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LIGHT PERCEPTION IN THE WHITE-TOOTHED SHREW (CROCIDURA SUAVEOLENS (MAMMALIA, INSECTIVORA)

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Abstract. The sensitivity to light stimuli of White-Toothed Shrews was studied. Two adult animals were trained under laboratory conditions in a dimly lighted room in a special apparatus with Y-shaped inner corridor to chose one of two possible ways leading to a food reward. One or the other branch of the "Y" was randomly lighted and only the lighted corridor opened to the reward. Thus the ability to immediately distinguish light from dark was tested. This experiment has shown the animal's ability to choose the correct way (the lighted one) by associating food with light stimulation. At the end of the experiment choice success reached about 90%. These results are discussed with respect to the low level of visual acuity in shrews.

Although some studies of sight in shrews have been published, the ability to perceive light stimuli has been evaluated only theoretically, on the basis of morphological or histological studies of the eyes (Schwartz. 1935; Grün and Schwammberger, 1980; Braniš. 1978. 1981. 1985a and 1985b). No discernible change in the behaviour of animals was recorded as a response to moving prey or moving objects in laboratory experiments (Rood, 1958; Gould, et al., 1964; Vlasák. 1970; Braniš, 1981). The only evidence of light perception in shrews was found in circadian and circanual rhythms of activity which, according to many authors, are mediated by light (Crowcroft, 1964; Gebczynski, 1965; Buchalczyk, 1972; Siegmund and Sigmund. 1983).

The controversy between morphological and behavioral studies led me to ascertain whether a shrew species can distinguish dark from light and immediately adapt its movement and behavior to these conditions.

A preliminary report of this experiment was presented as a poster on the Third International Theriological Congress in Helsinki, Finland, 1982. I decided to publish the full version because aside from the Common mole (Johannesson-Gross, 1983) this aspect has been studied in no insectivore species. In addition, the White-Toothed Shrew is a species in which the eye morphology (Braniš, 1981; 1985a; Sigmund et al., 1985) as well as circadian rhythms of activity (Vogel et al., 1981; Siegmund and Sigmund, 1983) have been already studied in detail.

MATERIAL AND METHODS

Two live-trapped adult animals of the White-Toothed Shrew *Crocidura suaveolens* (one male and one female) were housed individually under laboratory conditions in clear glass cages on peat bedding and fed once daily with beef and water with essential vitamins "ad libitum". No other natural food was added.

Both animals were for about two months separately trained in a special dark-coloured terrarium made of resin varnish covered cardboard (*Figs 1, 2*) where their movement was restricted by a system of one-way doors (so that the shrews could run throughout the apparatus in one direction only) to choose one of two possible ways — branches of the Y-shaped corridor — leading to the reward box.

Y branches were alternately lighted from two round windows 3 cm in diameter, the center of which was 4 cm above a small one-way door leading to the reward box. Only the lighted branch of the "Y" was opened at its end to the corresponding reward box. The animals were rewarded by a piece of cut mealworm. To avoid possible influence of olfactory stimulation on the animal's choice, the reward was not released from forceps until the animal had entered the reward chamber of the chosen corridor. After having left the reward box by another one-way door, the shrew entered the side corridor from which it could enter the beginning of the Y-corridor from which it could enter the beginning of the Y-corridor again and start the next trial.

An attempt to run towards the unlighted corridor terminated by trying to open the "false" door was classified as a mistake (pressure of the animal's snout against the closed door was registered electronically). The correct choice was reinforced with the reward and evaluated as a successful one.

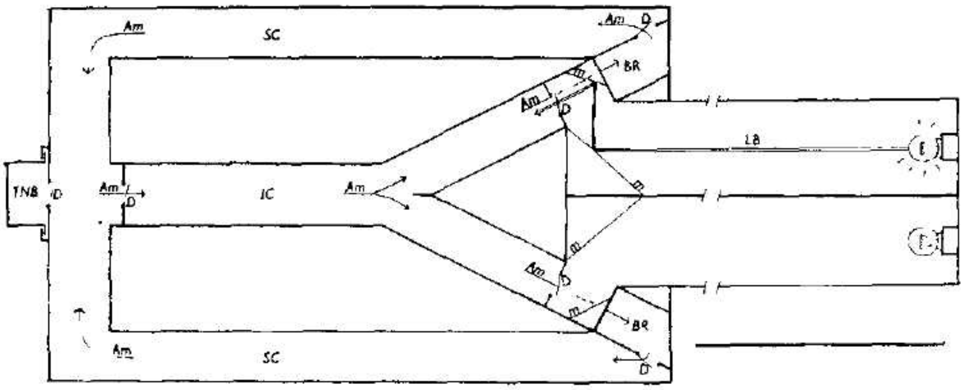


Fig. 3. Scheme of the experimental apparatus. IC — inner corridor, SC — side corridor, BR — box of reward, m — mirror, Am — possibilities of animal's movement, D — one-way door, LB — light beam, TNB — transportable nest box. Bar — 0.2 m.

Tests were performed once or twice a day. The number of trials (entering the inner corridor, passing into the reward box and leaving it out was scored as one trial) in one test varied between ten and twenty. Repetitions were run until the animal was fed or judged tired.

Mistakes and successful choices of one test were compared and the number of successful choices was expressed as a percent of the total trials.

The experiments were carried out in a dimly lighted laboratory (2 to 4 Lux). The lights which the animals were trained to run to reached an intensity of approximately 100 Lux at the beginning of the Y shaped corridor and 200 Lux at the bifurcation. In front of the round window (at the end of each branch) it was about 450 Lux. No difference in temperature between the lighted and unlighted ways was found since the light beam was aimed into the glazed windows from a 30 cm tubular extension by means of mirrors. The apparatus is diagrammed on Fig. 3.

RESULTS

Alltogether 1086 trials in 88 tests with the female and 1078 trials in 72 tests with the male were performed. The experiments with both animals were divided into three parts.

1. (orientation) On the beginning of each experiment 626 trials (311 — male, 315 — female) in 25 tests were performed to acquiant the shrews with the apparatus. The lights were switched off and the animals were positively rewarded immediately after entering the reward box.

2. (training) 659 following trials (304 — male, 355 — female) were aimed at training the subjects to take the lighted way to reach a piece of mealworm. In this part the lights were changed according to the experimentor to prevent the animal's preference to one of two possible ways of the "Y".

3. (random light) The lights in corridors were changed on a random schedule in order to exclude any possible regular pattern in the animal's choice. In 671 successive trials (257 — male, 414 — female) both shrews chose the correct (lighted) corridor to the reward very successfully. As is shown in Figs 4 and 5 the mean percentage of the choice was 82.9% in the male and 82.7% in the female in the third part of the experiment. However, regression analysis revealed a slowly increasing trend of successful choices when the light was changed randomly ($y = 0.83x + 39.3$ for the male and $y = 0.44x + 50.83$ for the female).

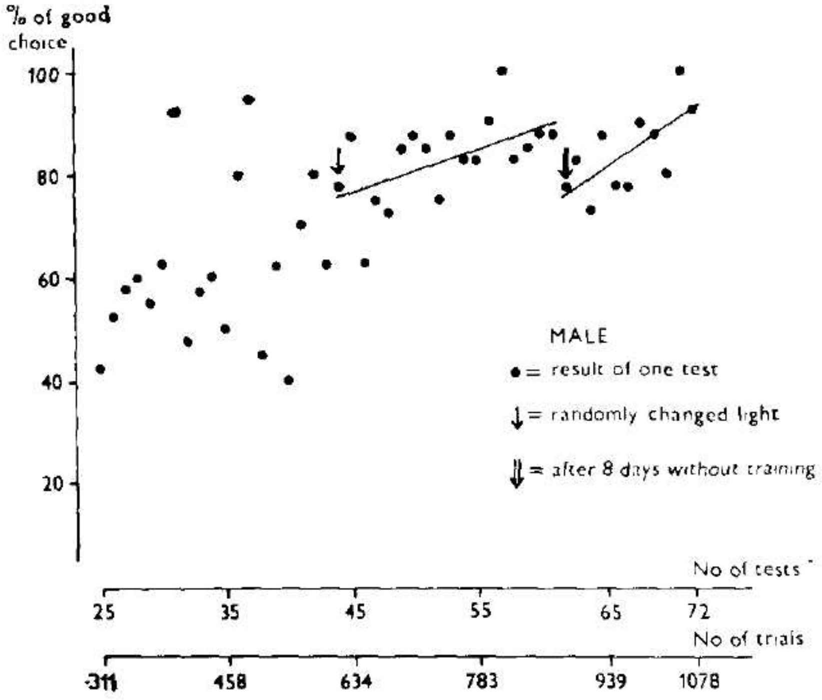
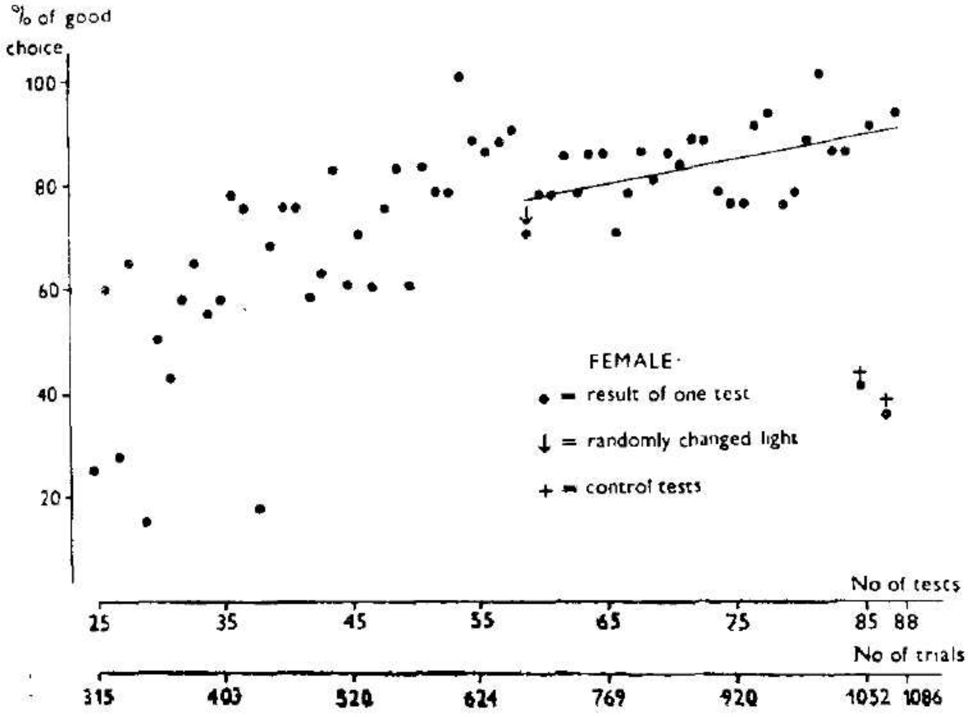


Fig. 4. Graph demonstrating the trend of successful choice in the male.

This situation rapidly changed during two closing control tests with the female. At the end of the experiment two abnormal tests were introduced. In these the animal was let into the apparatus but light stimulation was not used. Rather both doors leading to the reward box were randomly closed and opened. Choice success was very low, reaching 40% and 35% in these control tests. This degeneration of correct choice without light contrasts sharply with the success rates (82%, 87%, and 90%, see Fig. 5) of the usual light stimulus tests alternating with the abnormal ones. The animal seemed very disturbed; scanned the Y-corridor and repeatedly assumed an upright posture, presumably searching for the source of light. Two control tests are indicated by cross on Fig. 5).

Eight days without any training had, however, only a slight influence on the shrew's (male) skill to distinguish the lighted way from the unlighted one, as it was in the case of the experiment with the male After this period without apparatus contact the male shrew was let into the Y-maze but its choice success fell only from 87% to 77% but rapidly recovered. In eleven successive tests (206 trials) it finally reached 100% and 92% correct choices, the regression line beeing steeper (y = = 1.64x − 25.5) and the mean higher (84.1%) than within the third part of the experiment (see Fig. 4).



.**Fig5.** Graph demonstrating the trend of successful choice in the female.

DISCUSSION

It is well known that the activity rhythm in shrews, as in many other mammalian species, is closely correlated with light conditions (Crowcroft, 1964; Buchalczyk, 1972; Ingles, 1960; Vogel et al., 1981; Siegmund and Sigmund, 1983). Retinal rods and cones, as well as other structures of the eye are sufficiently developed to enable perception of several components of light stimuli (changes in intensity or spectral composition during 24-hour and annual cycles). However, in some simple behavioral experiments by Rood(1958), Gould et al., (1964), Vlasák (1970) and Braniš (1981) aimed at studying the capability to react to moving prey (cricket mealworm) or objects (pencil, sheet of white paper etc.) no positive reactions were observed. I was unable to stimulate the animal optically, even with a camera flash (National PE-2850, electronic flash).

The present behavioral study indicates that shrews show some behavioral response when tested by a light-based discrimination conditioning experiment. Similar results for the Common Mole were presented by Lund and Lund (1966) and by Johannesson-Gross (1983 and 1984). In the latter work the author gives detailed learning curves which are very similar to those given for the White-Toothed Shrew in the present study. However, the length of the shrew's learning period seems to be slightly longer than the mole's one. That the learning period is relatively long in shrews has been already reported for another soricid species by **Sedláček** (1986) who studied olfactory thresholds in the Common Shrew (*Sorex araneus*) by means of discrimination conditioning.

The ability of the male shrew to remember causal connections (ascertained during control tests within the experiment) can be compared with an earlier study by **Johannesson-Gross** and **Gross** (1982). In it five Common Moles were tested in an Y-shaped glass tube to discriminate left from right. The skill of tested moles depressed after 41 days without training to about 75% of correct runs and then gradually improved, quickly reaching 90–100%, similar to the success rate of the White-Toothed Shrew male during this investigation.

When the light stimulation was switched off (as in the control case with the female) the animal presumably looses the leading clue and is unable to adapt its behavior to this "nonsense" conditioning.

The controversy between results of light-dark discrimination testing and results of experiments using moving targets (c.f. with **Rood**, 1958; **Vlasák**, 1970; **Braniš**, 1981) could be well explained in terms of functional morphology. There is now no doubt that shrew eyes contain some well developed structures, such as rods and cones, however, the eye-ball is very small, reaching only about 1 mm to 1.5 mm in diameter (**Schwartz**, 1935; **Braniš**, 1981). There is neither fovea nor area centralis and the acomodative apparatus is very simple, sometimes described as reptile-like (**Duke-Elder**, 1958; **Braniš**, 1986). These facts thus presumably restrict visual function of the shrew's eye to a great extent. According to many authors (**Rochon-Duvigneaud**, 1943; **Duke-Elder**, 1958; **Braniš**, 1981 and 1986) shrews are generally considered microopthalmics. In view of this we may expect that shrews discriminate between light and dark and even between colours, but hardly posses the high visual acuity which is usually called contour vision. This limitation is not restricted to shrews. Suthers (1970) similarly suggests that the "little" eyes of some Microchiroptera may be limited to providing information concerning only the presence or absence of light.

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

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BIRD AND MAMMAL COMMUNITIES OF THE SUBARCTIC PEATBOG IN THE KRKONOŠE MTS. (CZECHOSLOVAKIA)

Dedicated to Dr. Karel Hudec, CSc. on the occasion of his 60th birthday

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Abstract. Qualitative, quantitative and production characteristics of bird and mammal communities in the subarctic peatbog and its close vicinity (1.410–1,440 m a. s. l., four different plant communities distinguished) were studied, using mapping (birds) and quadrate methods (mammals), in 1983–1985.

Altogether twelve bird species with the density of 6.7–9.8 pairs . 10 ha^{-1} bred in the study area (the most abundant *Anthus pratensis*, *Prunella modularis*, *Carduelis flammea*, *Alauda arvensis*, *Luscinia s. svecica*). Coenological characteristics of the bird community: BSD = 2.68, E = 0.75, c = 0.20. Correlations were ascertained between density, production, bird species diversity and dominance concentration, and foliage height diversity of searched plant communities. Almost geometrical course of the dominance-diversity curve indicates simple community influenced by environmental severity (simple vegetation structure, food limitation, thermoregulation demands, etc.).

Only three mammal species with the density of 4.0–7.1 $ind.ha^{-1}$ were considered to reproduce in the subarctic peatbog itself (the most abundant *Microtus agrestis*, further *Sorex minutus* and *Sorex araneus*).

Total biomass resp. production of birds and mammals in the subarctic peatbog itself reached 166 $g.ha^{-1}$ resp. 1.655 $kJ.ha^{-1}.year^{-1}$ on average and out of it about 65% were formed by mammals.

INTRODUCTION

Raised subarctic peatbogs in the Krkonoše National Park, NE Bohemia, rank, thanks to their unique character, among the very valuable but at the same time much endangered ecosystems not only in Czechoslovakia but also in Central Europe. Owing to their uniqueness, the peatbogs have drawn attention of many naturalists since the very beginning of this century. Due to this fact, the peatbogs have been studied quite intensively from many points — geomorphological, geological, hydrological, climatical and geobotanical (Rudolph & Firbas 1926, Rudolph et al. 1927, Jeník 1961, Mejstřík & Straka 1964, Hadač & Váňa 1968, Očadlík & Fuksa 1968, Tolpa 1985 and others). However, knowledge of the zoology of raised peatbogs is rather limited for species lists of some groups of evertebrates (Obenberger 1952, Hůrka 1958, Doskočil 1973, Horník 1976 and others) and qualitative evaluation of vertebrate fauna (Pax 1925, Anděra et al. 1974, Miles 1986) with minimum of quantitative data.

The submitted paper aims at fulfilling this gap and deals with qualitative, quantitative and production characteristics of two most important groups of vertebrates (birds, mammals) in the mentioned ecosystem (the remaining classes of vertebrates are represented only by two species, *Lacerta vivipara* and *Vipera berus*). Together with the conclusions of research of an epigeic component of evertebrates (in progress) and linking up to still unpublished results of research of primary production (Academy of Agriculture Wrocław, Poland) we will obtain very valuable characteristics of this unique ecosystem in Central Europe.

STUDY AREA

All the studies have been carried out in a ridge of the eastern part of the Krkonoše Mts. (max. 1,602 m a. s. l.) in the area of the Úpa and Bílé Labe river sources. The study area is located in the altitude of 1.410–1.440 m a. s. l. and comprises 71.4 ha. It is bordered by the edge of Obří důl valley in the east, frontier with Poland in the north, touristic path (Polish frontier — Luční bouda challet) in the west, upper stream of the Bílé Labe river and a contour line of 1,440 m a. s. l. in the south-west and the south. The area mentioned includes subarctic peatbog (Úpská rašelina) itself and its close vicinity.

