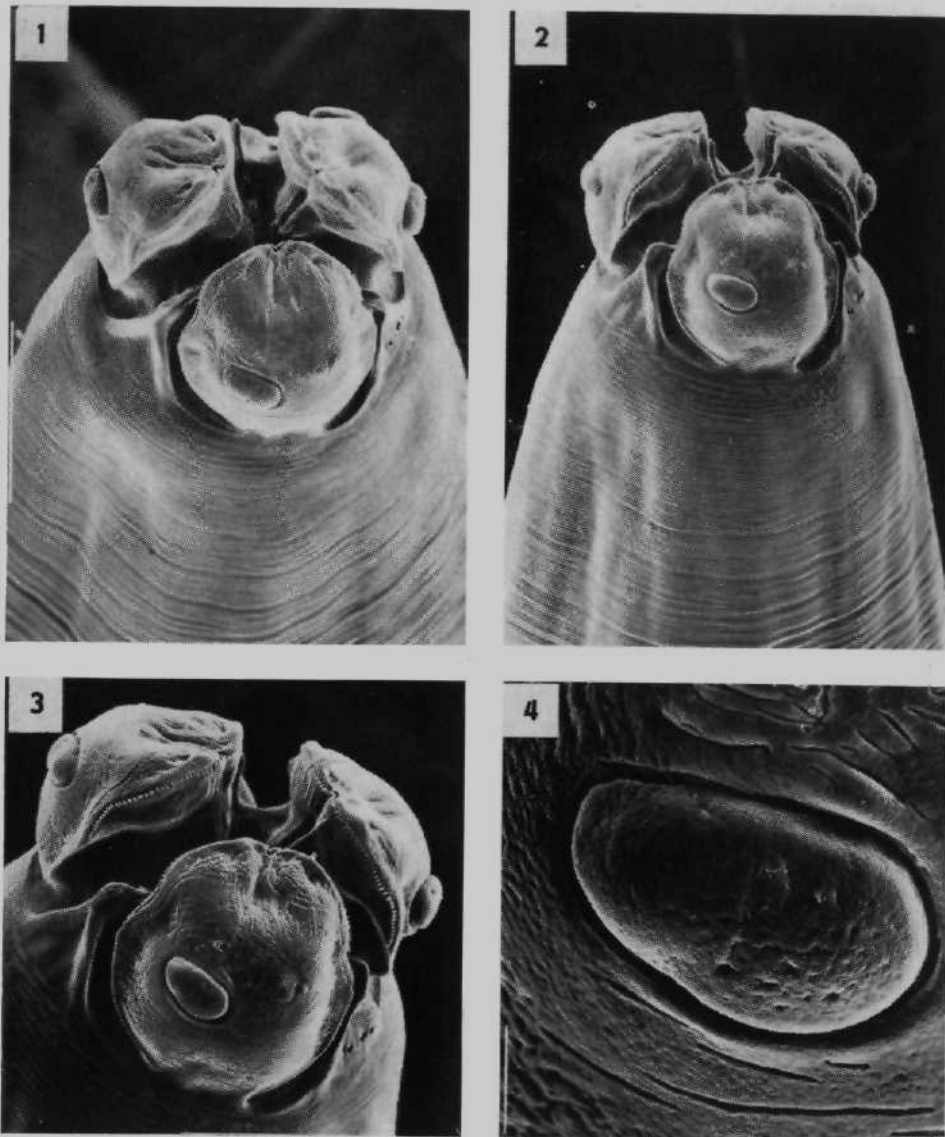


Plate I

Figs. 1-4. Scanning electron micrographs of *Porrocaecum ensicaudatum*.

Fig. 1. Head end of female - apical view (white scale = 0.1 mm; x 300); Fig. 2. Head end of male - lateral view (white scale = 0.1 mm; x 260); Fig. 3. Head end female - lateral view (white scale = 0.1 mm; x 360); Fig. 4. Elliptical papilla on lateral lip - detail (white scale = 0.01 mm; x 1800).