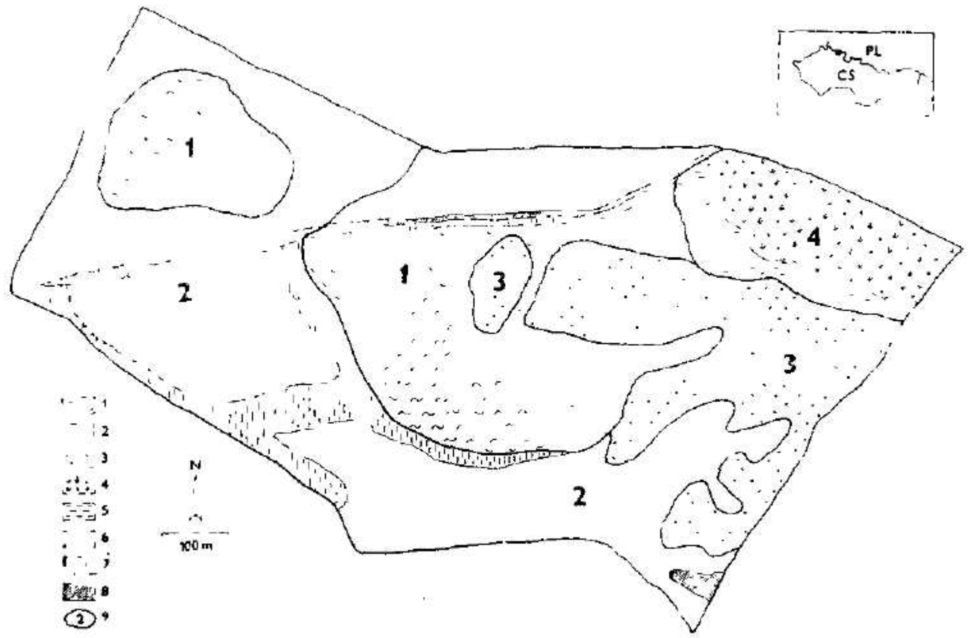


Fig. 1. Geobotanical characteristics (alliences) of the study area, 71.4 ha (Štursa in litt.)
1: Rhynchosporion albae × Oxycocco-Empetrion hermaphroditi (abbr. in text: R. a. × O.-E. h.), 2: Nardo-Caricion rigidae (N.-C. r.), 3: Pinion mughi (P. m.), 4: Calamagrostion villosae × Pinion mughi (C. v. × P. m.), 5: Caricion fuscae × Rhynchosporion albae (C. f. × × R. a.), 6: Cardamino-Montion, 7: Caricion fuscae, 8: Poo (chaixii)-Deschampsion caespitosae, 9: plant communities under study (1–4: see Material and Methods).

Biotitic granite forms a base rock of Úpská rašelina peatbog. It is covered with a layer of peat with an average thickness of 0.5 m (max. 1.3 m): chemical characteristics: humidity 87.1–89.5%, pH = 3.9 (Očadlík & Fuksa 1968). The peatbog surface is rather broken, modelled mainly by frost and water erosion.

Vegetation cover is formed by three layers: moss, herb and shrub ones (here only *Pinus mugo*, *Sorbus aucuparia*, *Picea abies*, *Salix silesiaca*). From a geobotanical point of view (Figs 1, 6–9) the subarctic peatbog itself is covered with a mosaic of alliances of ***Rhynchosporion albae*** × ***Oxycocco-Empetrion hermaphroditi*** (discontinuously scattered stands of *Pinus mugo*, humid substratum with dominant stands of *Trichophorum caespitosum*, *Eriophorum vaginatum*, *Carex limosa*, *Polytrichum strictum*, *Sphagnum* sp., representatives of family Vacciniaceae; numerous pools gradually drying out in consequence with the top of vegetation period). In the direction to less humid, even dry areas, the peatbog is surrounded by the alliances of *Nardo-Caricion rigidae* (dry meadows with dominant stands of *Nardus stricta*, *Carex rigida*, *Avenella flexuosa*) and *Pinion mughi* (more or less continuous stands of *Pinus mugo* with *Avenella flexuosa*, *Calamagrostis villosa*, *Vaccinium myrtilus* in herb layer). Remaining communities are of no importance because of their small size: *Caricion fuscae* (narrow edges of the peatbog itself and sources of the Bílé Labe river), *Poo(chaixii)-Deschampsion caespitosae* (mainly close vicinity of a touristic path), *Cardamino-Montion* (the area around the Úpa river at the edge of Obří důl valley), *Calamagrostion villosae* (north-east edge of the study area) (Hadač & Štursa 1983, Štursa in verb.).

As for the climate, the Úpská rašelina peatbog belongs to a cold mountaneous area with an average annual temperature of 1.5 °C (during vegetation period of 4.9 °C), an average annual precipitation of 1.500 mm, an average of 187 days with the presence of snow cover (the end of September up to the middle of May) (Očadlík & Fuksa 1968).

MATERIAL AND METHODS

Vegetation

Both the qualitative and quantitative comparison of avifauna in single vegetation communities required mainly to find out a vertical structure of these communities. A modified method of Emlen (1967) was used to state the vegetation cover. Two transects were drawn in each community and in every three meters the presence or absence of herb and shrub layers were studied (totally 150—250 points according to the size of the study area). Then the cover of each layer was calculated as a rate of a number of points with its presence and of a total number of studied points.

Foliage height diversity FHD was stated on the base of cover of both the layers (in case of herb layer, important for ground-nesting birds, only the cover outside the stands of *Pinus mugo* was considered) with the help of index of species diversity (Shannon & Weaver 1949, Cyr 1977): $FHD = -\Sigma p_i \log_2 p_i$, where $p_i = cc_i \, . \, k^{-1} \, . \, 10^{-2}$, cc_i — *cover of relevant layer* i, k — number of layers (here two).

Four plant communities were distinguished: (1) *Rhynchosporion albae* × *Oxycocco-Empetrion hermaphroditi* (later only R. a. × O.-E. h., total surface area of 22.8 ha, cover of shrub layer 48.5%, cover of herb layer 45.9%), (2) *Nardo-Caricion rigidae* (N.-C. r., 29.7 ha, 14.5%, 85.5%), (3) *Pinion mughi* (P. m., 12.2 ha, 76,7%, 23.3%), (4) *Calamagrostion villosae* × *Pinion mughi* and *Caricion fuscae* × *Rhynchosporion albae* (C. v. × P. m. — C. f. × R. a., 6.7 ha, 47.3%, 51.6%). Remaining communities in small areas were, due to their structure (though we are quite aware of a certain geobotanical inaccuracy which, however, does not influence the studied relations) ranked among *Nardo-Caricion rigidae* alliance.

Birds

Combined mapping method (Šťastný 1974, Janda & Řepa 1986, Tomialojc 1980) and the consecutive flush (Wiens 1969, Verner 1985) were used to study a quantitative composition *of birds in order to obtain maximally objective results.*

In the breeding period of 1983—1985 altogether 26 main controls in morning hours were carried out (4.00—9.00 CET; 1983: 10 controls from 18 May to 29 June; 1984: 7 controls from 18 May to 22 June; 1985: 9 controls from 21 May to 12 June) and next 9 supplementary controls (lasting about 1 hour) during afternoon and evening hours in May and June (to obtain a complete survey of peatbog fauna) and in July (to record the second breeding of some species).

The obtained results were treated in a usual way for evaluating mapping method (Šťastný 1974, Janda & Řepa 1986). The territory was classified into certain plant community if its major part lied in this community (size measured by a planimeter with the accuracy of 100 m^2).

The structure of avifauna in the whole study area as well as in single plant communities was described using following characteristics:

abundance A — total number of breeding pairs of a given species in the study area;
dominance d_i — rate of the number of breeding pairs of the species i in the total number of pairs breeding in the study area; values in tables presented in % (single categories see Palmgren 1930);
density D_A — abundance converted to 10 ha;
bird species diversity (Shannon & Weaver 1949): $BSD = -\Sigma d_i \log_2 d_i$;
equitability (Sheldon 1969): $E = BSD \,.\, (\log_2 s)^{-1}$, where s — number of species;
index of dominance concentration (Simpson 1949): $c = \Sigma d_i^2$;
Sorensen's index of similarity (Schwerdtfeger 1973): $QS = 2c \,.\, (a + b)^{-1}$, where a, b — total number of species on localities a and b, c — number of species common to both localities;
Renkonen's index of similarity (Pikula 1976): $Re = \Sigma d_{i\,min.}$, where $d_{i\,min.}$ — minimal dominance of species i from two compared localities, values of both indices in tables are presented in % (single categories see Jablonski 1972);
biomass $B_A = D_A \,.\, \bar{w}$, where $\bar{w}$ — average weight of a breeding pair of a given species,
production P_A (Zlatnik et al. 1973) — calculation based on a graphical method (Allen 1951).

Data concerning bird and egg weights and breeding bionomy were drawn from monographical papers on single species (*Anthus spinoletta*: Pätzold 1984, *Luscinia svecica svecica*: Jarvinen & Pryl 1980, Jarvinen & Pietainen 1983; *Phylloscopus trochilus*: Schonfeld 1984), as well as from general compendia on birds of the Krkonoše Mts. (Miles 1986) or Czechoslovakia (Bouchner 1962, Hudec & Černý 1972, Hudec 1983) and were supplemented by our own data (rate of birds involved in the second breeding — *Carduelis flammea* 100%, *Anthus pratensis* 25%, other species breed only once).

Energy values were estimated as the multiple of biomass B resp. production P and energy value of 1 g biomass of the given component: $6.70\ kJ.g^{-1}$ for birds (Buckner 1967) resp. $4.19\ kJ.g^{-1}$ for their eggs (Pinowski 1967). Egg production makes only an insignificant part of the total production and that was the reason for using the value $6.28\ kJ.g^{-1}$ (Chytil 1981) for other calculations.

Habitat preference of each species was characterized using Simpson's index again (Simpson 1949, Rosenzweig & Abramsky 1985): $c_h = \Sigma(D_i^2 \,.\, (\Sigma D_i)^{-2}$, where D_i — density of an evaluated species in the plant community i. Owing to the fact that there are four distinguished plant communities (see above), the index c_h can vary from 0.25 (the same density in all plant communities) to 1.00 (species found in one plant community only).

Mammals

Quantitative composition of small mammals was studied by quadrate method. The area of 75 × 75 m (0.56 ha) with 36 trapping points (6 × 6 points in the distance of 15 m, 2 break-back traps on point) was situated in the subarctic peatbog itself (*Rhynchosporion albae* × *Oxycocco-Empetrion hermaphroditi*) and exposed during six nights of autumn periods (20—25 September 1983, 23—28 September 1984, 13—18 September 1985) In the years 1984—1986 five 100 m lines were exposed (34 traps in the distance of 3 m) during 4—5 nights in other plant communities. Thus altogether 1968 traps were set and 58 small mammals of 8 species were caught (Tab 1) Wicks soaked with fat and flour were used as uniform baits.

Common mammalogical techniques (G, LC, LCd, LA, LTP, sex, size of testes, number and size of embryos, presence of maculae cyaneae, length and diameter of uterus, diameter of vagina) were applied to caught specimens.

Regular occurrence of larger mammal species, whose presence in reproduction season was studied both by direct observation and indirectly according to footprints and excrements, showed no evidence in the study area.

Only the results of quadrate method (Tab. 1: R. a × O.-E. h.) were used for evaluating quantitative and production relations. *Sorex araneus*, *Sorex minutus* and *Microtus agrestis* are considered the only species reproducing in the peatbog (owing to the state of reproduction organs, age of individuals and results of orientation catches in spring and summer seasons). The remaining species were young, most probably migratory individuals (*Apodemus flavicollis* and *Clethrionomys glareolus* from populations in Obří důl valley, *Microtus arvalis* from the neighbouring community *Nardo Caricion rigidae*).

A commonly used technique was used for evaluating the obtained data:
elimination of edge effect (Pelikán 1968) — was not necessary;

Tab. 1. Small mammal species and their dominance d_i (%) in the study area

Plant community	R. a. × O−E.h.	N−C. r.	P. m.	Total	d_i
S. araneus	3	—	3	6	10.3
S. minutus	6	—	1	7	12.1
S. alpinus	—	—	3	3	5.2
A. flavicollis	3	—	—	3	5.2
M. arvalis	4	18	—	22	37.9
M. agrestis	8	—	6	14	24.1
C. glareolus	2	—	—	2	3.5
P. subterraneus	—	—	1	1	1.7
Total	26	18	14	58	100.0
No. trap-nights (in years)	1224 (1983−85)	472 (1984−86)	272 (1985−86)		

S. — *Sorex*, A. — *Apodemus*, M. — *Microtus*, C. — *Clethrionomys*, P — *Pitymys*, **abbr.** of plant communities see Fig 1

size of catch N (Janion et al. 1968) — owing to a small amount of material the estimated size of the catch $\hat{N}$ was identified with the real size of the catch N;

observed range length (Pelikán et al. 1974) — following data were used: *Microtus agrestis* *o. r. l.* 30 m for males and 20 m for females, Myllymaki 1977), *Sorex araneus* resp. *Sorex minutus* (o r. l. 26 m resp. 36 m for both sexes, Croin-Michielsen 1966);

density D_M — conversion of the catch N and the observed range length to 1 ha; (in ind.ha^{-1})

biomass $B_M = D_M . \overline{w}$, where $\overline{w}$ — average weight calculated out of all the individuals of certain

Tab. 2. Abundance A (pairs), dominance d_i (%), breeding bird density D_A (pairs . 10 ha^{-1}), bird species diversity BSD and equitability E in different years

	1983			1984			1985			1983−85	
	A	d_i	D_A	A	d_i	D_A	A	d_i	D_A	d_i	D_A
A. pla.	—	—	—	—	—	—	1	2.1	0.14	0.5	0.05
G. gal.	1	1.4	0.14	1	1.5	0.14	—	—	—	1.1	0.09
A. arv.	7	10.0	0 98	8	11.6	1.12	6	12.5	0.84	11.2	0.98
A. tri.	—	—	—	1	1.5	0.14	—	—	—	0.5	0.05
A. pra.	24	34.3	3.36	23	33.3	3.22	13	27.1	1.82	32.1	2.80
A. spi.	—	—	—	1	1.5	0.14	1	2.1	0 14	1.1	0.09
P. mod.	16	22.9	2.24	15	21.7	2.10	13	27.1	1.82	23.5	2.05
L. sve.	6	8.6	0.84	4	5.8	0.56	5	10.4	0.70	8.0	0.70
P. tro.	3	4.3	0.42	2	2.9	0.28	—	—	—	2.7	0.23
F. coe.	5	7.1	0.70	5	7.2	0.70	1	2.1	0.14	5.9	0.51
C. can.	1	1.4	0.14	—	—	—	—	—	—	0 5	0.05
C. fla.	7	10.0	0.98	9	13.0	1.26	8	16.7	1.12	12.8	1.12
Total	70	100.0	9.80	69	100.0	9.66	48	100.0	6.72	99.9	8.73
BSD		2.624			2.682			2.518		2.681	
E		0.828			0.807			0.839		0.748	

A. pla. — *Anas platyrhynchos*, G. gal. — *Gallinago gallinago*, A. arv. — *Alauda arvensis*, A. tri — *Anthus trivialis*, A. pra. — *Anthus pratensis*, A. spi. — *Anthus spinoletta*, P. mod. — *Prunella modularis*, L. sve. — *Luscinia svecica svecica*, P. tro. — *Phylloscopus trochilus*, F. coe. — *Fringilla coelebs*, C. can. — *Carduelis cannabina*, C. fla. — *Carduelis flammea*

Tab. 3. Abundance A (total pairs in 1983–85), dominance d_i (%), breeding density D_A (pairs . 10 ha^{-1}), biomass B_A ($g.ha^{-1}$) and production P_A ($g.ha^{-1}.year^{-1}$) of birds in different plant communities

	Rhynchosporion albae × Oxycocco-Empetrion hermaphroditi					Nardo-Caricion rigidae				
	A	d_i	D_A	B_A	P_A	A	d_i	D_A	B_A	P_A
A. pla.	1	1.3	0.15	26.2	7.0	–	–	–	–	–
G. gal.	2	2.6	0.29	6.2	9.7	–	–	–	–	–
A. arv.	5	6.5	0.73	5.6	7.7	16	34.8	1.79	13.8	18.8
A. tri.	–	–	–	–	–	1	2.2	0.11	0.5	0.8
A. pra.	25	32.4	3.65	13.5	25.6	22	47.8	2.47	9.1	17.2
P. mod.	17	22.1	2.49	10.5	17.2	1	2.2	0.11	0.5	0.8
L. sve.	15	19.5	2.19	8.1	21.7	–	–	–	–	–
F. coe.	3	3.9	0.44	1.9	3.2	3	6.5	0.34	1.5	2.4
C. can.	1	1.3	0.15	0.6	0.9	–	–	–	–	–
C. fla.	8	10.4	1.17	2.6	7.9	3	6.5	0.34	0.8	2.3
Total	77	100.0	11.26	75.2	100.8	46	100.0	5.16	26.2	42.3

	Pinion mughi					Calam. villosae × Pinion mughi Caricion fuscae × Rhynch. albae				
	A	d_i	D_A	B_A	P_A	A	d_i	D_A	B_A	P_A
A. pra.	4	10.8	1.09	4.0	7.6	9	33.3	4.48	16.5	31.2
A. spi.	–	–	–	–	–	2	7.4	0.99	4.6	6.7
P. mod.	17	46.0	4.65	19.6	32.1	9	33.3	4.48	18.9	31.0
P. tro.	3	8.1	0.82	1.5	2.7	2	7.4	0.99	1.8	3.2
F. coe.	3	8.1	0.82	3.6	5.9	2	7.4	0.99	4.4	7.2
C. fla.	10	27.0	2.73	6.1	18.3	3	11.2	1.50	3.3	10.0
Total	37	100.0	10.11	34.8	66.6	27	100.0	13.43	49.5	89.3

Abbr. of bird species names see Tab. 2

Tab. 4. Relationships between characteristics of breeding bird community and FHD in different plant communities

Plant community	FHD	s	D_A	P_A	BSD	E	c
1. R. a. × O–E. h.	0.983	9	11.26	100.8	2.546	0.803	0.209
2. N–C. r.	0.799	6	5.16	42.3	1.794	0.694	0.359
3. P. m.	0.892	5	10.11	66.6	1.960	0.844	0.309
4. C. v. × P. m. C. f. × R. a.	0.996	6	13.43	89.3	2.244	0.868	0.251
r (* $p < 0.05$)		0.47	0.96*	0.97*	0.89	0.80	−0.95*

s — number of species, D_A — breeding density in pairs.10 ha^{-1}, P_A — production in $g.ha^{-1}.years^{-1}$, BSD — bird species diversity, E — equitability, c — Simpson's index, FHD — foliage height diversity, r — correlation coefficient, abbr. of plant communities see Fig. 1

Tab. 5. Similarity of breeding bird communities (Sörensen's QS and Renkonen's indices, both in %) in different plant communities

Plant community	QS				Re			
	1.	2.	3.	4.	1.	2.	3.	4.
1. R. a. × O–E. h.	100.0	66.7	57.1	53.3	100.0	51.5	47.2	68.6
2. N–C. r.		100.0	72.7	66.7		100.0	26.0	48.5
3. P. m.			100.0	90.9			100.0	70.1
4. C. v. × P. m. C. f. × R. a.				100.0				100.0

Abbr. of plant communities see Fig. 1

species caught in subalpine range of the Krkonoše Mts. (1,200–1,600 m a. s.) during autumn season 1983 to 1986; *Sorex araneus* (n = 35): $\overline{w} = 8.2$ g for both sexes, *Sorex minutus* (n = = 15): $\overline{w}♂ = 3.9$ g, $\overline{w}♀ = 3.4$ g, *Microtus agrestis* (n = 50): $\overline{w}♂ = 30.5$ g, $\overline{w}♀ = 26.6$ g;
production (Ryszkowski & Petruszewicz 1967): $P_M = B_M . \Theta$, where Θ – turnover rate: *Sorex araneus* $\Theta = 6.41$ kJ.g^{-1}, *Sorex minutus* $\Theta = 6.81$ kJ.g^{-1}, *Microtus agrestis* $\Theta = = 6.15$ kJ.g^{-1} (Hansson 1971, Ryszkowski 1982).

RESULTS

Birds

Altogether 12 breeding species (Tab. 2) were present in the study area – 6 dominant species with total dominance of 93.6%, 1 influent (2.7%) and 5 accessoric species (3.7%).

Average density of breeding species during the study period reached 8,7 p . 10 ha^{-} ($D_A = 6.7-9.8$ in different years). Bird community characteristics were as follows: BSD = 2.68 (2.52–2.68), E = 0.75 (0.81–0.84), c = 0.20 (0.20–0.21). The most

Tab. 6. Habitat preference of breeding bird species (in % out of total breeding density)

Plant community	n	R. a. × O–E. h.	N–C. r.	P. m.	C. v. × P. m. C. f. × R. a.	c_h
A. pla.	1	100.0	–	–	–	1.000
G. gal.	2	100.0	–	–	–	1.000
A. arv.	21	29.0	71.0	–	–	0.588
A. tri.	1	100.0	–	–	–	1.000
A. pra.	60	31.2	21.1	9.3	38.4	0.298
A. spi.	2	–	–	–	100.0	1.000
P. mod.	44	21.2	0.9	39.7	38.2	0.348
L. sve.	15	100.0	–	–	–	1.000
P. tro.	5	–	–	45.3	54.7	0.504
F. coe.	11	17.0	13.1	31.7	38.2	0.292
C. can.	1	100.0	–	–	–	1.000
C. fla.	24	20.4	5.9	47.6	26.1	0.340
Total	187	28.2	12.9	25.3	33.6	

c_h – Simpson's index see Material and Methods, further abbr. see Fig. 1 and Tab. 2

Tab. 7. Biomass B_A and production P_A of breeding birds in different years (abbr. of bird species names see Tab. 2)

	B_A ($g.ha^{-1}$)			B_A ($kJ.ha^{-1}$)			P_A ($g.ha^{-1}.year^{-1}$)			P_A ($kJ.ha^{-1}.year^{-1}$)		
	1983	1984	1985	1983	1984	1985	1983	1984	1985	1983	1984	1985
A. pla.	—	—	25.1	—	—	157.6	—	—	6.7	—	—	41.8
G. gal.	3.0	3.0	—	18.5	18.5	—	4.6	4.6	—	29.1	29.1	—
A. arv.	7.6	8.6	6.5	47.4	54.2	40.6	10.3	11.7	8.8	64.4	73.7	55.3
A. tri.	—	0.6	—	—	3.8	—	—	1.0	—	—	6.1	—
A. pra.	12.4	11.9	6.7	77.9	74.7	42.2	23.4	22.4	12.7	147.0	140.9	79.6
A. spi.	—	0.6	0.6	—	4.0	4.0	—	0.9	0.9	—	5.9	5.9
P. mod.	9.5	8.9	7.7	59.4	55.7	48.2	15.5	14.5	12.6	97.3	91.2	79.0
L. sve.	3.1	2.1	2.6	19.5	13.0	16.3	8.3	5.6	6.9	52.3	34.9	43.5
P. tro.	0.8	0.5	—	4.7	3.1	—	1.4	0.9	—	8.5	5.7	—
F. coe.	3.1	3.1	0.6	19.5	19.5	3.9	5.0	5.0	1.0	31.7	31.7	6.3
C. can.	0.5	—	—	3.3	—	—	0.8	—	—	5.2	—	—
C. fla.	2.2	2.8	2.5	13.7	17.6	15.6	6.6	8.5	7.5	41.3	53.1	47.2
Total	42.2	42.1	52.3	263.9	264.1	328.4	75.9	75.1	57.1	476.8	472.3	358.6

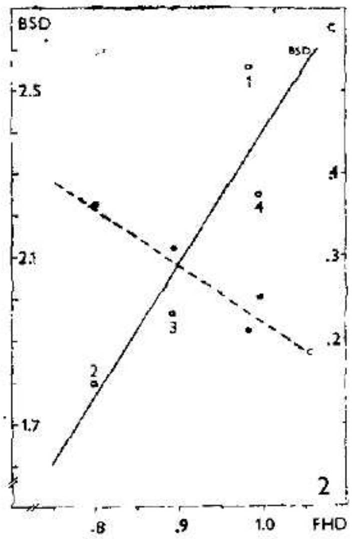
abundant species were *Anthus pratensis* ($D_A = 1.8-3.4$ p . 10 ha^{-1} in different years) and *Prunella modularis* ($D_A = 1.8-2.2$). The differences in numbers of single species in the years 1983—1984 were minimal, on the contrary in 1985 the density of most of the ground-nesting species (*Anthus pratensis*, *Phylloscopus trochilus*, *Alauda arvensis*) decreased by 36 % on average (20—100%).

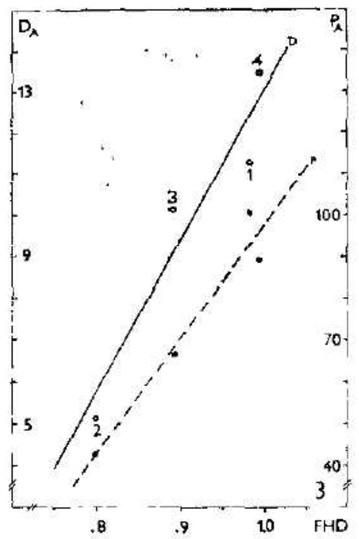
Bird composition in different plant communities showed correlation with the structure of vegetation cover (Tabs. 3—4). Most of the evaluated characteristics were highly correlated with FHD (Figs. 2—3) though only in cases D_A, P_A, c these correlations were statistically significant (Tab. 4, $r > 0.95$, $p < 0.05$).

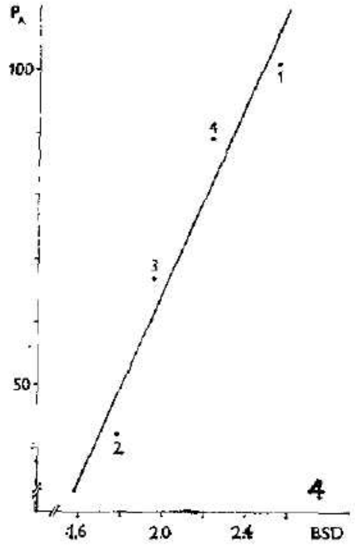
The highest density, production and BSD were ascertained in plant communities with similarly complicated vegetation structure R. a. × O.-E. h. and C. v. × × P. m.-C. f. × R. a. on the contrary to structurally simple community N.-C. r. with minimal values of the mentioned characteristics (Tab. 4). Indices of similarity of compared plant communities (Tab. 5) corresponded with the structure of vegetation cover (Renkonen's index), they were, however, influenced by small number of species (Sörensen's index).

Habitat preference of dominant species was in correspondence with their ecological demands (Tab. 6). *Carduelis flammea* (correlation coefficient $r = 0.97$) and *Prunella modularis* ($r = 0.88$) resp. *Alauda arvensis* ($r = 0.87$) showed strict relation to cover of shrub resp. herb layer; *Fringilla coelebs* occurred in shrub layer, no matter what its size ($r = 0.63$). *Anthus pratensis* nested in the whole area without shrub layer (no matter what its size) with the preference of humid habitats (R. a. × × O.-E. h.) to dry ones (N.-C. r.). *Luscinia s. svecica*, the last dominant species, occupied only humid habitats with about 50% cover of *Pinus mugo* in plant community R. a. × O.-E. h.

Average biomass resp. production of birds in all the study area reached 45.5 $g.ha^{-1}$ ($B_A = 42.1-52.3$ in different years) resp. 435.9 $kJ.ha^{-1}.year^{-1}$ ($P_A = 358.6-476.8$) (Tab. 7). The highest average biomass and production were in the subarctic peatbog itself (R. a. × O.-E. h.: $B_A = 75.2$ $g.ha^{-1}$, $P_A = 100.8$ $g.ha^{-1}.year^{-1} = 633.0$ $kJ.ha^{-1}.year^{-1}$) and the lowest in subalpine meadows (N.-C. r.: $B_A = 26.2$ $g.ha^{-1}$,







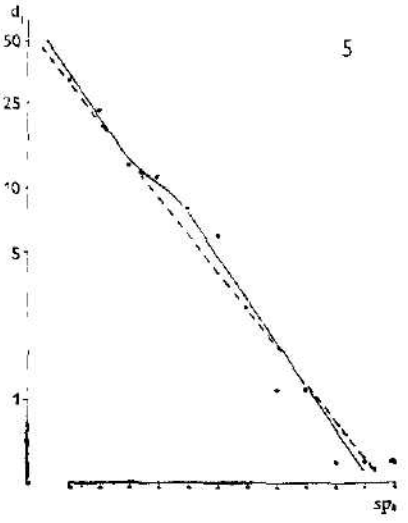


Fig. 2. Relationships between bird species diversity BSD (open circles: $y = 3.20x - 0.80$, $r = 0.89$) and index of dominance concentration c (black dots: $y = 0.90 - 0.68x$, $r = -0.95$), and foliage height diversity FHD (1–4: different plant communities, see Material and Methods).

Fig. 3. Relationships between breeding bird density D_A (pairs . 10 ha^{-1}, open circles: $y = 36.7x - 23.7$, $r = 0.96$) and production of bird community P_A ($g.ha^{-1}.year^{-1}$, black dots: $y = 274.5x - 177.1$, $r = 0.97$), and foliage height diversity FHD (1–4: different plant communities).

Fig. 4. Relationship between production of bird community P_A ($g.ha.^{-1}.year^{-1}$, $y = 75.6x - 86.8$, $r = 0.97$) and bird species diversity BSD (1–4: different plant communities).

Fig. 5. Dominance-diversity curve of the breeding bird community in the study area. altitude 1,410–1,440 m a. s. (d_i: dominance in log-scale, sp.: bird species rank)

Tab. 8. Dominance d_i, **density D_M, biomass B_M and production P_M** of mammals in the subarctic **peatbog itself**
(Rhynchosporion albae × **Oxycocco-Empetrion hermaphroditi)**

	d_i (%)	N (ind)			D_M (ind.ha^{-1})		
		1983	**1984**	**1985**	**1983**	**1984**	**1985**
S. araneus	**17.6**	1 − 0	0 − 1	1 − 0	0.98	0.98	0.98
S. minutus	35.3	–	1 − 0	3 − 2	—	0.81	4.07
M. agrestis	**47.1**	3 − 1	0 − 2	1 − 1	3.84	2.22	2.02
Total	100.0	**4 − 1**	1 − 3	5 − 3	4.82	**4.01**	7.07

	B_M (g.ha^{-1})			B_M (kJ.ha^{-1})		
	1983	1984	1985	1983	1984	1985
S. araneus	8.0	8.0	8.0	51.3	51.3	51.3
S. minutus	—	3.2	15.0	—	21.5	102.1
M. agrestis	113.1	59.6	57.6	695.3	366.4	353.9
Total	121.1	70.8	80.6	746.6	439.2	507.3

	P_M (g.ha^{-1}.year^{-1})			P_M (kJ.ha^{-1}.year^{-1})		
	1983	1984	1985	1983	1984	1985
S. araneus	9.6	9.6	9.6	61.5	61.5	61.5
S. minutus	—	8.5	40.5	—	58.1	275.6
M. agrestis	203.5	107.2	103.6	1251.6	659.5	637.1
Total	213.1	125.3	153.7	1313.1	779.1	974.2

N – **caught individuals: males – females, abbr. of mammal species names see** Tab. 1

Tab. 9. Proportion of **birds** A, mammals **M** and four the most abundant species (4 sp.: ***Anthus** pratensis, Prunella modularis, Luscinia s. svecica, Microtus agrestis*) in the total **biomass B** and production P of bird and mammal communities in the subarctic peatbof itself
(**Rhynchosporion** albae × **Oxycocco-Empetrion hermaphroditi)**

	1983	1984	1985	1983 – 85
B_A	**34.5**	**44.0**	56.8	45.3
B_M	**65.5**	56.0	43.2	54.7
4 sp.	81.2	73.9	**44.5**	65.6
P_A	36.1	45.8	33.7	38.2
P_M	**63.9**	**54.2**	66.3	**61.8**
4 sp.	**83.8**	**74.8**	65.6	**75.8**

$P_A = 42.3$ g.ha^{-1}.year^{-1} = 265.6 kJ.ha^{-1}.year^{-1}) (Tab. 3). Both the presented characteristics (B_A, P_A) were significantly correlated with BSD (Fig. 4, $r > 0.97$ $p < 0.05$).

Mammals

All the production parameters in the subarctic peatbog itself (R. a. × O.-E. h.) were characterized by only three reproducing species (Tab. 8) and out of these mostly by *Microtus agrestis* ($d_i = 47.1$).

During the whole study period the average mammal density reached 5.3 ind.ha^{-1} without considerable fluctuations in different years ($D_M = 4.0-7.1$) with the exception of *Sorex minutus* in 1985. Average biomass resp. production of mammals represented 90.8 g.ha^{-1} ($B_M = 70.8-121.1$) resp. 1,022.1 kJ.ha^{-1}.year^{-1} ($P_M = 779.1-1,313.1$) and were in different years out of 65–95% formed by production characteristics of *Microtus agrestis* (Tab. 8).

Comparison of bird and mammal production

Average biomass resp. production of birds and mammals in the subarctic peatbog itself (R. a. × O.-E. h.) reached 166.0 g.ha^{-1} ($B = 126.4-186.6$ in different years) resp. 1,655.1 kJ.ha^{-1}.year^{-1} ($P = 1,437.2-2,053.5$). Birds shared 45% and mammals 55% (Tab. 9) of the total biomass. Having excluded extreme values of *Anas platyrhynchos* in 1985, the share of mammals increased to 65% of the total biomass. The proportions of birds (38%) and mammals (62%) on the total production were similar.

Four most abundant species (*Anthus pratensis*, *Prunella modularis*, *Luscinia s. svecica*, *Microtus agrestis*) represented 66% of the total biomass and 76% of the total production (*Anas platyrhynchos* being excluded, both the values increased to 78%).

DISCUSSION

Owing to a unique character of the study area, the obtained results can be compared only with minimum of avifauna data from Czechoslovak localities of similar character. *Comparison with montane peatbogs of South Bohemia is quite valuable* (the Šumava Mts. — Janda et al. 1984). The authors have noted the decrease of species diversity and on the contrary the increase of dominance with elevation of the peatbog: 740 m a. s. — 73 sp. — total dominance of dominant species 66.3 %; 910 m a. s. — 45 sp. — 76.9%; 1065 m a. s. — 34 sp. — 87.7%. The subarctic peatbog studied has enlarged the above-mentioned results by other related data (1410 m a. s. — 12 sp. — 93.6 %). The highest situated raised peatbog in the Šumava Mts. (Jezerní slať) had similar composition of dominant species as well (*Anthus pratensis, Carduelis flammea, Phylloscopus trochilus, Fringilla coelebs, Prunella modularis*). Fundamental difference, however, was in number of species (34 against 12 sp.); average bird abundance was higher too : our results obtained by using point-count method (modified I. P. A. — cf. Janda et al. 1984) have reached 7.25 ind.point^{-1} in comparison with 11.53 ind.point^{-1} from the Jezerní slať peatbog.

Both the decrease of species diversity and the increase of dominance along the elevational gradient, indicating more simple communities in higher elevations (see above, $r = 0.95$, $P = 0.05$), can be explained by the influence of environmental severity and connected factors, especially simpler vegetation structure, food limitation and higher thermoregulation demands (cf. Connell 1975, Sabo 1980). An important relation between foliage height diversity and qualitative and production characteristics of avian community (in the same elevation), already recorded in many different habitats (MacArthur & MacArthur 1961, Karr & Roth 1971, Røv 1975, Cyr 1977 and others), can, according to our results, be found also in such structurally simple plant communities, as can occur in subalpine areas of Central European mountains.

The course of dominance-diversity curve (Fig. 5) was also characteristic for the studied bird community. Typical "broken-stick" type is gradually steeper in higher elevations (cf. Whittaker 1965) and in our community almost geometric distribution is followed. Sabo (1980) records practically the same course of the above-mentioned curve, including corresponding values of Simpson's index of dominance concentration ($c = 0.183-0.285$), for bird communities in the upper part of the subalpine belt of the White Mts., NE USA (mountains geomorphologically almost identical to the Krkonoše Mts. with similar anemo-orographic effects — Jeník 1961, 1986).

The character of studied habitat (subarctic peatbog itself, R. a. × O.-E. h.) offers a comparison with wide spectrum of Scandinavian peatbogs and mostly with subarctic palsa peatlands and open subalpine peatlands (Finland: Järvinen & Väisänen 1976) or dry and wet peatlands (Norway: Järvinen & Väisänen 1978). The basic difference is caused by the absence of representatives of Charadriiformes (with the exception of *Gallinago gallinago*) in the Krkonoše Mts. Having compared the representatives of Passeriformes only, BSD and densities are fully comparable (Krkonoše Mts.: BSD = 2.33, 7 sp., D = 10.8 p.10 ha^{-1}; Scandinavia: BSD = 2.06—2.49, 9—13 sp., D = 9.6—23.3 p . 10 ha^{-1}; Re = 25.2—52.0). Species composition is similar as well (cf. Tab. 3): high abundance of *Anthus pratensis* (D = 2.0—4.9 p.10 ha^{-1}), common occurrence of *Carduelis flammea* (D = 0.1—1.3) and *Luscinia svecica svecica* (D = 0.4—1.5). Out of dominant species *Prunella modularis* is characteristic for the Krkonoše Mts. peatbogs, *Calcarius lapponicus* (D = 0.2—6.4) and *Motacilla flava* (D = 1.3—4.0) for Scandinavian peatbogs; *Fringilla ccoelebs* is replaced by the species of *Fringilla montifringilla* (D = about . 0.1).

Comparison of meadow biotops *Nardo-Caricion rigidae* (of Tab. 3) with dry alpine meadows (Järvinen & Väisänen 1976) gives an evidence of roughly similar composition of dominant passerines (*Anthus pratensis* D = 0.1, *Alauda arvensis* is replaced by *Eremophila alpestris* in D = 0.2, a striking difference is caused by the presence of a dominant *Oenanthe oenanthe* in D = 0.2). The abundance of passerines, however, is almost ten times lower in alpine meadows in Finland (D = 0.6 p . .10 ha^{-1}, BSD = 1.55) compared to the Krkonoše Mts. (D = 5.2, BSD = 1.79).

The proportion of non-passerine (2%) and passerine birds (98%) in the study area, their density (0.14 resp. 8.6 p . 10 ha^{-1}), total bird biomass (45.5 g.ha^{-1}) and mean body weight (27.4 g.bird^{-1}) corresponds well with latitudinal gradients found in ornithological characteristics of Swedish raised peatbogs : increasing proportion of non-passerines, their density, mean body weight and total bird biomass, decreasing proportion of passerines and total bird density towards the north (Boström & Nilsson 1983).

Out of the total number of investigated species only *Luscinia svecica svecica*, a typical Scandinavian representative, is mentioned. This species occurred in two subarctic peatbogs in the Krkonoše Mts. (the only breeding locality in Czechoslovakia) with the breeding density of 2.2 p . 10 ha^{-1} ($d = 19.5\%$), which roughly corresponds with half of its density in optimal habitats of northern Scandinavia (D = 4.9 p . 10 ha^{-1} with the dominance of about 4% — Järvinen & Pietiäinen 1983).