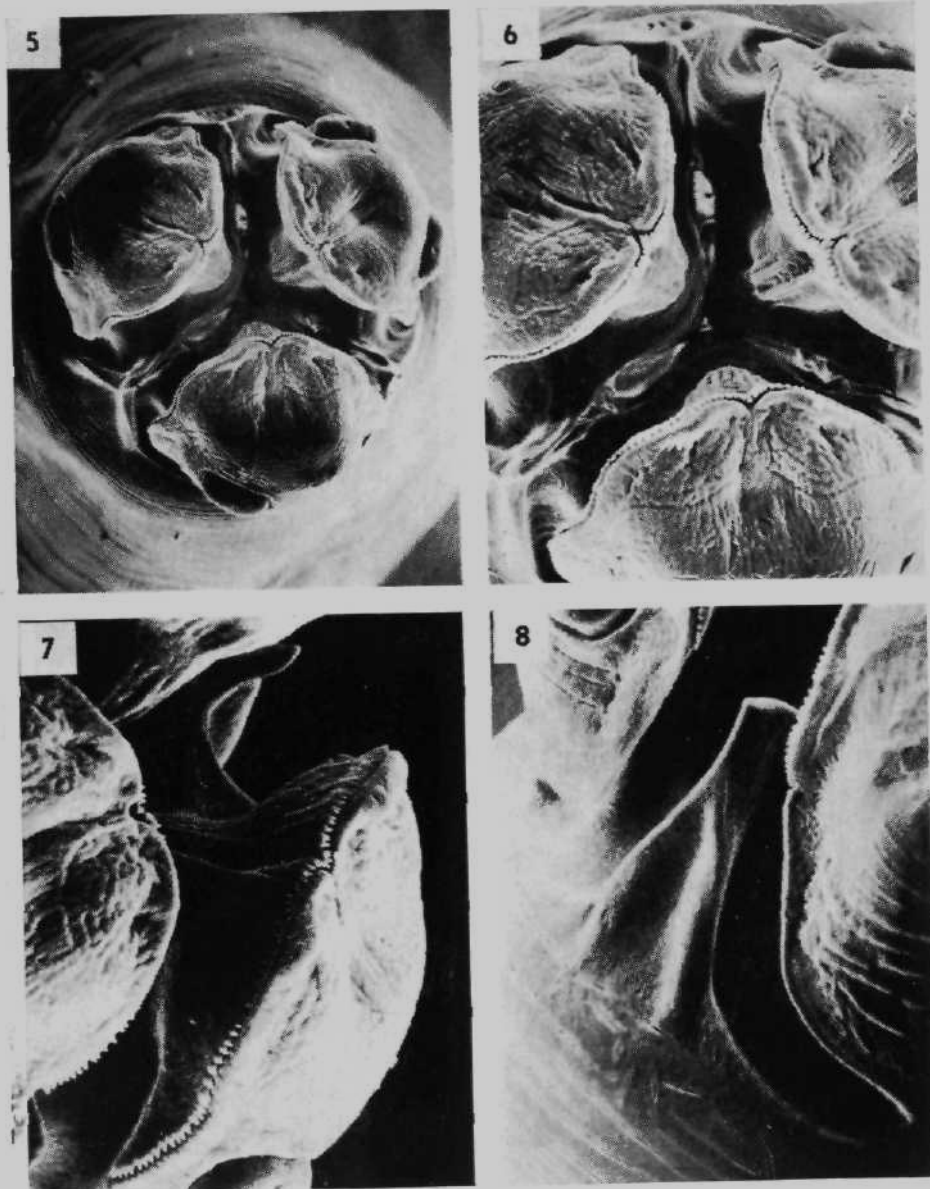


Plate II

Figs. 5—8. Scanning electron micrographs of *Porrocaecum ensicaudatum*.
Fig. 5. Head end of female — apical view (white scale = 0.1 mm; x 360); Fig. 6.
Head end (mouth opening) — apical view (white scale = 0.01 mm; x 600); Fig. 7.
Armament of lateral lip — detail (x 1000); Fig. 8. Ventral interlabium — detail
(x 1000).