Production of avian community in the study area was very low, roughly half in comparison with minimal values from different habitats (min. $P = 840$ kJ.ha^{-1}.year^{-1} in North American grasslands — Smith & MacMahon 1981). Wiens & Nussbaum (1975) state that production represents about 1% of seasonal energy flow through the avian community; in case of the study area, however, production rate can be expected to be even lower ($<1\%$) due to extreme climatic conditions and thus higher rate of remaining energetic characteristics (especially thermoregulation).

In our sample mammals have been represented mostly by *Microtus agrestis* (83% of total production on average). Seasonal density of 5 ind. ha^{-1} is noted by French et al. (1975) for approximately similar habitats of northern Scandinavia. Stenseth et al. (1977) note even 3 ind. ha^{-1} as a minimal density in peak years. Having recalculated the stated data, we get values of biomass $B =$ ca. 50—150 g.ha^{-1} and production $P =$ ca. 1.0—1.7 MJ.ha^{-1}.year^{-1}, approximatelly comparable with our data (cf. Tab. 8). Petrusewicz & Hansson (1975) presented a low production of *Microtus agrestis* also for meadow ecosystems ($P = 5.4$—14.5 MJ.ha^{-1}.year^{-1}) and its increase towards forest habitats (cf. Hansson 1971 and others). Thus mammal production of subarctic peatbogs approaches only minimal values of small mammal production in the poorest Scandinavian ecosystems of a corresponding character (cf. Kalela et al. 1971).

Having compared the total production of birds and mammals of subarctic peatbogs in the Krkonoše Mts. with one of the most productive Czechoslovak ecosystems, floodplain forest ($P = 127.8$ MJ.ha^{-1}.year^{-1} — Chytil 1981), we arrive at a conclusion that the studied habitat ranks unambiguously among the poorest ones from the point of view of secondary production (production is about 100 times lower than in floodplain forest). Similar proportion of birds and mammals on a total production (birds 39%, mammals 61% — Chytil 1981) has been assessed in both the compared habitats. Having used a preliminary comparison of primary and secondary production of the studied ecosystem (very rough values of primary production for tundra and subalpine belt of the Alps, 26 000—39 000 MJ.ha^{-1}.year^{-1} — Odum 1977, Vareschi et al. in Denffer et al. 1978), it is possible to estimate the effect of energy transfer on the level of roughly hundredths of per cent.

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Figs 6—9 will be found at the end of this issue.

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THE DECIDUOUS TOOTH MORPHOLOGY IN THE MYSTACINE BAT, MYOTIS MYSTACINUS (MAMMALIA, CHIROPTERA)

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Abstract. A description is given of desiduous tooth morphology, which is based on a juvenile *Myotis mystacinus* male. The article enclosses figures of respective teeth and teeth positions in the upper and lower jaw. The results acquired are compared to the available data upon deciduous tooth morphology in the other three species of the genus *Myotis*: *M. myotis*, *M. daubentoni* and *M. vivesi*.

INTRODUCTION

The period of birth and growth of their young is a most interesting part of bats' life and not only from the ethological point of view. In its wider aspects, ethology is connected with body morphology of juvenile specimens. Typical dental structure of the juveniles appears to have specific functions. This applies namely to the species in which the milk teeth is present throughout the postnatal development in contradistinction to those in which it is resorbed as soon as before birth. The mystacine bat, one of the smallest representatives of the genus *Myotis* in Czechoslovakia, belongs to the first group. In Czechoslovakia, the species is only scarcely of frequent occurrence. It is most widely found in humid and woody areas ranging from medium high altitudes. It is a synanthropous species; the most common roosting places are crevices and cavities of medium-sized buildings. Its way of life is similar to that of the other synanthropous bats living in our country. During the summer, females gather in nursery colonies where they bear and raise their young.

Deciduous tooth morphology has been described in a number of works. The earliest dates as far back as to the second half of the last century (Leche, 1877). Several years later, Miller (1907) presented basic description of dentition and dental formulae for Chiroptera. The knowledge on the dentition of bats has become much deeper ever since. Authors have been concerned not only with the description of dental structures found in the ontogenetic development of bats, but also with the observation of their functioning, growth, replacement and mutual phylogenetic relationship.

MATERIAL AND METHODS

In the course of our faunistic research on synanthropous bats in the Šumava Mountains we have found only one large nursery colony of female mystacine bats at Střelské Hoštice village (**Krátká**, **Krátký**, 1985), in the Strakonice region. On July 6th, 1977, we have selected a solitary juvenile (♂). The study of its milk teeth yielded the material for this article.

The bat was chloroformed and fixed in 10% formalin. Body and skeletal measures of the conserved material were taken. Positions of the milk teeth in the upper and lower jaw were also drawn after the conserved material. Each milk tooth was dissected out of the gum and examined using a binocular microscope SMXX. The figures were drawn using drawing facilities.

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RESULTS AND DISCUSSION

The *juvenile male which was the subject for my research on deciduous tooth* morphology, had closed eyes, erect pinnas and tragi. He had no umbilical cord. There was a visible groove in the concrescence of the eyelids. The spinal area as well as the adjacent plagiopatagial and uropatagial areas were thickly covered by long reddish brown hairs. A typical hair whirl was visible in the back of the neck. In the glandular area vibrissae grew. The ventral part of the body as well as the adjacent patagial areas were covered by thin white fur, slightly longer on the neck and in the genital area. *At the time of my observations*, the fur had already covered a large part of the pink skin and therefore the bat's belly was coloured in white.

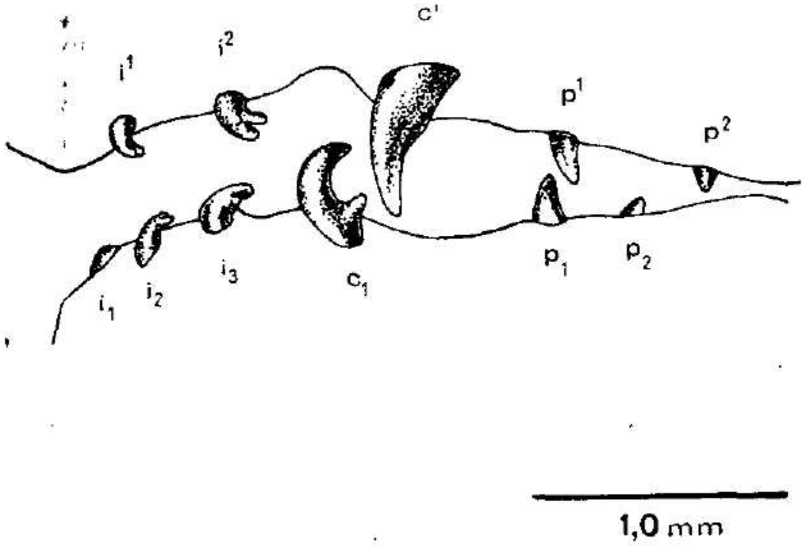

Fig. 1. The position of the milk teeth in the jaws of the juvenile mystacine bat.

Body and skeletal measures:
head and body length 29.2 mm; tail length 15.1 mm; ear length 8.9 mm; tragus length 4.1 mm; hind foot length 6.2 mm; forearm length 18.8 mm; humerus length 12.0 mm; thumb length 5.7 mm; 3rd metacarpus length 12.6 mm; 5th metacarpus length 13.2 mm; 3rd finger length 9.1 mm; 5th finger length 4.7 mm; femur length 7.9 mm; tibia length 7.4 mm; condylobasal length 10.5 mm; interorbital width 3.2 mm; zygomatic width 6.5 mm; mandibula length 7.5 mm.

The study of the dentition in bats requires a proper determination of the specimens' age. In the group described, the deciduous teeth is completed and replaced by the permanent teeth relatively soon after birth. The age of a specimen collected more or less at random can only be determined indirectly, by comparing its habit to that of the juveniles belonging to the related species in which the postnatal development has already been described. During the first days of a juvenile's life there is a number of traits indicating its age, such as the umbilical cord, closed eyes, the quality of the fur etc.

Umbilical cord is usually gone within about two days after birth (**Gaisler**, 1962, **Sklenář**, 1962). According to my observations, members of the familyVespertilionidae tend to open their eyes in the beginning of the second week. At that time the pink colour at the belly gradually disappears, as the area has already been covered by the fur of sufficient thickness (Kratky, 1981). It follows that the mystacine bat male is about 5—7 days old. This means he has lived almost up to the end of the first week of his life.

The specimen has all the milk teeth fully erupted. The dental formula is as for the other representatives of the family Vespertilionidae $\frac{2\,1\,2}{3\,1\,2}$. Under the epithelium of the gums the permanent teeth have already been formed although they have not erupted yet. The position of the milk teeth in the gums is illustrated in Fig. 1. We see from it that the premolars project into the mouth cavity only slightly, their lateral projections are almost invisible above the level of the gum. However, the present state may not fully correspond to the reality. The tissues of the gingival epithelium might have been damaged and bulked out, as a consequence of the long-time conservation.

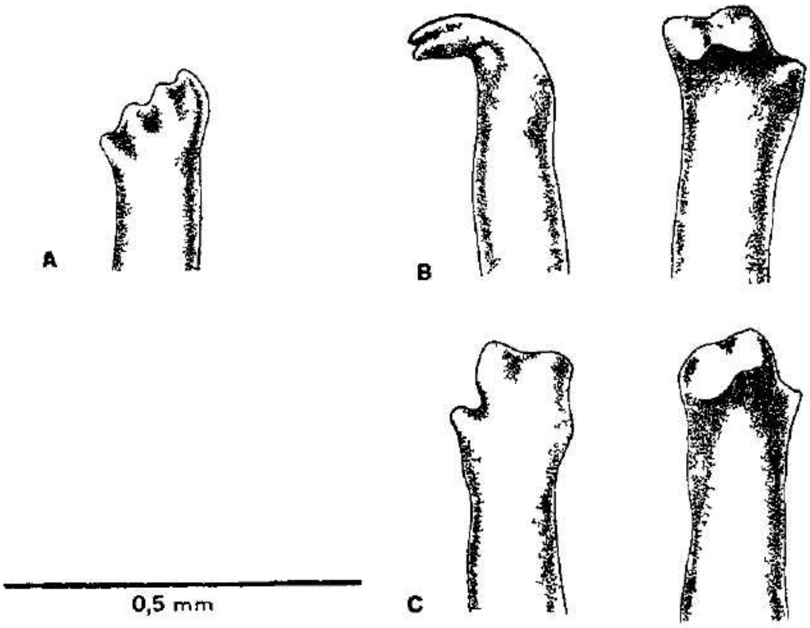

Fig. 2. The deciduous dentition of the mystacine bat. A. 1st left lower incisor i_1 — lingual side. B. 2nd right lower incisor i_2 — distal and lingual sides. C. 3rd right lower incisor i_3 — labial and lingual side.

The group of animals described has characteristic shapes of teeth: the long and single root imperceptibly merges into a crown of various shapes which is usually fitted with lateral lobes and projections. The shape of the crowns (Figs. 2—5) is usually determined by the degree of the reduction as well as by the position and shape of their three lobes.

After comparing the shapes of the milk teeth in the genus *Myotis* I came to the following conclusions. I had the following data at my disposal: *M. myotis* (Spillmann, 1927), *M. vivesi* (Reeder, 1953) and *M. daubentoni* (Kratký, 1981).

Upper incisors are trilobed in all the four species The lateral lobes are best developed in *M myotis* and *M daubentoni* growing almost as high as the central lobe The distal lobe is slightly reduced in *M mystacinus* and so are the lateral lobes in *M vivesi* The lobes are pointed and recuvered thus forming sharp spikes

Lower incisors The first incisor i_1 in *M mystacinus* and *M daubentoni* has rather concrescent and poorly visible lobes The crown in *M vivesi* and *M myotis* is more articulate though not that rugged as the upper incisors

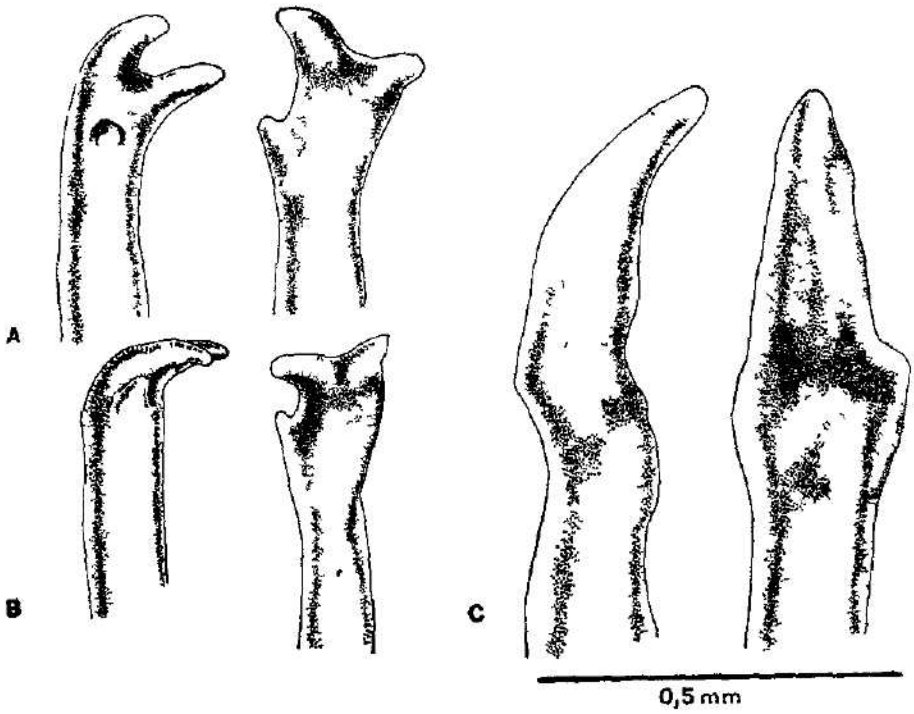

Fig 3 The deciduous dentition of the mystacine bat the right maxilla A 2nd upper incisor i^2 — distal and lingual side, B 1st upper incisor i^1 — distal and lingual side, C upper canine c^1 — labial and distal side

The second incisor i_2 in *M daubentoni* is flattened from the frontal side The lobes are rather fused and equal In *M vivesi* the lobes of the tooth are also fused and recurved In *M mystacinus* the central and medial lobe are fused and recurved almost at a right angle The reduced distal lobe is subequal The lobes of the tooth are best developed in *M myotis*

Except for *M myotis* the third incisors i_3 are of similar shape in the other three species the central and medial lobes are fused and more or less recurved The distal lobe is smaller It is situated under the central lobe In *M myotis* the crown is more ragged The slightly recurved central lobe is the largest

Upper canines are sabre like in all the four species The lateral lobes are considerably reduced In *M vivesi* they are missing *M mystacinus* has one rudimentary lingual lobe at the base of the crown In *M daubentoni* there is a ledge shaped projection at the inner side of the tooth. *M. myotis* has two small lateral lobes. Lower canines. In *M. daubentoni*, *M. myotis* and *M. vivesi* the sizable labial and central lobes are equal, being variably fused and recurved. The smaller lingual lobe is shifted under the central and pointed forward. In *M. mystacinus* the crown is

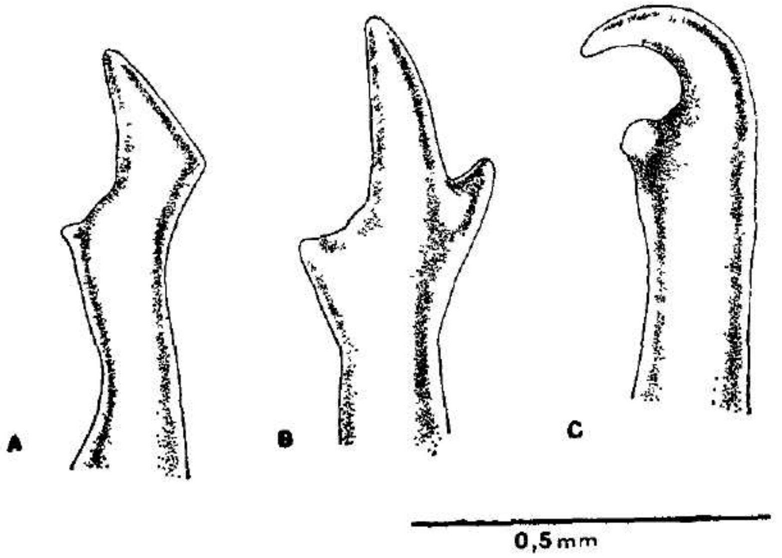

Fig. 4. The deciduous dentition of the mystacine bat, the right mandible. A. 2nd lower premolar p_2 — labial side; B. 1st lower premolar p_1 — labial side; C. lower canine c_1 — labial side.

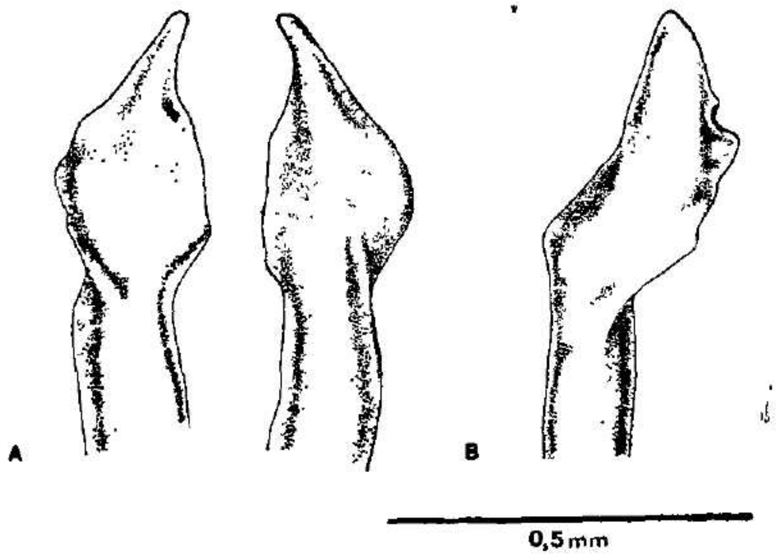

Fig. 5. The deciduous dentition of the mystacine bat. A. 2nd left upper premolar p^2 — lingual and labial side; B. 1st left upper premolar p^1 — lingual side.

bilobed. The point of the sizable upper lobe is recurved and arched. Underneath, there is a small protuberance, which is directed opposite the point of the lobe.

Upper premolars are simple, without considerable articulation frequently showing a thickened and regged crown, which usually doesn't form a sharp point.

Lower premolars are trilobed, the sizable central lobe is either recurved or vertical to the jaw. The smaller lateral lobes are situated in proximal and distal positions under the central lobe. The shape of the teeth is rather similar in all the four species, except for the first premolar p_1 in *M. vivesi*, which looks rather like a lower canine.

It follows from the survey that the lateral lobes are best developed in *M. myotis*. The upper incisors have the most articulate and rugged crowns in all the species observed. The upper canine (the most sizable tooth in the dentition) and the upper premolars are the least rugged teeth. In *M. mystacinus* and *M. vivesi* the lobes forming a crown of the 2nd and 3rd incisor are rather recurved at right angles to the tooth. The curvature does not obstruct the occlusion. It is partially eliminated by the position of the teeth in the jaws (Fig. 1).

SUMMARY

The article presents the results of the research on the deciduous teeth morphology in *Myotis mystacinus*. The milk teeth were observed using a male of about one week of age.

The descriptions of the habit, body and skeletal measures of the specimen are given as well as the traits indicating its age.

The shapes of the respective teeth and their positions in the jaws are given. The results are taken to mean that the milk teeth is complete.

The results acquired were compared to the data upon the shapes of the milk teeth in *Myotis myotis*, *M. daubentoni*, and *M. vivesi*. The observations suggest that *M. myotis* has the best developed lobes of the milk teeth of all the species mentioned. In all the four species the upper incisors have the most articulate crown, while in the upper canines and upper premolars the crown is almost without any articulation. The 2nd and 3rd lower incisor in *M. mystacinus* and *M. vivesi* have the crown recurved to the right angle. The same applies to the 1st upper incisor in *M. mystacinus*.

The evidence presented indicates that the species of the genus *Myotis* have a similar deciduous dention in spite of the minor differences mentioned.

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SUR LA PRÉSENCE DE L'ASIDA RUFICORNIS EN TUNISIE ET SUR QUELQUES DISCONTINUITÉS REMARQUABLES DE LA RÉPARTITION NORD-AFRICAINE DES TENEBRIONIDAE APTÈRES (COLEOPTERA)

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Abstract. The paper summarises and explains two instructive types of geographic discontinuity in north-african areals and dispersion patterns of wingless ground-inhabiting Tenebrionid beetles. The causal explanation of these discontinuities, which requires primarily a geologically oriented approach reaching far in the Tertiary, lies in the Vindobonian marine transgression over Berberia and Tripolitania and in the changes in the northern zone of Libya during the Neogene.

Consécutivement à ma révision des Asidini d'Algérie et de Tunisie (Kwieton 1986), j'ai reçu pour détermination un couple d'*Asida ruficornis* Solier provenant de la forêt de la Kessera en Tunisie centrale (J. Picka lgt. et coll.).

Cette récolte confirme l'indication de Normand ("El-Kef" — Normand 1936) que j'avais considérée, à la base de matériels importants et représentatifs, comme invraisemblable (Kwieton 1986). En même temps, l'image résultant de la dispersion géographique de l'espèce nous rappelle immédiatement d'autres cas semblables où une espèce répartie quasi-continuellement depuis l'Espagne jusqu'en Algérie occidentale présente ensuite une brèche sensible de son aire et ne réapparaît qu'en Tunisie (cf. par. ex. *Sepidium aliferum* Er. — v. Kwieton 1980) — discontinuités difficiles à interpréter à la base de la situation actuelle puisque la zone à conditions écologiques propices aux espèces en question est pratiquement continue et sans des barrières réellement tranchantes, mais aisément compréhensible lorsque l'on prend en considération l'évolution géologique tourmentée de la Berbérie au cours du Tertiaire, avec, outre les plissements orogéniques, quelques transgressions marines. Si, dans son ensemble, le territoire des Hauts-Plateaux algéro-oranais actuels était émergé depuis l'Éocène supérieur (v. Furon 1950, 1960, Termier 1952, Courme-Rault 1974), une grande transgression au Vindobonien recouvrit la majeure partie du territoire, ne laissant que quelques îlots. A l'ouest, l'île bético-rifaine restait émergée et fonctionnait et tant qu'un asile à partir duquel le territoire algérien berbérique aurait pu être ultérieurement repeuplé par les lignées occidentales. A l'est, un des îlots susdits se trouvait en Tunisie nord-occidentale, correspondant justement à la position géographique des localités El-Kef et La Kessera et assez grand pour fonctionner pendant un certain temps comme un asile restreint, mais emprisonné parmi les eaux marines. Le *Sepidium aliferum* Er. aurait pu en descendre plus tard vers les basses régions près de la côte orientale de la Tunisie où l'on le retrouve aujourd'hui et qui représentent une zone correspondant mieux aux préférences écologiques de l'espèce discutée.

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Comme les Asidini ainsi que les Sepidiini sont des groupes anciens datant assurément au moins du Crétacé (Kwieton 1981) et dont les centres de différenciation secondaire étaient situés justement en Méditerranée sud-occidentale (Kwieton 1981, 1980, 1986), les changements géologiques venant d'être rappelés les ont certainement atteints.

Dans le cas de *S. aliferum*, on ne peut toutefois pas entièrement écarter de vue l'hypothèse alternative que l'espèce ait été venue en Tunisie par le Nord, par une voie trans-tyrrhénienne. Vu cependant la situation du *S. cyrenaicum* (v. ci-dessous) ainsi que celle d'autres représentants du genre (Kwieton 1980), une dispersion analogue à celle de l'*Asida ruficornis* paraît être à retenir.

On peut alors tenter de rechercher la limite temporelle inférieure de la colonisation de la Berbérie qui soit compatible avec l'image que l'on constate. Consultant les reconstructions paléogéographiques (op. cit.), on se rend compte qu'encore à l'Éocène, la Berbérie orientale n'était pas émergée. Ce n'était que depuis l'Éocène supérieur que la mer se retirait progressivement vers le Nord-Est (Courme-Rault 1974) et ce n'était qu'à l'Oligocène que la majeure partie de la Berbérie, notamment l'ensemble de la région de Hodna, fut abandonnée par la mer (ce que disait déjà Arldt, 1919) et c'est donc cette époque que l'on peut retenir comme la limite inférieure recherchée.

La voie empruntée par les formes telles que l'*A. ruficornis* aurait été donc: Bibans, Mts. de Hodna, Aurès, Mts. de Tébessa, Dorsale Tunisienne — cf. la répartition significative de deux espèces très localisées et endémiques: *A. radulicollis* Kwiet. et *A. sacculipennis* Kwiet.!

Comme tout cela concerne — dans les cas discutés ici — des espèces actuelles, il est légitime de se demander si une telle datation correspond à leur âge présumable. Eh bien, oui — d'une part des trouvailles entomologiques dans l'ambre indiquent une ancienneté comparable de plusieurs espèces vivant actuellement et, d'autre part, le centre de différenciation bético-rifain des Asidini paléarctiques (Kwieton, supra cit.) date du Crétacé déjà, ainsi n'est-il point surprenant qu'à l'Oligocène la différenciation ait été avancée jusqu'au niveau d'espèces actuelles.

Or, il existe des types beaucoup plus remarquables encore de la discontinuité géographique dans la répartition nord-africaine.

Laissant maintenant à part le cas des genres *Eulipus* Woll. et *Arthrodeis* Sol. qui sont des lignées venues de l'Est de l'Afrique du Nord et donc d'une histoire nettement différente, et se concentrant sur des lignées originaires des territoires ibéro-marocains et progressant par suite en Berbérie de l'Ouest vers l'Est comme il en était précisément dans le cas des Asidiini, une brèche géographique très notable s'observe par ex. chez les Akidini où l'espèce la plus primitive du g. *Akis* (ou, si l'on préfère, la plus dérivée du g. *Morica* — v. Kwieton 1980), l'*A. costitubera* Marseul habitant la Cyrénaïque est largement isolée de ses ancêtres marocains. D'un autre exemple expressif et semblable, où toutefois l'origine marocaine ne vaut qu'au niveau du groupe d'espèces en question (Kwieton 1980), peut servir le *Sepidium cyrenaicum* Schuster, membre d'un groupe qui est actuellement, à l'exception de l'espèce citée, strictement atlanto-marocain.

Dans ce type de discontinuité géographique en Afrique du Nord, ce ne sont pas seulement les changements géologiques de la Berbérie qui sont en cause, mais également ceux de la Libye actuelle, occupée jadis (encore au Pliocène) dans sa partie septentrionale par la mer (v. Desio 1971) et par des marécages sublittoraux intermittents (Kwieton 1977 — hypothèse confirmée ultérieurement par des géologues tchèques de l'Institut géologique central, ayant travaillé directement sur le terrain — comm. pers.)

Ces obstacles obligeaient les formes terrestres à descendre plus vers le Sud pour que celles-ci pussent les contourner (Kwieton 1977). Lorsque la mer et les marécages sublittoraux eurent cédé le terrain au désert qui arriva par suite partiquement au bord de la Méditerranée, les lignées discutées, étant pincées entre le désert et la mer, auraient été éliminées de la zone exposée vu leur orientation écologique érémoxene (cf. Kwieton 1981), ne survivant qu'en Cyrénaique plus hospitalière (la Cyrenaique serait émergée depuis le Miocène supérieur — Desio 1971). Or, cette image se complète encore, tout en offrant une cause concourante, plus "mécanique" et plus brutale, mais aussi plus ancienne (Vindobonien vs. Pliocène) de la brèche zoogéographique en Libye — la transgression marine de Vindobonien a recouvert aussi la Tripolitaine, s'y avançant jusqu'à Djafra (Desio 1971), de même que, d'ailleurs, les îles Canaries et celle du Cap Vert (Furon 1960), modifiant ainsi profondément la zoogéographie nord-africaine.

Note: les deux ex. susdits de l'*A. ruficornis* représentent la var. *gebieni* Rttr leur habitat sylvestre confirme donc l'’hypothèse de la nature écotypique de cette variété — v. Kwieton 1986.

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REGULARITIES IN THE GROWTH RATE OF PIKEPERCH (STIZOSTEDION LUCIOPERCA) IN THE BATAK DAM, BULGARIA

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Dedicated to the 60 Anniversary of Assoc. Prof. Dr. Ota Oliva

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Abstract. Examined are the differences in the growth rate and condition of different generations of pikeperch in the process of the formation of its population in a reservoir located in the *furthermost point of the range of the species. The growth of length frequences (L) and weight* (G) with population ageing is given by the equation of Bertalanffy (1938). Studied are age *variability of the L-S correlation (scale dimensions) and G-L. The authors consider the metho*dological significance of this variability. Coefficient k of the equation $G = kL^n$, describing the dependence between *G and L of fish in each age group separately, has also been used* as coefficient of condition. Data on the growth of pikeperch in other reservoirs are cited.

Regardless of the major biological role of pikeperch its growth rate in reservoirs in Bulgaria has not been studied so far. The only available information comes from **Marinov** and **Boyadzhiev** (1967) for the G. Dimitrov Dam and **Ivanov** (1968, *1970) for some Bulgarian lakes near of Black Sea and the Danube.*

The species was introduced in the Batak Dam in 1971. Ten years later industrial catch of pikeperch was characterized by a comparatively complex structure (9 age groups), *with relative stability and small values — generally approximately 2000 ± ± 400 kg annually* (**Petrova & Živkov**, in print).

The purpose of this study is to reveal the specific characteristics and regularities *of the growth of pikeperch in the course of the building up of its population in the* Batak Dam.

A brief outline of the hydrological, hydrochemical and hydrobiological characteristics was also worked out. (**Živkov & Petrova**, 1984).

MATERIALS AND METHODS

The material was collected over the 1972–1983 period. Fishing was carried out by means of nets 12 m high, up to 400 long and with meshes between 16 to 26 mm. A total of 410 specimen was measured up to the end of the scale cover (L) with a precision up to 1 cm and weight (G) with a precision to 1 gm. Scales were used to determine the age of fish. The scales were drawn from the area of the body immediately above the lateral line and below the dorsal fin A projector model Dokumator (Lesegerat) made by Carl Zeiss, Jena, GDR at a magnification 17.5× was used for the purpose. Annual marks are well outlined. Certain difficulties arose in determining the first annual mark, because of the changed manner of feeding and food composition of pikeperch (plankton, benthos, fish) during the first year of its life Frequently an additional, (false) annual mark makes the differentiation of the real first annual mark more difficult.

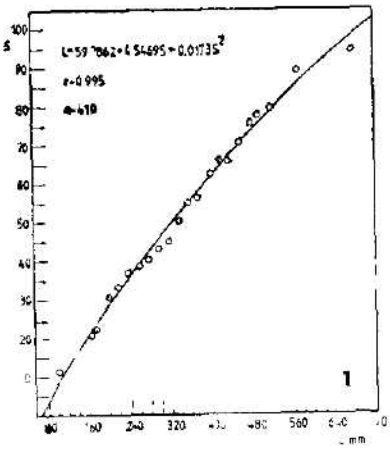
The rate of linear growth was determined by means of back calculation of lengths (L) through the radius of their scales (S). With this aim in mind the values of S were grouped as shown in Table 1. *Further calculations were carried out in two ways: with the first we initially estab*lished L and S relationship for the whole population (Fig. 1) — $L = 59.786 + 4.547\,S + 0.0173\,S^2$, $r = 0.99$. *After that we calculated the respective values of L by means of equations,* through the values of S from Table 1. With the second, a separate equation was drawn for each age group: for the first age group — $L_1 = 32.948 + 6.475\,S_1$, $r_1 = 0.99$, for the second — $L_2 = 66.429 + 4.349\,S_2$, $r_2 = 0.99$, for the third — $L_3 = 35.442 + 6.112\,S_3$, $r_3 = 0.99$; for the fourth — $L_4 = 44.214 + 5.819\,S_4$, $r_4 = 0.99$; for the fifth — $L_5 = 75.706 - 7.768\,S_5$, $r_5 = 0.97$, for the sixth — to the ninth (taken together, owing to the small number of specimens) — $L_{6-9} = 116.901 + 5.685\,S_{6-9}$, $r_{6-9} = 0.703$. After that the values of S_1 from Table 1 were used for the computation of l_1 by their substitution in the formula for the first age group, the values of S_2 for the calculation of L_2 by means of the formula for the second age group, etc. The values of **L** obtained through the first method are denoted by L′, that of the second — by L″.

The values of L″ served for the registration of finer changes of the growth rate (for example in the course of the study of the relationship between changes in L in various years, however, only in one and the same age group and the relative fish abundance, which constitute the food component of pikeperch from the studied age group (**Petrova** & **Živkov**, in print). Where we used mean values for the entire population, we resorted to the values of L′ (for instance in calculating the parameters of the Bertalanffy equation).

The values of G were calculated in a analogous way by means of the length weight relationship, which has the character of a power function of the type $G = kL^n$ (with k and n as coefficients). The coefficient of condition (k) was taken into account in three ways: 1) Directly, as a coefficient k in the equation $G = kL^n$, whose parameters were determined separately for each group: 2) after Fulton's formula $k = G/L^3 \,.\, 100$; 3) after Fulton's formula, however, the power indice was replaced by n, the power index from the formula $G = kL^n$, based on the overall material. Correlation-regression analysis was carried out in the customary manner applied in biostatistics (**Lakin**, 1973). The parameters of Bertallanffy's equation were determined by means of the method of **Hohendorf** (1966).

RESULTS

Table 2 presents the mean lengths in different generations and age groups, obtained through back calculations of the first (L′) and second (L″) method. The relationship between mean lengths at age t (L_t) and mean lengths in a years time



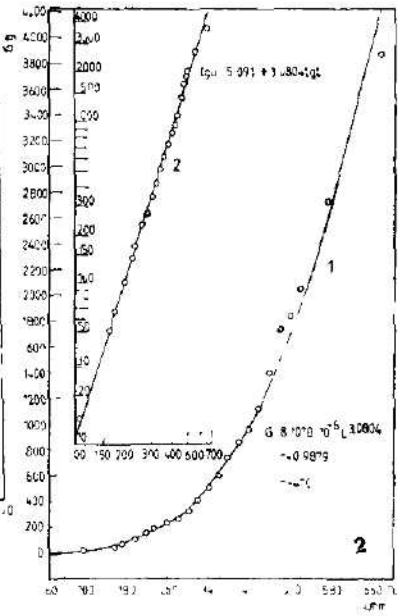


Fig. 1. Body length (L) — Diagonal radius of scale length (S, in parts of micrometer eyepiece) relationship.

Fig. 2. Body length (L) and weight (G) relationship (1) and its logarithmic anamorphosis (2).

Table 1. Grouping of average lengths of radius' of annual marks on scales (S) and their corresponding back calculated body lengths (L)

Generation	Age - Group	Average values of S and their corresponding back calculation values of L at the end of each vegetation period									No. of the specimens
		Ist	IInd	IIIrd	IVth	Vth	VIth	VIIth	VIIIth	IXth	
1982	I	S_1 L_1	S_2 L_2	S_3 L_3	S_4 L_4	S_5 L_5	S_6 L_6	S_7 L_7	S_8 L_8	S_9 L_9	n
1981	II	S_1 L_1	S_2 L_2	S_3 L_3	S_4 L_4	S_5 L_5	S_6 L_6	S_7 L_7	S_8 L_8	S_9 L_9	n
1980	III	S_1 L_1	S_2 L_2	S_3 L_3	S_4 L_4	S_5 L_5	S_6 L_6	S_7 L_7	S_8 L_8	S_9 L_9	n
1979	IV	S_1 L_1	S_2 L_2	S_3 L_3	S_4 L_4	S_5 L_5	S_6 L_6	S_7 L_7	S_8 L_8	S_9 L_9	n
.	.	. .	. .	. .	. .	. .	. .	. .	. .	. .	
.	.	. .	. .	. .	. .	. .	. .	. .	. .	. .	

Table 2. Average body lengths (mm) in various generations

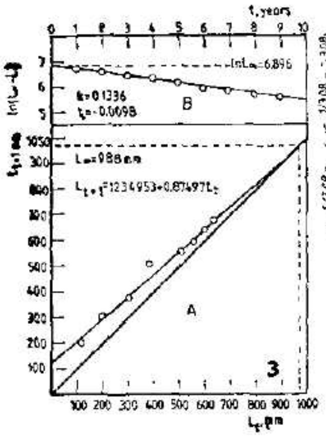
Generation	Age – Group	Average body lengths at each vegetation period obtained through back calculation by the I-st method (L′) and second (L″) method																		Number
		L_1'	L_1''	L_2'	L_2''	L_3'	L_3''	L_4'	L_4''	L_5'	L_5''	L_6'	L_6''	L_7'	L_7''	L_8'	L_8''	L_9'	L_9''	
1982	I	155	159																	28
1980	I, III	105	95	180	172	367	376													16
1979	II–IV	101	89	208	194	285	296	362	364											17
1978	III–V	108	99	197	186	320	331	412	409	504	506									40
1977	I, IV/VI	114	107	156	152	249	258	360	362	435	431	513	555							45
1976	I, II	102	91	217	201															4
1975	II, VII, VIII	109	101	202	189	339	349	438	430	525	528	571	600	599	621	664	668			4
1974	II, IV, VII, VIII	111	102	201	188	278	289	436	429	535	539	591	615	637	649	652	660			42
1973	II–IV, IX	102	91	133	133	232	241	296	303	545	550	586	612	586	637	644	654	684	683	62
1972	II–V	126	122	248	224	358	368	413	409	522	526									152
Total average		113	106	194	182	304	314	388	387	511	513	565	595	607	636	653	661	684	683	410
$t' = L'_{t+1} - L'_t$		113		81		110		84		123		54		42		46		31		
$t'' = L''_{t+1} - L''_t$			106		76		132		73		126		82		41		25		22	

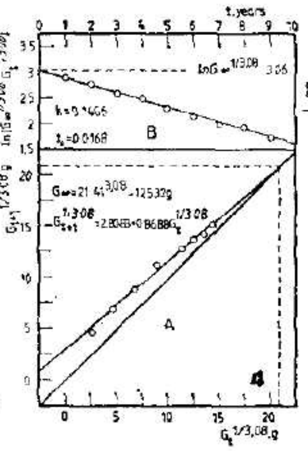
(L_{t+1}) *is well expressed in a line* (*Fig.* 3a), which is described by the equation $L_{t+1} = 123.4953 + 0.875L_t$. This brings out a regularity in an increase of age described by the equation of Bertalanffy (Fig. 5,1) — $L_t = 988[1 - e^{-0.1336(t+0.0098)}]$.