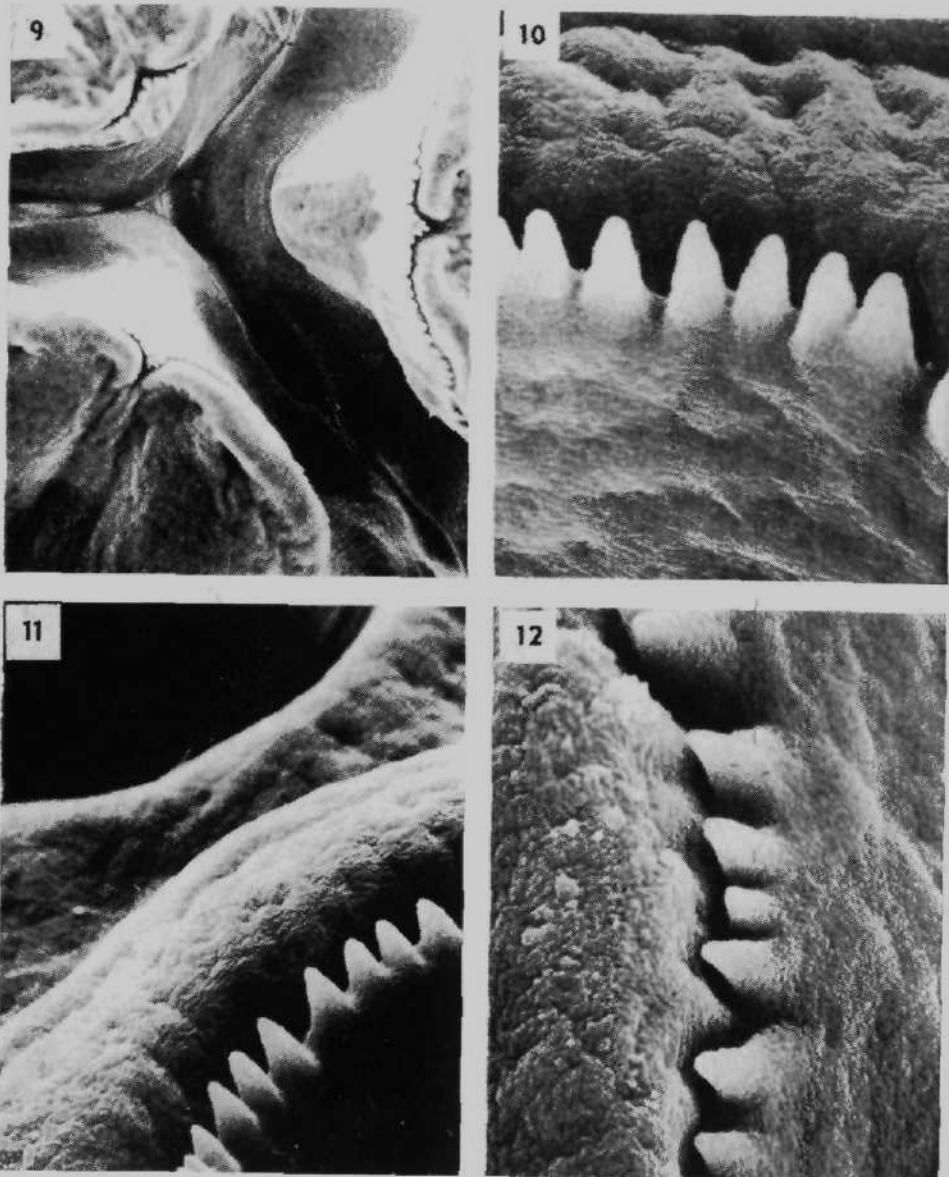


Plate III

Figs. 9–12. Scanning electron micrographs of *Porrocaecum ensicaudatum*.
Fig. 9. Inner areas of lips and mouth cavity — detail (x 2000); Fig. 10. Teeth in upper part of ridge — detail (x 10 000); Fig. 11. Teeth in lateral part of ridge — detail (x 5000); Fig. 12. Teeth in upper part of ridge — detail (x 10 000).