Length/weight (L)/(G) relationships at the time of catch and weight (G) is described by the equation $G = 8.1078 \,.\, 10^{-6} L^{3.0804}$ $/\lg G = -5.0911 + 3.0804 \lg L/$, $r = 0.988$ (Fig. 2). Changes in values of G depending on L in the various age groups are described by the following equations:

$G_1 = 3.8724 \,.\, 10^{-5} L_1^{2.7691}$ $/\lg G_1 = -4.412 + 2.7691 \lg L_1/$, $r = 0.999$
$G_2 = 1.2094 \,.\, 10^{-6} L_2^{3.4503}$ $/\lg G_2 = -5.9174 + 3.4503 \lg G_2/$, $r = 0.998$
$G_3 = 4.5058 \,.\, 10^{-3} L_3^{2.018}$ $/\lg G_3 = -2.3426 + 2.0185 \lg L_3/$, $r = 0.958$
$G_4 = 2.6009 \,.\, 10^{-5} L_4^{2.8751}$ $/\lg G_4 = -4.5849 + 2.8751 \lg L_4/$, $r = 0.999$
$G_5 = 4.4074 \,.\, 10^{-8} L_5^{3.9213}$ $/\lg G_5 = -7.3558 + 3.9213 \lg L_5/$, $r = 0.998$
$G_{6-9} = 2.7438 \,.\, 10^{-4} L_{6-9}^{2.5176}$ $/\lg G_{6-9} = -3.5616 + 2.5176 \lg L_{6-9}/$, $r = 0.996$.

Table 4 *gives the conditions* coefficients obtained through these equations, by means of the first, second and third method (v. Materials and Methods).





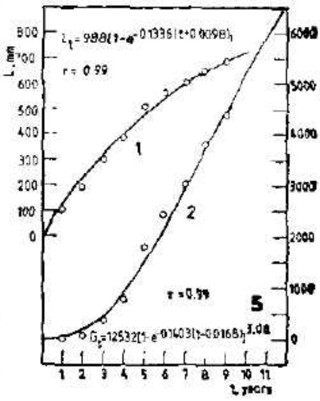


Fig. 3. Walford graph for length of linear increment. A — Relationship between body length of pikeperch at t age (L_t) and t + 1 age (L_{t+1}). B — age relationship between (t) and $l_n(L_\infty - L_t)$; L_∞, k, t_0 — parameters of Bertalanffy's equation.
Fig. 4. Walford graph for weight increment. A — relationship between the weight of pikeperch at age t years (G_t) and t + 1 years (G_{t+1}). B — Relationship between age (t) and $l_n(G_\infty - G_t)$; G_∞, k, t_0 (*parameters of Bertalanffy's equation*; *parameters of the equation on Fig.* 2.
Fig. 5. Graphs of Bertalanffy's equation for linear (1) and weight (2) increment.

By means of the established L and G relationship for the entire population we calculated the average length of fish with average weight: *1 g per* 44.95 ≈ *45 mm* (so-called "start" of Bank). *According to* **Bank** (*1940, the higher the value, the* better the start of the population. Drawing the L and G relationship from the equation separately for the first age group allowed us to establish the real mean length of fishes with a mean weight of 1 g = which was 39.2 mm.

Substituting the values of L′ and L″ from *Table* 1 *in the respective equations, describing the relationship between* G *and* L *we obtained the figures given in Table* 3.

The increase of mean annual values of G together with an increase of age (t) is well described by Bertalanffy's equation for weight increment (Fig. 5,2) — $G_t = 12532[1 - e^{-0.1403(t-0.0168)}]^{3.08}$. G and t show a high degree of proximity almost

Table 3. Average fish weights (g) in various generations

Generation	Age Group	Average fish weights at each vegetation period obtained through back calculation by the Ist method (G′) and second (G″ method																		Number
		G_1'	G_1''	G_2'	G_2''	G_3'	G_3''	G_4'	G_4''	G_5'	G_5''	G_6'	G_6''	G_7'	G_7''	G_8'	G_8''	G_9'	G_9''	
1982	I	45	48																	28
1980	I, III	14	12	72	63	643	710													16
1979	II – IV	12	10	113	95	295	438	619	602											17
1978	III – V	15	13	95	81	424	550	924	838	1710	1774									40
1977	I, IV – VI	18	16	46	41	194	333	607	592	1088	941	1802	2222							45
1976	I, II	12	10	128	108															4
1975	II, VII, VIII	15	14	102	87	504	612	1107	971	1936	2097	2518	2710	2914	2953	3995	3553			4
1974	II – IV, VII, VIII	16	14	100	85	274	417	1097	964	2057	2273	2794	2881	3521	3300	3789	3445			42
1973	II – IV, IX	12	10	28	26	158	289	332	353	2182	2456	2728	2841	2728	3150	3542	3366	4375	3747	62
1972	II – V	24	23	192	156	599	680	929	842	1908	2056									152
Total average		18	17	98	82	386	504	802	737	1814	1933	2460	2663	3054	3134	3809	3455	4375	3747	410
$t' = G'_{t+1} - G'_t$		18		80		288		416		1012		646		594		755		566		
$t'' = G''_{t+1} - G''_t$			17		65		422		233		1196		730		471		321		292	

Table 4. Coefficient of condition of pikeperch calculated in three different ways

Manner of of calculations	K_1	K_2	K_3	K_4	K_5	K_{6-9}
	Coefficient of condition (K) in different age groups					
K*	$3.88 \cdot 10^{-5}$	$1.21 \cdot 10^{-6}$	$4.51 \cdot 10^{-3}$	$2.60 \cdot 10^{-5}$	$4.41 \cdot 10^{-8}$	$2.74 \cdot 10^{-4}$
$K^{**} = G/L^3 \cdot 100$	1.52	2.15	1.67	1.36	1•34	1.25
$K^{***} = G/L^{3.08} \cdot 100$	0.85	0.82	0.74	1.01	1.37	1.04

* Coefficient K drawn from equation $G = kL^n$, for each separate age group

** Coefficient of Fulten

*** *Value 3.08 from* equation $G = 8 \cdot 1078 \cdot 10^{-6} L^{3.0804}$ for the whole population (Fig. 2)

reaching a functional level ($r = 0.99$). Mean error (S_D) of theoretical values of G related to empirical values does not exceed $\pm$ 8.29%. On Fig. 4, Bertalanffy's equation is presented in linear form $G_{t+1}^{1/3.08} = 2.8083 + 0.8688\, G_t^{1/3.08}$. It is evidentl from Bertalanffy's equation that the relationship between the mean weights at the end of the t year (G_t) and weights measured a year later (G_{t+1}) constitute a wel expressed line.

DISCUSSION

It is evident from Table 2 that the values of L_1'' and L_2'' in all generations are lower than their respective *values* L_1' and L_2'. Usually the difference is between 10 and 15 mm, however, in separate specimens it is much greater – 25 mm. At the end *of the third generation* period the reverse phenomenon occurs – the values of L obtained by means of the second method (L_3'') are greater than those obtain by the first method (L_3'). *In two* successive generations, which take up a middle position between the youngest and oldest age groups, the differences between L′ and L″ are relatively small and do not follow a regular pattern. Later, however, all values of L_6'', L_7'', L_8'' become considerably higher than those of L_6', L_7', L_8', as with L_3, where the difference reaches 30–40 mm. These results confirm our earlier conclusion that if age groups differences in the changes of L to S are not taken into consideration major errors ranging on serious errors may occur in the back calculations *of* L to S (Živkov & Vassilev, 1977, Živkov, 1980a, b, *Dikov & Živkov, 195a, b*). The table also shows the substantial differences in the growth rate of the different generations in the course *of the formation of the* population. The 1972 and 1982 generations are characterized by a comparatively rapid growth rate, while the 1973 and 1977 generations (after the first year) show a slower growth rate. Growth rate differences are greater illustrated during the first and in particular during the second year (*v.* the values of L_1 and L_2). For instance, L_2' in the 1972 generation is 248 mm. while that of the 1973 generation only 133 mm; L_1 in the 1973, 1976, 1979 and 1980 generations are approximately 100 mm, while that of the 1982 generation – 155 mm. These differences are considerably greater with the mean weight values (Table 3) for instance G_2' in the 1972 generation is 192 g, while with the 1973 generations it is hardly 28 g. Similar results have been reported by other authors. Serenko (1980) for instance, points out that in a 1978 generation pikeperch from the Beloe lake, L_1 differences are equal to a fourfold increase and those of G_1 a fiftyfold increase. This pheno-

Table 5. The growth of pike-perch in different water bodies

Locality and author	Average body lengths (mm) in different age (years)									
	l_1	l_2	l_3	l_4	l_5	l_6	l_7	l_8	l_9	l_{10}
Verchnaja Kama (Mensikov, Bukirov, 1934, by Bastl, 1965)	61	124	202	272	335	389	460	—	—	—
Gorkovskoe vodochranilišče reservoir (Koževnikov, 1965, by Tanasijčuk, 1974)	77	186	278	376	409	—	—	—	—	—
East part golf of Finland (Ilenkova, 1972)	82	179	246	284	347	412	471	500	560	—
Kama (Lukin, 1951)	91	212	326	390	456	498	526	—	—	—
Ilmen lake (Fedorova, 1974)	104	229	321	361	430	483	598	620	670	—
Onežskoe ozero-lake (Colmužskaja guba) (Klimova, 1935, by Ilenkova, 1972)	110	168	231	282	328	373	403	439	478	509
Rybinskoe vodochranilišče reservoir (Barsukov, 1959, Matjuchin, 1969)	110	202	272	321	363	402	423	—	—	—
Kujbyševskoe vodochranilišče reser (Smirnov, 1969, by Tanasijčuk, 1974)	111	206	297	381	443	—	—	—	—	—
*Tuusula (Oliva et all., 1968)	113	198	277	350	384	478	523	—	—	—
*Goplo lake (Oliva et all., 1968)	116	247	306	370	440	508	549	609	665	762
*Ladožskoe ozero lake (Oliva et all., 1968)	116	196	250	—	—	—	—	—	—	—
Batak reservoir (our data)	117	202	308	386	514	565	606	647	683	—
Orava reservoir (Bastl, 1965)	118	199	275	347	424	489	540	599	—	—
Hjálmaren See (Freidenfelt, 1922, by Bastl, 1965)	120	310	390	450	—	—	—	—	—	—
*Labe (Mohr, 1916, by Bastl, 1965)	120	—	230	—	280	300	320	—	—	—
Rańsk lake (Nagięc, 1961)	121	258	380	—	—	—	—	—	—	—
Kievskoe vodochranilišče reservoir (Konstantinova, 1973, by Tanasijčuk, 1974)	123	237	334	428	466	—	—	—	—	—
Jammo lake (Nagięc, 1961)	124	257	361	424	481	549	587	616	—	—
Batak reservoir, generation 1972 (our data)	125	247	358	413	522	—	—	—	—	—
Sneiardwy lake (Nagięc, 1961)	125	230	370	420	455	—	—	—	—	—
Ladožskoe ozero lake (Efimova, 1939, by Ilenkova, 1972)	127	200	258	318	373	415	458	497	565	603
Slapy reservoir (Oliva et all., 1968)	128	252	380	440	—	—	—	—	—	—
*Norddeutsche Seen (Bauch, 1955, by Bastl, 1965)	130	240	340	430	490	550	560	570	—	—
Iriklinskoe vodochranilišče reservoir (Matjuchin, 1969)	131	231	334	426	516	584	615	710	—	—
Wda river (Nagięc, 1961)	131	222	339	438	515	—	—	—	—	—
Pozedrze lake (Nagięc, 1961)	132	231	346	430	481	558	615	—	—	—
Zdruzov lake (Nagięc, 1961)	135	243	342	428	497	520	—	—	—	—
Ilmen lake (Berg, 1949)	142	251	344	425	502	572	638	686	725	—
Wzdydze lake (Nagięc, 1961)	142	243	344	423	479	527	—	—	—	—
*Muggel See (Oliva et all., 1968)	144	289	410	527	593	623	—	—	—	—
Dlugie lake (Nagięc, 1961)	148	250	355	428	486	560	—	—	—	—
Toften See (Alm, 1936, by Bastl, 1965)	150	230	290	340	390	440	480	530	580	640
Slapy reservoir (Čihaš, 1961)	150	225	301	402	497	522	—	—	—	—
*Charzykovo lake (Oliva et all., 1968)	150	280	—	400	505	585	625	662	720	—
Lemiet lake (Nagięc, 1961)	154	253	376	458	517	555	566	563	—	—
Strengiel lake (Nagięc, 1961)	154	257	362	430	—	—	—	—	—	—

Table 5. Continuation

Locality and author	Average body lengths (mm) in different age (years)									
	l_1	l_2	l_3	l_4	l_5	l_6	l_7	l_8	l_9	l_{10}
Wegielsztynskie lake (Nagięc, 1961)	155	275	365	438	—	—	—	—	—	—
Turawa lake (Nagięc, 1961)	156	292	394	489	538	—	—	—	—	—
Beloslavsko ezero-lake (Ivanov, 1968)	194	397	526	599	670	—	—	—	—	—
Mandrensko ezero lake (Ivanov, 1968)	218	366	466	539	608	700	—	—	—	—
Burgasko ezero lake (Ivanov, 1968)	219	383	489	550	—	—	—	—	—	—
G Dimitrov reservoir (Marinov, Bojadžiev, 1967)	231	369	477	595	632	—	—	—	—	—
Blatniško ezero-lake (Ivanov, 1968)	232	374	483	556	605	670	—	—	—	—
Danube Bulgarien (Ivanov, 1970)	158	235	345	422	482	—	—	—	—	—
Wenern See (Freidenfelt, 1922, by Bastl, 1965)	160	250	340	410	—	—	—	—	—	—
Cimljanskoe vodochranilišče-reservoir (Koval, 1980)	162	265	345	410	465	512	556	597	635	670
Aral See (Novokšonov, 1974)	166	269	359	425	476	521	566	608	644	665
Kuban (Berg, 1949)	168	372	438	488	560	613	696	726	—	—
Don (Berg, 1949)	169	320	374	423	479	544	609	681	—	—
Kuban (Cugunova, 1931, by Ilenkova, 1972)	170	299	407	484	519	556	594	695	—	—
Zyvy lake (Nagięc, 1961)	173	255	335	398	455	—	—	—	—	—
Sulak river (Glebov, 1932, by Ilenkova, 1972)	176	296	382	450	506	560	—	—	—	—
Don (Čugunova, 1931, by Ilenkova, 1972)	178	289	359	449	462	495	—	—	—	—
Cimljanskoe vodochranilišče reservoir (Tjunjakov, 1967, by Tanasijčuk, 1974)	179	271	371	426	463	501	—	—	—	—
Pamer lake (Nagięc, 1961)	192	289	379	451	543	535	570	600	—	—
Volga-delta (Kuzmin, 1952, by Tanasijčuk, 1974)	192	335	427	508	580	603	—	—	—	—
Kura Malt, 1932, by Ilenkova, 1972)	196	287	385	449	498	534	555	—	—	—
Južny Bug river (Ščerbucha, 1976, by Tanasijčuk, 1974)	196	316	392	436	494	567	636	—	—	—
Volga (Nagięc, 1961)	206	280	343	412	468	530	591	852	680	—
G Dimitrov reservoir (Marinov, Bojadžiev, 1967)	231	369	477	595	632	—	—	—	—	—
*Balaton (Oliva et all , 1968)	—	215	260	400	—	—	—	—	—	—
Kremenčugskoe vodochranilišče -reservoir (Tanasijčuk, 1974)	—	249	335	411	499	566	613	—	—	—
Kachovskoe vodochranilišče -reservor (Vaščenko, 1973, by Tanasijčuk, 1974)	—	305	408	468	555	—	—	—	—	—
Danube Slovakia (Sedlar, 1963, by Bastl, 1965)	—	—	363	440	535	660	—	—	—	—

* Total length

menon at the Batak Dam is due to the transition of pikeperch towards different types of food (zooplankton benthos, fish), and hence the growth rate depends on changes of qualitative development of invertebrates and fish-prey during different years. By studying the length relationship (L) of the predator in a given age group during different years and the mean abundance size in percentage of age groups, participating in the food chain ($N_1, \bar{N}_{1-2} \cdots$) of the dominant prey (roach), we established that the first and second age group between L and N do not show any correlation, or the correlation is insignificant (Petrova & Živkov, in print). This is due, as we see it, to the fact, that during the first two years of development of pikeperch, zooplankton and above all benthos organisms still play a major part in its diet. It is noteworthy here that the high values of L_2 in some generations are connected with the high water level values, while low values in years with lower water level. For example the mean quantity of water in the dam in 1977 was 258.5 mil. m^3 while the respective values of L_2' and G_2' during the same year were 217 mm and 128 g (Table 2 and 3). However, in 1974 the quantity of water in the dam was hardly 101.8 mill m^3 and the mean values of L_2' and G_2' respectively hardly 133 mm and 28 g.

Another cause for the absence of any relationship between L and N in the first age groups stems from relatively low numbers of the population (Petrova & Živkov, in print) during the initial period of the formation of the predator population (1972—1974), when the prey population is still relatively high, and has no limiting effect on the growth rate of the small numbers of predators.

A high correlation, almost a functional relationship between L and N/$L_3' = 256.88 + 1.72 \bar{N}_{1-3}$, $r = 0.95$; $L_3 = 282.42 + 5.14 \bar{N}_{1-4}$, $r = 0.98$/, was established during the third and fourth years of life of the predator population when it begins feeding entirely on fish.

Tables 2 shows that as age increases changes of the average annual increment (t) outline two periods: a period of relatively high values, ranging between 80 to 123 mm up to the fifth year, and a period of a fall in values later between 30—54 mm.

Similar observations could be made on variations of weight in various generations and ages, as well as with linear increments. Changes in annual growth ($t = G_n - G_{n-1}$) are different here. Up to the fifth year technical values show a regular growth, and after that the values of t'vary around 640 g, while t values (considerably more precise) show a regular fall from 730 g during the sixth year to 291 g during the ninth (Table 3).

Equations and graphs from Fig. 3 and Fig. 5.1 show that maximum (asymptomatic) average size of pikeperch under the conditions at the Batak Dam is 988 mm. If we resort to the coefficient $\frac{L_{max}}{L_\infty}$ of Hoendorf (1966) in order to make a comparison with the maximum length observed in the dam, we arrive at a comparatively low value of 0.77. This comes to show that the population, which only began to take shape since 1971, has not made sufficient use of its growth potential as yet. The growth rate or rather growth coefficient (after Ricker, 1975) is 0.1336, while prenatal time (t_0) is $-$ 0.0098, that is the hypothetical age at zero length of the fish if it has grown after the law described by that equation (Fig. 3,B).

Regardless of the great variation in growth rate of pikeperch in the process of the formation of its population, and the variation of abiotic factors in the dam, the degree of relationship between mean values of L and age (t) is considerable ($r = 0.99$), while the error (S_D) of theoretical values of L as compared with empirical values f does not exceed $\pm$ 8.1%.

As research on the parameters of this equation with other populations of pikeperch is not cited in literature, a comparative assessment of their values is not possible. Nevertheless it is interesting to compare the theoretical mean length

$L_\infty = 988$ mm with empirical max. lengths of individual specimens, found in this and other reservoirs. In the Batak Dam it is 760 mm; in other dams approximately 1000 mm. *in the Ladoga Lake 1300 mm etc.* (Petrova & Živkov, *in print*). Thus calculated, theoretical length is close to maximum empirical lengths of pikeperch from other dams and lakes, where it is a local species or had been introduced prior to its introduction at the Batak Dam.

The specific linear increment of pikeperch at the Batak Dam can also be established through its comparison with populations from other reservoirs (Table 5). Hence the arranging of reservoirs in this table either according to highest annual increment *value or last value of L in compared populations* (Živkov, 1972). Thus the populations at the beginning of the table are those with the slowest growth rate, and those at the end with the highest. It is evident from the table that the population from the Batak Dam (determined in this manner) comes 37th out of 60 compared populations, so that it represents an average situation.

However, what draws one's attention is the fact that in most cases the values of L_1 and L_2 at the Batak Dam are lower than those of L_1 and L_2 from other resérvoires, including many reservoirs preceeding Batak in the Table, i.e. where the average annual growth is smaller. This is due to the specific feeding base of the dam and in particular the comparatively poor development of zoobenthos (Dimitrov, 1962, 1967), which plays a major role in the diet of pikeperch during the first and second year. The average position of the population of the Batak Dam *in the Table is determined by the comparatively quicker growth rate of the older* age groups. This particularly comes out in the growth rate of the 1972 generation (Table 2 and 5). The numbers of non-predator fish-prey during this initial period of the formation of its population remain very high.

It follows from the equations and graphs (Fig. 4 and 5.2) that the asymptotic theoretical mean weight of pikeperch from the Batak Dam $(G)_\infty$ is 12532 g. If we use the coefficient of Hohendorf (1966) G_{max}/G_∞ as a comparison with the maximum weight at the dam ($G_{max} = 5000$ g), we arrive at a comparatively low value — 0.40. This is related to the population, which was only formed as far back as 1971, and not having reached its climax yet. Growth rate (k) is 0.1406, prenatal time (t_0) 0.0168. The power index (n = 3.0804 in Bertalanffy's equation for weight increment was drawn by the equation $G = 8.1078 . 10^{-6} L^{3.0804}$ (Fig. 2).

The results of the study of G and L relationships (v. Fig. 2) and equation $G = kL^n$, calculated for each age group separately, show the coefficient of correlation of these values, almost reaching the level of a functional relationship (in almost all instances $r = 0.99$).

We should note that the "start" of Bank of the Batak Dam population (45 mm per 1 g) *(Fig. 2) was almost identical with that of the population of the Orava Dam,* Czechoslovakia — 46 mm (Bastl, 1965).

Substantial differences occur in the changes of G to L relationship in the separate age groups; the values of the power indice (n) vary around 2.0185 in the third age group to 3.9213 in the fifth, while the remaining coefficient (k), which we used a a coefficient of condition, was respectively from $4.5058 . 10^{-3}$ to $4.4074 . 10^{-8}$. The cause for such variability should not only be sought with age differences in the condition of fish. In fact, with the increase of age no regular change occurs in the values of k, neither increase nor decrease, as the fish were caught during different periods and years, when the maturity of their gonades, the degree of the fullness of their stomachs and in particular the numbers of fish prey (Petrova & Živkov, in print) were quite different. These factor exercise a greater impact on the nature of the L-G relationship, i.e. on the condition of pikeperch, than its age structure For example, the small value of k in the fifth group is rather striking — $4.4074 \cdot 10^{-8}$ (see the equation for G_5) as the age line of regression between L and G is chiefly based on data on five year old specimens, caught in the spring of 1982. Hence the parameters of the equation shall be determined above all by the values of L and G at the end of the fifth vegetation period of the 1977 generation. It is evident from Table 3 that the mean value of G′ was only 1088 g, and that of G″ even smaller — 941 g, while the remaining values of G_5 are considerably higher (in some instances doubled). In fact the entire generation from 1977 after the first year is characterized by a comparatively slow growth rate.

Generally speaking great changes of the coefficient k in different age groups speak of its great sensitivity, potential and precision, if used as a coefficient of condition. Table 4 and earlier results and conclusions (Dikov & Živkov, 1985a, b) indicate that this is neither the case with the classical coefficient of Fulton nor the coefficient $k = \frac{G}{L^n}$, where $n = 3.08$ (Fig. 2).

CONCLUSIONS

The relationship between mean length (L) and mean length of the diagonal radius of the scale (S) is described by the equation $L = 59.7862 + 4.5469\,S + 0.0173\,S^2$. However, in the various age groups this relationship is described by linear equations with different parameters.

The relations between length (L) and weight (G) is given by the equation $G = 88.1078 \cdot 10^{-6}\,L^{3.0804}$. Age lines of regression between L and G are described by equations of the same type, however, their coefficients vary considerably. The differences are not only determined by age differences in the fish condition, but above all by the fact that the fish were caught over different years and seasons, when the maturity of their gonades, the degree of the fullness of their stomachs, and in particular the numbers of the prey population were quite different. Errors occur if age differences are not taken into consideration in L/S and G/L relationships through the use of age lines of regression for back calculation of L by S and of G by L. They range in certain cases between 30—40 mm and of over 400 g.

Different generations have varied growths rates, which are connected with differences in the quantitative development of invertebrates and prey-fish over different years. An almost functional relationship is established between the variations of body length of three and four year old pikeperch over various years and the numbers of roach — the dominant prey in the dam. The rapid growth of some generations is linked with the high values of the water level, the slow growth rate — with drier years. Up to the fifth year mean annual linear increment are comparatively high, after that much lower. Weight increment up to the fifth year grows regularly, followed by a downward trend.

In spite of the great variations of the growth rate of the different generations, a high degree of co-relationship between the mean values of L and (t) is established, as well as a high degree of relationship between G and t ($r = 0.99$). These relationships are satisfactorily expressed by Bertalanffy's equation.

The low values of the correlation between the maximum empirical length ($L_{max} = 760$ mm) and the asymptotic length ($L_\infty = 988$ mm) — 0.77 and in particular the correlation between G_{max} (5000 g) and G_∞ (12532 g) — 0.40 come to show that the population, which only began its formation in 1971, does not make sufficient use of its growth potential.

A complete picture of the condition for the pikeperch is obtained if k is used as a coefficient of condition in the equation $G = kL^n$, calculated for each age group.

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POCSIA KUNSTI N. SP. FROM TANZANIA (ACARI: ORIBATIDA: EUPHTHIRACARIDAE)

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Abstract. A new species of oribatid mites, *Pocsia kunsti* n. sp. is described and figured. A key for the species of the genus *Pocsia* Mahunka, 1983 is given.

INTRODUCTION

Dr. Purrini, protozoologist and pathologist of insects, working in Tanzania within the framework of the National Cononut Development Programme, sent me for determination a rich material from various parts of Tanzania. Four specimens of the genus *Pocsia* Mahunka, 1983 were found in this material. They differ from so far described *Pocsia* species by tridactylous legs and by different notogastral chaetotaxy. They evidently belong to the new species of this endemic genus. Diagnosis of the genus *Pocsia* Mahunka, 1983 will be necessarily extended by the fact that legs of this genus bear one or three claws and aspis is with one lateral carine or without one. This is the first contribution dealing with the rich material of Oribatida from Tanzania.

Pocsia kunsti sp. n.

Diagnosis: aspis with one lateral carine, 7 pairs of genital setae present on the genital plates, all legs tridactylous.

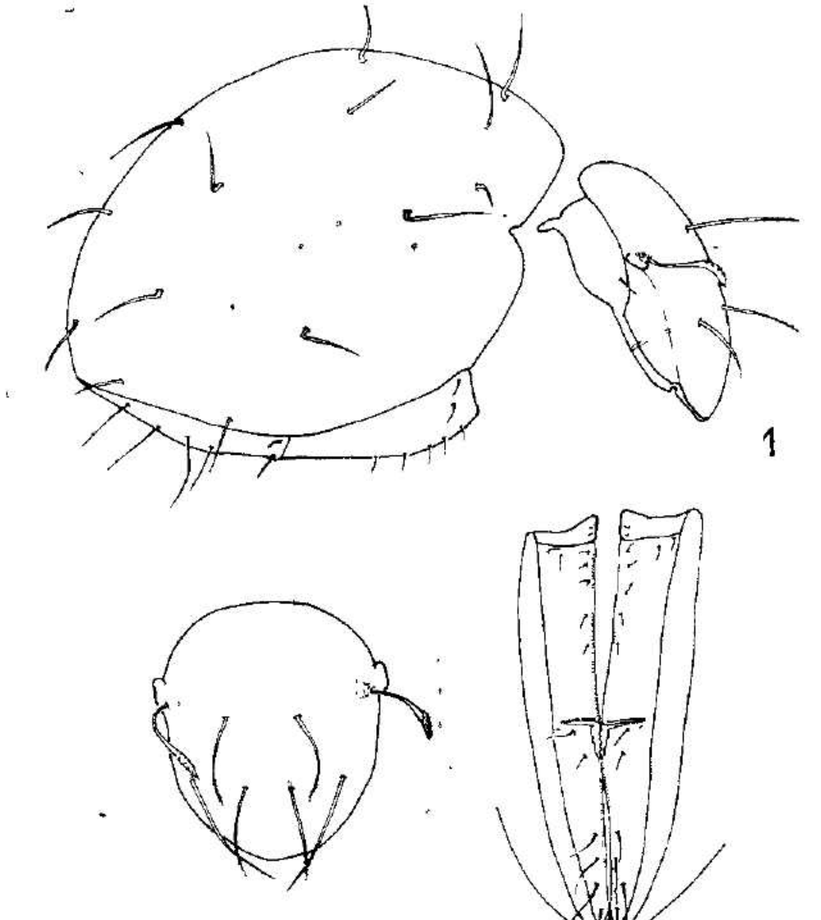
Description: Length of aspis 240—255 μm, length of notogaster 465—490 μm, height of notogaster 365—385 μm. Holotypus: length of aspis 249 μm, length of notogaster 479 μm, heigth of notogaster 376 μm. Colour dull ochre yellow. Cuticle fine smooth, without pits, grooves, and other structures.

Aspis (Fig. 1, 2) with well-developed lateral carine. Anterior border of aspis strong cut to the distinct incision, lateral border with conspicuous rim. Interlamellar setae 1,5× longer than the lamellar ones. Length of rostral setae approximately equal with lamellar ones, lying on the level of the lamellar ones. Exobothridial setae fine, approximately equal in the length with bothridial scale lying under bothridium. All setae on aspis comparatively strong, tapering of the sharp spike. Lamellar and interlamellar setae bear very fine, badly observable, bristles on their distal third. Rostral setae wholy smooth. Sensillus, originating in pear-shaped bothridium, has slender stalk gradualy extended, without conspicuous head on the top, distal part of the sensillus terminated with short spike and roughed with several bristles.

Notogaster oval, smooth, without distinct structures, four pairs of lyrifissures well visible. Notogastral setae arched, very finely roughed in distal part. Setae c3 are the shortest and cp longest ones on notogaster. Setae cp three times longer than c3, setae c1 approximately 1.5× longer than d1, setae of the c row do not reach the base of the setae in the following rows.

Anogenital region (Fig. 3). genitoadgenital plates with 7 genital setae, genital ones g1—g5 fine, smooth. equal in the length. In the anterior part of genitoadgenital plates two, badly observable genital setae g6 and g7 present. Genitoadgenital and adanalanal plates separated by well-developed suture, which begin in the interlocking triangle, second interlocking triangle connects the end of the adanalanal plates. Adanal setae ad 1 three times longer than ad 2 and ad 3, anal setae and adanal setae ad 1 fine pointed, several times longer than genital ones, and equal in the length to notogastral ones.

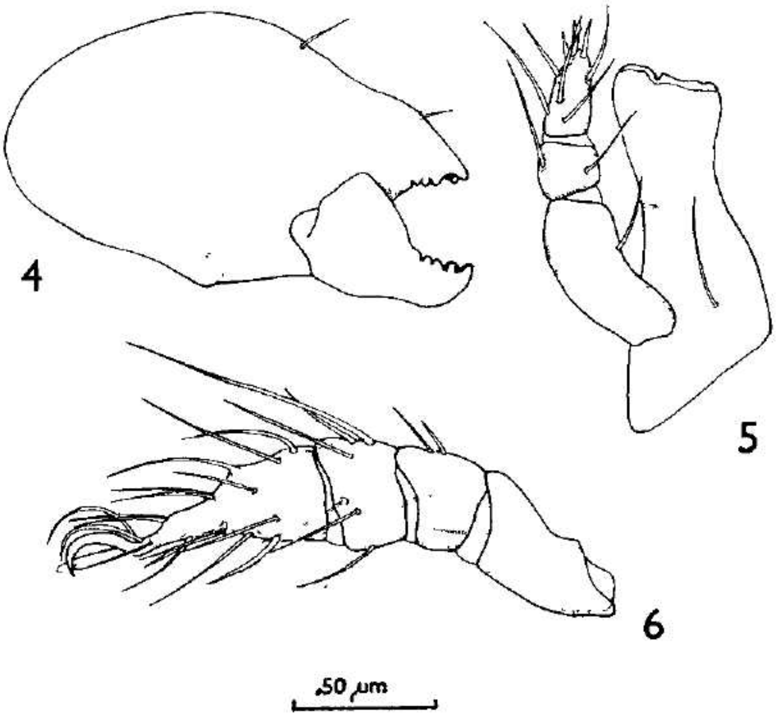
Chelicerae (Fig. 4) bulk large, robust, digitus fixus 2.5× longer than digitus



Figs. 1—3. ***Pocsia kunsti* sp. n.: 1** — lateral view, 2 — aspis, 3 — anogenital region

mobilis, both with 5 teeth, surface of the chelicerae smooth without sculpturae seta chb longer than cha. Length of digitus fixus (holotypus) 161 μm, width 90 μm. length of the digitus mobilis 64 μm. Palps (Fig. 5) added to masive genae bearing broad bluntly ended rutelum with one conspicuous incision.

Legs (Fig. 6) thickset, all tridactylous.



Figs. 4—6. *Pocsia kunsti* sp. n.: 4 — chelicera, 5 — palpus, 6 — leg.

Discussion: The genus *Pocsia* Mahunka, 1983 was described as monodactylous. The new species is easily distinguishable from all other species of this genus by tridactylous legs. The closest related species is *Pocsia secunda* Mahunka, 1983. The new species differs from it by smaller size, seta c2 equal in the length to c1 (*P. secunda:* c2 twice longer than c1), seta g1 equal in the length to g2 (*P. secunda:* g1 three times longer than g2). Four species of the genus *Pocsia* Mahunka, 1983 are known in the world oribatid fauna up to now. All those species were described from Tanzania and it is possible to distinguish them according to the following key:

1 Legs tridactylous . . . . *Pocsia kunsti* n sp.
— Legs monodactylous 2
2 Aspis without lateral carine . . . . *Pocsia trenta* Mahunka, 1983
— Aspis with one lateral carine 3
3 Length of the setae cp approximately equal to the length c3, posterior part of the genitoadgenital plates with 3 genital setae . . . . *Pocsia africana* Mahunka, 1983
— Seta cp three times longer than c3, posterior part of genitoadgenital plates with 5 genital setae . . . . *Pocsia secunda* Mahunka, 1983

Locus typicus: Tanzania, Mts. Usambara, 2500 m, 24. 4. 1985, four specimens in Berlese sample from *Sphagnum* sp. litter with humus from stones in a tropical wet rainforest, leg. K. Purrini.

Holotypus (female) No. 999-1, in slide, and 3 paratypes in etanol deposited in the author's collection in the Institute of Soil Biology of the Czechoslovak Academy of Sciences, České Budějovice.

Derivatio nominis: The new species was named in honour of my university teacher, the renowned Czechoslovak and world acarologist, the late Dr. Miroslav Kunst CSc., Department of Zoology, Charles University, Prague, who brought me to soil zoology and acarology.

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NEUE PALÄARKTISCHE ARTEN UND UNTERARTEN DER GATTUNGEN CHALICODOMA UND MEGACHILE (HYMENOPTERA, APOIDEA, MEGACHILIDAE)

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Abstract. There are described the following taxa: *Chalicodoma* (*Pseudomegachile*) *ericetorum eurou* ssp. n. from Algeria, *Chalicodoma* (*Chalicodoma*) *kashmirensis* sp. n. from Kashmir, *Chalicodoma* (*Chalicodoma*) *albonotata italica* ssp. n. from Central Italy, *Chalicodoma* (*Chalicodoma*) *mongoliae* sp. n. from Mongolia, *Chalicodoma* (*Chalicodoma*) *karatauensis* sp. n. from USSR, Kazakhstan, *Chalicodoma* (*Chalicodoma*) *ladakhensis* sp. n. from Ladakh, *Chalicodoma* (*Chalicodoma*) *pyrenaica asiae* ssp. n. from Asia Minor, *Chalicodoma* (*Chalicodoma*) *cressa* sp. n. from Crete, *Chalicodoma* (*Chalicodoma*) *palaestina* sp. n. from Israel, *Megachile* (*Delomegachile*) *circumcincta numidica* ssp. n. from Algeria, *Megachile* (*Delomegachile*) *willughbiella zeraldae* ssp. n. from Algeria, *Megachile* (*Delomegachile*) *analis ulangomensis* ssp. n., *turgensis* ssp. n. and *batsumberensis* ssp. n. from three separated areas of Mongolia, *Megachile pilicrus sogdiana* ssp. n. from USSR, Kirghisia and *Megachile* (*Neoeutricharaea*) *jakesi* sp. n. from Afghanistan.

Im weiblichen Geschlecht erscheint die Morphologie der *Chalicodoma* s. str.-Arten ungemein konform und die quantitativen sowie qualitativen Nuancen in der Punktierung der einzelnen Sklerite stehen oft gerade an der Grenze der optischen Wahrnehmung. Hier und da ist zwar dieses oder jenes Merkmal recht kenntlich ausgeprägt, so dass es doch als ein verlassliches diagnostisches Kriterium verwendet werden kann [wie beispielsweise die relativ sehr dichte Punktierung der Tegulae bei *Chalicodoma canescens* (Brullé, 1839), die charakteristische Bildung des Clypeus-Vorderrandes bei *Ch. nasidens* (Friese, 1898), die deutlichen Unterschiede in der Anordnung der Punktierung des Propodeum bei einer Reihe weiterer Arten, die grobe und einigermassen ungleichmässige Punktierung des Vertex bei *Ch. albonotata* Radoszkowski, 1886, die Wangenlänge und die relativ weitläufige Punktierung der Clypeus-Scheibe bei *Ch. ladakhensis* sp. n.], im allgemeinen ist aber die cuticulare Skulptur an sich allein für die eindeutige taxonomische Abgrenzung der Arten kaum genügend. Eben deshalb ist hier in den Beschreibungen der neuen Arten die artspezifische Farbung der Cuticula (ausgenommen die Trophi, Komplexaugen und Ocelli) sowie das Kolorit und die Beschaffenheit der Behaarung akzentuiert. Die genaue systematische Stellung aller dieser indes leider nur im weiblichen Geschlecht angeführten Arten wird allerdings erst nach dem Bekanntwerden der einschlagigen Männchen klargestellt sein, denn allein die Bildung der Sternite 5 und 6 sowie die der terminalen Partie der Laciniae des männlichen Kopulationsapparats stellt ein unverkennbares Kriterium der echten Verwandtschaft dar.