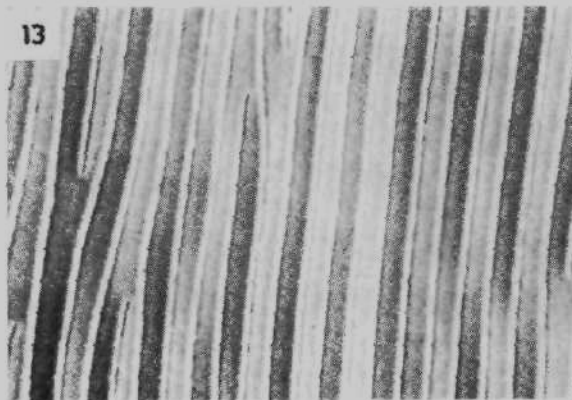
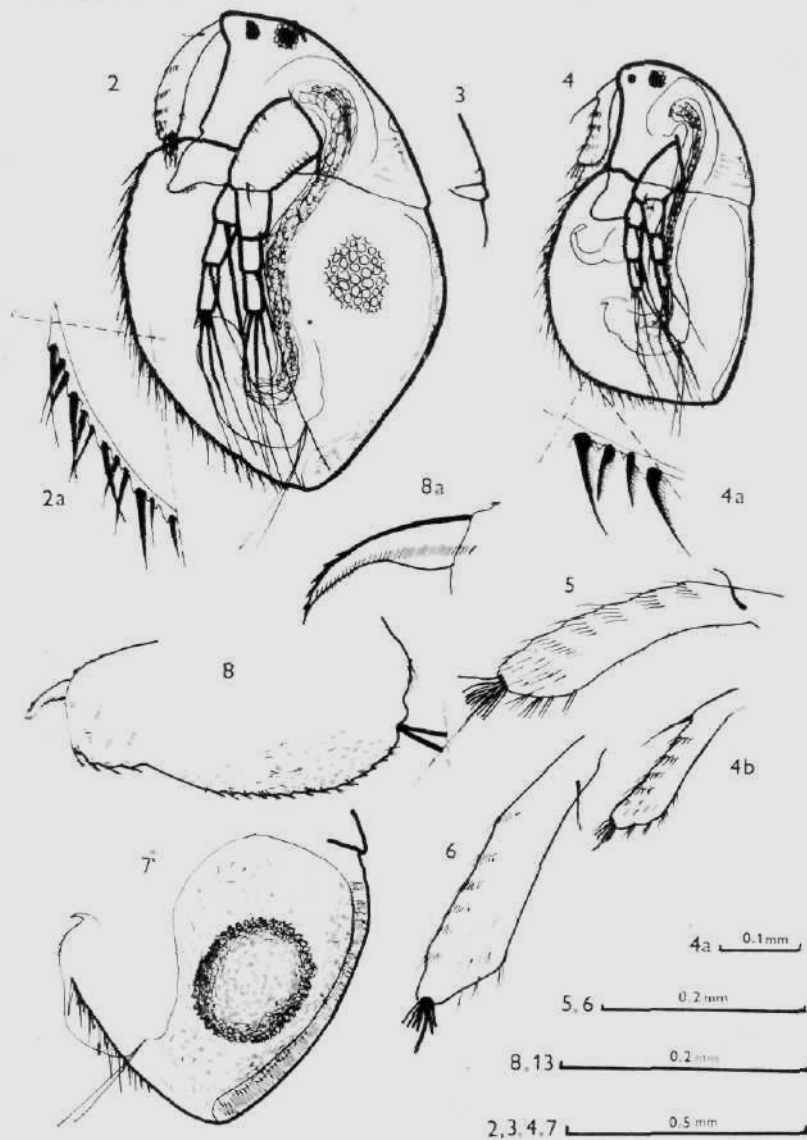
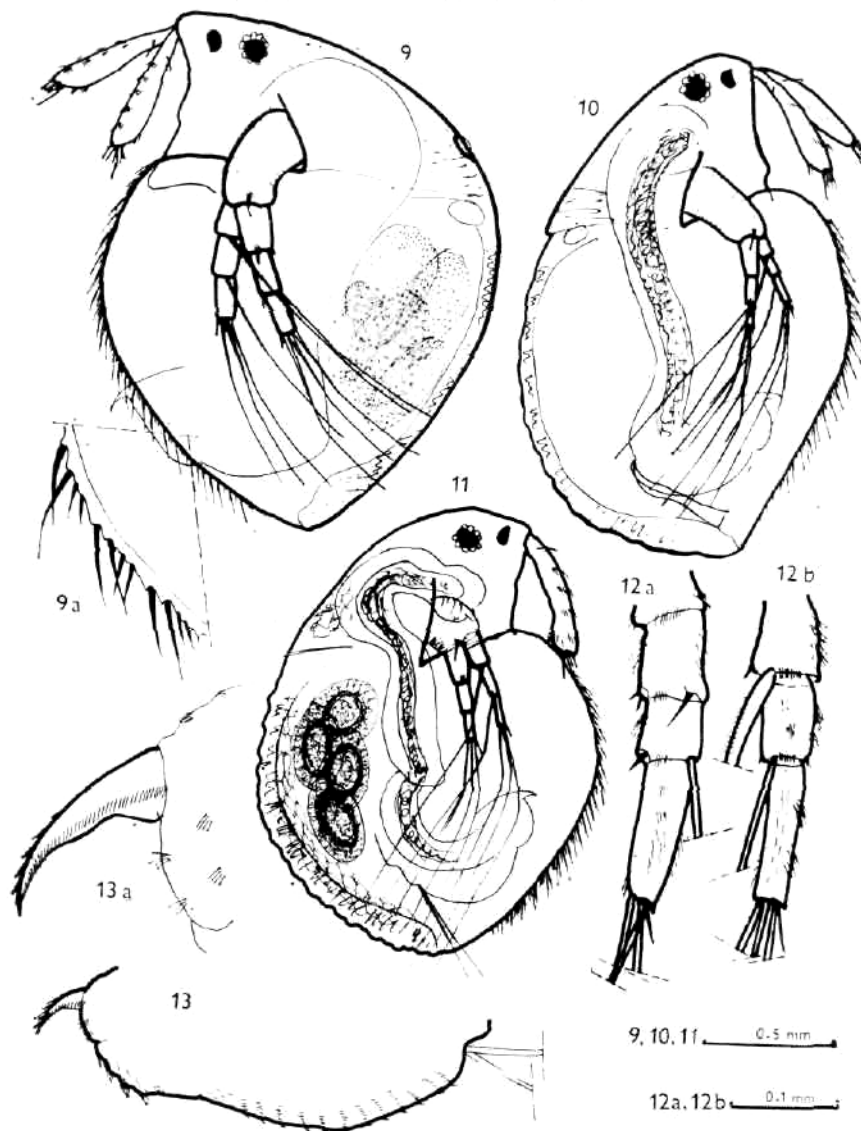


Plate IV

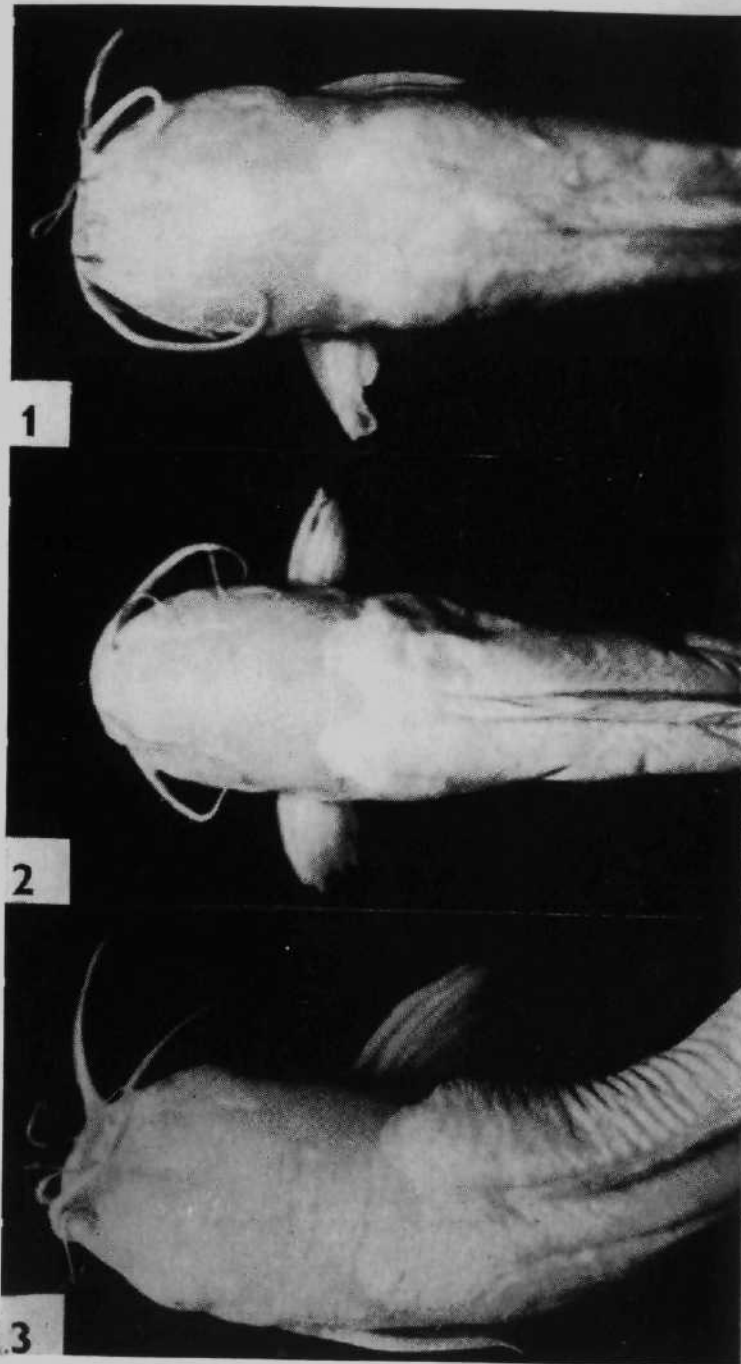
Figs. 13—15. Scanning electron micrographs of *Porrocaecum ensicaudatum*.
Fig. 13. Surface structure of cuticle in cervical part of body (x 1000); Fig. 14. Surface structure of cuticle in cervical part of body — detail (x 3000); Fig. 15. Vulva and adjacent region — ventral view (x 1000).



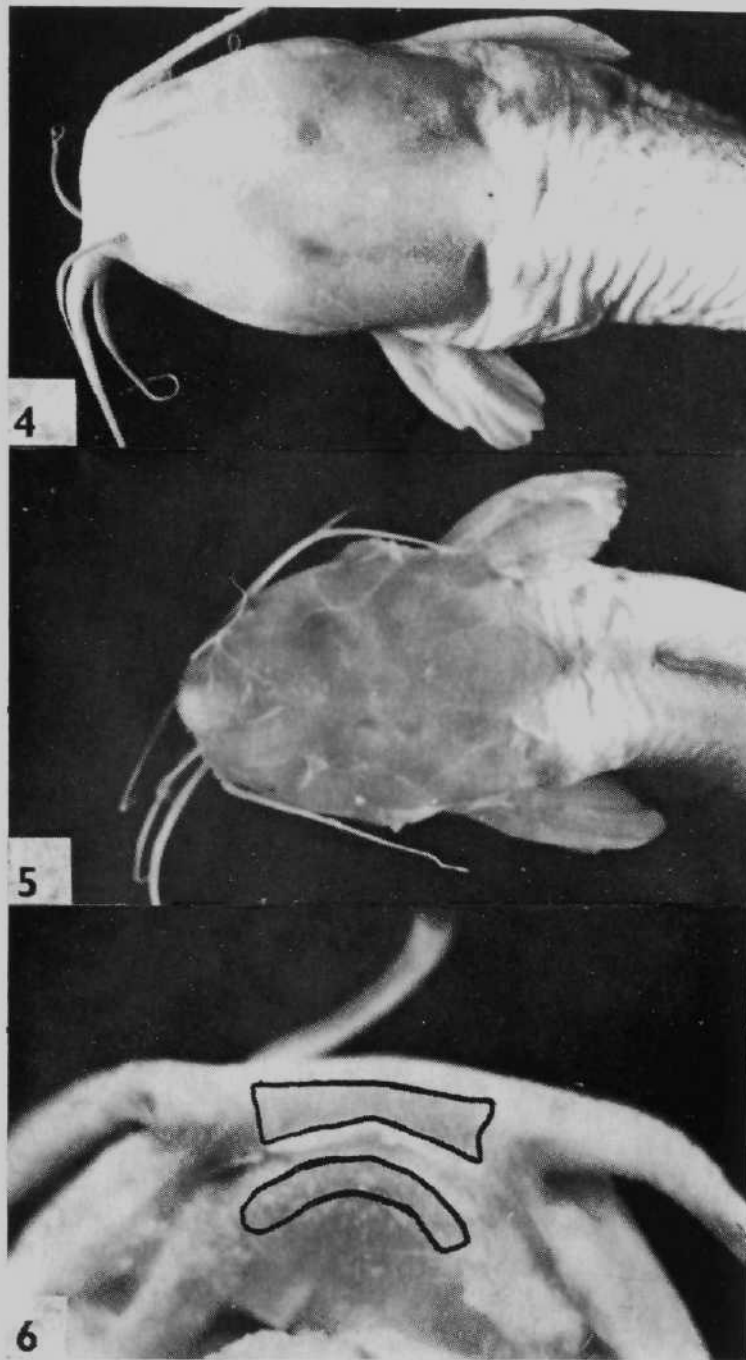
Figs. 2—8. *Macrothrix hirsuticornis*. 2 — female (tarn Velické pleso), 2a — marginal setae of valves; 3 — double fold of female (tarn Velické pleso); — male (tarn Velické pleso), 4a — marginal setae of valves, 4b — antennula; 5 — antennula of female (tarn Velické pleso); 6 — antennula of female (Jenkovce); 7 — ephippium (Játov); 8 — postabdomen of female (tarn Velické pleso), 8a — terminal claw.



Figs. 9–13. *Macrothrix hirsuticornis*. 9 – female (Jatov), 9a – marginal setae; 10 – female (Jatov); 11 – female (Jenkovce); 12a, 12b – hooked spine on each segment on female antennae (tarn Velické pleso); 13 – postabdomen of female (Jatov), 13a – terminal claw.



Figs. 1-3. The occipital process of *Clarias batrachus*. 1-153 mm TL, 2-193 mm TL, 3-300 mm TL.



Figs. 4—5. The occipital process of *Clarias batrachus*. 4—300.5 mm TL, 5—495 mm TL. Fig. 6 — The intermaxillary and vomerine band of teeth of *Clarias batrachus* 153 mm TL; the intermaxillary band (above) is in the centre as broad as the vomerine band (below).

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