Bemerkenswert ist die Tatsache, dass einige in Mitteleuropa häufig vorkommende *Megachile*-Arten sowie eine *Chalicodoma*-Art im paläarktischen Teil N-Afrikas auffallende, durch recht stark melanisierte Behaarung übereinstimmend gekennzeichnete geographische Rassen bilden. In der Literatur wurde dieses Phänomen bisher nur bei *Chalicodoma* (*Pseudomegachile*) *ericetorum* (Lepeletier, 1841) (cf. die Pérezsche, nomenklatorisch jedoch nicht belegte Definition zitiert von Friese, 1899 : 140) und bei *Megachile* (*Macromegachile*) *lagopoda* (Linnaeus, 1761) durch die Beschreibung

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der var. *algira* Friese, 1899 : 120, für die später als nomen novum *nigricans* Alfken, 1914* veröffentlicht wurde. Bei zwei weiteren *Megachile*-Arten wird auf diese charakteristische Melanisation erst an dieser Stelle eingegangen.

Das kürzlich in der Mongolei gesammelte Material zeigte, dass hier die eurosibirische, vor allem im weiblichen Geschlecht ungemein veränderliche, stark polytypische *Megachile* (*Delomegachile*) *analis* Nylander zumindest drei bisher ganz unbekannte geographische Rassen bildet. Die am nördlichsten vorkommende *batsumberensis* ssp. n. ist der sibirischen ssp. *chionura* Cockerell, 1924 noch ziemlich ähnlich, die zwei übrigen zeichnen sich aber schon durch ein recht abweichendes Kolorit der Behaarung aus: ein übereinstimmendes Merkmal aller dieser drei neuen Rassen ist das absolute Fehlen einer schwarzen Behaarung der Tergite.

Da es kaum möglich ist, die Körperlänge der getrockneten Sammlungsstücke infolge der Schrumpfung oder dagegen infolge eines eventuellen partiellen Herausziehens der abdominalen Segmente in exakter Weise anzugeben, wird durch die Bezeichnung „ca.“ eine ±0,5–1 mm Toleranz wiedergegeben.

Bei allen datierten Exemplaren werden wie üblich folgende Abkürzungen des Grades der Abgeflogenheit verwendet: sa = sehr abgeflogen, a = abgeflogen, ea = etwas abgeflogen, nf = nahezu frisch, f = frisch.

Der Verfasser dankt allen, die ihm durch die Bereitstellung des Materials oder der Literatur opferwillig behilflich waren; es sind dies die Herren Dr. M. Comba (Cecchina, Roma), Doz. Dr. M. Dorn (Halle), † J. Heinrich (Aschaffenburg, † Dr. A. Hoffer (Prag), Dr. Z. Pádr, CSc. (Prag), Dr. J. Stehlík, CSc. (Brno), Prof. P. Tyrner und G. v. d. Zanden (Eindhoven).

Chalicodoma (*Pseudomegachile*) *ericetorum euroa* ssp. n.

Holotypus: ♂ (f) „Africa sept. Algeria Alger Tipasa 8. VI. 1972, A. Hoffer“; coll. Autor
Paratypus: ♂ (f) „Africa sept. Algeria Alger Zeralda 10. VI. 1972, A. Hoffer“; coll. Autor

Körperlänge ca. 12 mm; Länge des Vorderflügels 7,5 mm.

Kolorit der Behaarung in folgenden Einzelheiten von der Nominatrasse verschieden: Pronotum, Mesoscutum, Scutellum und Metanotum dunkelbraun. Thorax-Unterseite schmutziggelb. Abstehende Behaarung der Tergite 1 und 2 meist dunkelbraun (bei dem Paratypus schmutzigbraungelb). Sämtliche abstehende Haare der Basalhälfte des 3. und der Basalpartie des 4. Tergits schwarz.

Chalicodoma (*Chalicodoma*) *kashmirensis* sp. n.

Holotypus: ♀ (ea) „Cashem et Jam. Chhantir Gali 5–7–VIII. 1954 F. Schmidt“; coll. Rijksmuseum van Natuurlijke Historie Leiden.

Eine auffallende, mit der Typusart der Gattung nahe verwandte und von ihr auf den ersten Blick besonders durch die markante leuchtend rötlichgelbe cuticulare Aufhellung der Beine sowie durch die relativ hellen Flügel gekennzeichnete Art.

Morphologie: Von der sehr nahe verwandten *Ch. parietina* (Geoffroy in Fourcroy, 1785) durch folgende (meist subtile) Merkmale verschieden: Punktierung des Vertex oberhalb der OOL weniger grob, Punkte im allgemeinen mehr rundlich und gleichmässiger, Zwischenräume zwar stark glänzend, stellenweise jedoch mit schwacher Andeutung einer verschwommenen Chagrinierung. Punktierung an und unterhalb der OOL ebenfalls weniger grob, deutlich mehr gedrängt, ausgesprochen wabig,

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* Prioritätsberechtigt und gültig erscheint dieser subspezifische Name allerdings nur unter der Voraussetzung, dass *Chalicodoma* mit *Megachile* nicht für kongenerisch gehalten wird; im Gegenteil müsste diese nordafrikanische Rasse umbenannt werden, weil der Name durch *Chalicodoma sicula* var. *nigricans* Friese, 1913 praeoccupiert wäre.

überall mit nur gratartigen Zwischenräumen. Die grob skulptierte Basalpartie des herzförmigen Raumes ausgedehnter.

Körperlänge ca. 15 mm; Länge des Vorderflügels 12 mm.

Färbung der Cuticula: Kopf, Thorax und Abdomen schwarz (stellenweise mit dunkel rötlichbraunem Anflug); Tegulae schwarzbraun, eine breite unbehaarte Partie am Aussenrand lehmgelb aufgehellt. Coxae und Trochanteren schwarz; Femora dunkel rotbraun, terminal (besonders die hinteren) partiell lehmgelb aufgehellt; Tibiae und Tarsi markant leuchtend rötlichgelb, Tibiae terminal an der Aussenseite schmal verdunkelt; Sporen honiggelb; Apikalhälfte der Klauen rötlichbraun. – Membran der Vorderflügel nur mittelmässig stark bräunlich getrübt (also wesentlich heller als bei der Vergleichsart). Apikalsaum nicht dunkler; ein dunklerer brauner Längswisch am Vorderrand der Radialzelle. Geäder dunkelbraun, stellenweise lehmgelb halbtransparent.

Behaarung im allgemeinen etwas länger und ungleichmässiger als bei der Vergleichsart. Kopf, Thorax, drei proximale Beinsegmente und Tergite schwarz. Pro- und Mesotibiae an der Aussenseite sowie Metatibiae am Hinterrand dunkelbraun, sonst gänzlich honiggelb; Tarsi honiggelb. Scopa lateral schwarz, in der Mittelpartie der Sternite hell fuchsrot.

Chalicodoma (*Chalicodoma*) *albonotata italica* ssp. n.

Holotypus: ♀ (f) Italien „Marsica (Appenn. Centr.) Km 25 della S. S. Marsicana (c. N del Val. di Gioia) m. 1200 1. VI. 1961 Comba leg.“; coll. Autor.

Paratypi: 2 ♀ (ea) „Parco Nazionale d'Abruzzo luglio 1957“; coll. Autor.

Körperlänge ca. 13 mm; Länge des Vorderflügels 9 mm.

Das **Kolorit der Behaarung** unterscheidet sich von der Nominatrasse und ssp. *setulosa* Pérez, 1895 durch das absolute Fehlen der hellen, fast schuppenartigen Behaarung der Tergite 5 und 6, von der Nominatrasse darüberhinaus auch durch die grauweisse Behaarung des Kopfes (Vertex schwärzlich), Thorax (Mesoscutum-Scheibe und Scutellum schwärzlich) und der Tergite 1 und 2, ferner durch die weissen Zilien am Apikalrand der Tergite 3 und 4 und durch die leuchtend rötlichgelbe Scopa.

Taxonomische Notizen über die Art cf. Tkalců (1974 : 344–345).

Chalicodoma (*Chalicodoma*) *mongoliae* sp. n.

Holotypus: ♀ (f) Mongolei, „Bulgan-gol SW MVR 23. 5. 1978 an *Caragana* leg. M. Stubbe, Ansorge, Uhlenhaut“; coll. Martin Luther-Universität, Halle-Wittenberg.

Paratypus: ♀ (f) SW-Mongolei, Bulgan-gol/Auwald, 12. V. 1974, leg. Piechocki/Stubbe; coll. Autor.

Morphologie: Wangen und Kaurand der Mandibulae ähnlich wie bei der Typusart (Wangenlänge in der Mitte 80 µm), Dorsalfläche der Mandibulae zum Teil chagriniert. Clypeus-Vorderrand Fig. 1; Scheibe dicht punktiert, basal (65–80 µm) gröber als in der Vorderhälfte (35–50 µm), fast wabig, Zwischenräume rippenartig (basal stellenweise etwas breiter), poliert. Stirnschildchen wie die Basalpartie der Clypeus-Scheibe punktiert. Abstand des Oberrandes des seitlichen Ocellus vom Kopfhinterrand nur ein wenig grösser als der Ocellus-Durchmesser. Punktierung der lateralen Partie des Vertex oberhalb der OOL noch etwas dichter als bei der Typusart. Durchmesser der gröbsten Punkte 75 µm, Zwischenräume nur rippenartig. Verhältnis der drei proximalen Geisselglieder Fig. 6. Punktierung des Mesoscutum ähnlich wie bei der Typusart, beiderseits der vorderen Mittellängsnaht wabig, mit nur gratartigen Zwischenräumen. Unbehaarte Partie der Tegulae mit nur vereinzelten, sehr ungleichmässig verstreuten Punkten, poliert, am Rand undeutlich mikroskopisch gerieft. Propodeum dicht, scharf eingestochen punktiert, Zwischenräume rippenartig bis (stellenweise) ca. punktbreit, chagriniert. Der konkave Basalteil des 1. Tergits poliert, im Bereich der ziemlich dichten Punktierung chagriniert; Zwischenräume noch breiter als der Punktdurchmesser. Punktierung der Tergite scharf eingestochen, ähnlich wie bei der Typusart.

Körperlänge ca. 12 mm; Länge des Vorderflügels 9,5 mm.

Färbung der Cuticula: Schwarz. Mandibulae gelbrot, mit einem schwarzen Fleck basal, schwarzem Apikal- und Subapikalzahn und einem dunkleren Saum am Kaurand. Tegulae hell bräunlichgelb, nur am Innenrand schwarz. Leuchtend rötlichgelb sind die Apikalpartie der Femora, Tibiae und Tarsen *aller drei Beinpaare*; Tibiae-Sporen honiggelb. Apikalhälfte der Klauen dunkler, rötlichbraun. — Membran der Vorderflügel fast wasserhell, Apikalfeld nur leicht bräunlichgelb angeraucht; ein hellbrauner Längswisch am Flügelvorderrand in der Radialzelle. Geäder pechbraun, nur Costa und die Basalpartie der Madialader heller bräunlichgelb.

Behaarung: Ziemlich lang und struppig. Kopf weisslich, Frontovertex braun. Mesoscutum und Scutellum gelblich, Thorax ansonsten weisslich; Mesosternum in der Mitte leicht gelblich. Coxae bis Tibiae weiss, die Tarsen gelblich. Die Anordnung der Behaarung der Tergite ähnlich wie bei *Ch. tenorai* Tkalců, 1970. Tergite 1 bis 5 ziemlich lang abstehend satt honiggelb behaart (dünne Borstenhaare), apikal mit dichten, breiten, aus kürzeren dicken, fast schuppenartigen gelblichen Haaren bestehenden Binden (beim 1. Tergit noch relativ locker). 6. Tergit fast gänzlich mit schuppenartiger Behaarung bedeckt, mit eingestreuten abstehenden, nur locker aufsitzenden Borstenhaaren; nur die Spitze frei von schuppenartiger Behaarung, mit unbewaffnetem Auge beobachtet dunkel erscheidend und nur unauffällig kurz honiggelb behaart. Scopa weisslichgelb, weiss schillernd.

Chalicodoma (*Chalicodoma*) *karatauensis* sp. n.

Holotypus: ♀ (ea) „USSR — Kazachstan Džambul env. 3. 6. 1980 Kara Tau, průsmyk Ujuk (1000 m) Dr. Z. Pádr lgt."; coll. Autor.

Paratypus: ♀ (ea) mit denselben Angaben wie der Holotypus.

Der vorhergehenden Art äusserlich täuschend ähnlich und von ihr durch folgende artspezifische Merkmale verschieden: Wangen kürzer, in der Mitte nur 65 µm lang. Clypeus-Vorderrand Fig. 2. Abstand des Oberrandes des seitlichen Ocellus vom Kopfhinterrand grösser, wie 1 1/2 Ocellus-Durchmesser. Vertex oberhalb der OOL deutlich gröber und weniger dicht punktiert, Durchmesser der gröbsten Punkte 80 µm; Zwischenräume dieser groben Punktierung von halber Punktbreite, stark glänzend (nur stellenweise bei bestimmtem Lichteinfall leicht chagriniert). Verhältnis der drei proximalen Geisselglieder Fig. 7. Mesoscutum im allgemeinen weniger gedrängt punktiert, die Punkte vorn zu beiden Seiten der vorderen Mittellängsnaht mehr rundlich, Zwischenräume wulstig, rippenartig bis zu halber Punktbreite, poliert.

Körperlänge 13 mm.

Membran der Vorderflügel in der Apikalhälfte ein wenig dunkler, auch der bräunliche Längswisch in der Radialzelle intensiver.

Behaarung des Vertex und des Mesoscutum von gleicher Färbung, satt bräunlichgelb. Behaarung der Tergite (besonders die dichten und breiten Apikalbinden) heller, blassgelb (ob bei ganz frischen Exemplaren, muss noch nachgeprüft werden).

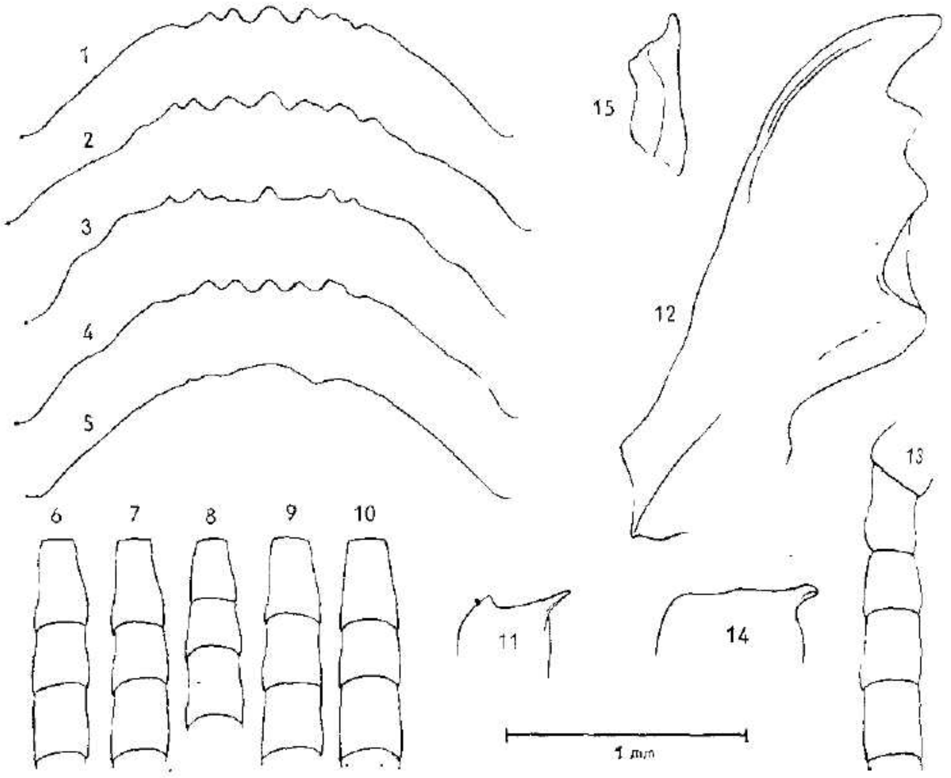

Fig. 1—5: Clypeus-Vorderrand. 1 — *Chalicodoma mongoliae* sp. n., ♀; 2 — *Ch. karatauensis* sp. n., ♀; 3 — *Ch. ladakhensis* sp. n., ♀; 4 — *Ch. cressa* sp. n., ♀; 5 — *Ch. palaestina* sp. n., ♀.
Fig. 6—10: Drei proximale Geisselglieder des rechten Fühlers. 6 — *Ch. mongoliae* sp. n., ♀; 7 — *Ch. karatauensis* sp. n., ♀; 8 — *Ch. ladakhensis* sp. n., ♀; 9 — *Ch. cressa* sp. n., ♀; 10 — *Ch. palaestina* sp. n., ♀.
Fig. 11: Uncus der rechten Protibia von *Ch. ladakhensis* sp. n., ♀.
Fig. 12—15: *Megachile jakesi* sp. n., ♀; 12 — Linke Mandibula; 13 — Drei proximale Geisselglieder des rechten Fühlers; 14 — Uncus der rechten Protibia; 15 — Strigilis.

Chalicodoma (*Chalicodoma*) *ladakhensis* sp. n.

Holotypus: ♀ (f) 1) „India, Ladakh J. Tangelder". 2) „Yuruche 20 km SW Leh meadow near brook 3900 m 30. VII. 1933"; coll. Rijksmuseum van Natuurlijke Historie Leiden.

Morphologie: Wangen deutlich länger als bei der Typusart, in der Mitte 110 µm lang, die glatte Stelle am vorderen Mandibelgelenk aber weniger markant. Kaurand der Mandibulae ähnlich wie bei der Typusart, Dorsalfläche fast gänzlich poliert. Clypeus-Vorderrand Fig. 3; Scheibe deutlich weniger dicht als üblich punktiert. Punkte rundlich, grubig, in der Basalhälfte 50—65 µm, in der Vorderhälfte weniger grob; Zwischenräume rippenartig bis (stellenweise) punktbreit, in der Basalhälfte poliert, in der Vorderhälfte chagriniert. Punktierung des Stirnschildchens noch ein wenig gröber und weitläufiger als die der Basalpartie der Clypeus-Scheibe. Abstand des Oberrandes des seitlichen Ocellus vom Kopfhinterrand wie 1 1/2 Ocellus-Durchmesser. Punktierung der lateralen Partie des Vertex oberhalb der OOL noch ein wenig dichter als bei der Typusart. Durchmesser der gröbsten Punkte 70 µm. Verhältnis der drei proximalen Geisselglieder Fig. 8. Punktierung des Mesoscutum weiger dicht als bei der Typusart, Punkte rundlich, Zwischenräume rippenartig bis zu halber Punktbreite (nur stellenweise fast punktbreit), in der Vorderhälfte chagriniert, in der Hinterhälfte poliert. Unbehaarte Partie der Tegulae mit nur vereinzelten, sehr ungleichmässig verstreuten flachen und unscharf eingestochenen Punkten, glänzend, am Rand undeutlich mikroskopisch gerieft. Propodeum (auch oben) weniger dicht, unscharf eingestochen und feiner punktiert, Zwischenräume vielfach punktbreit, glänzend, verschwommen chagriniert. Beine auffallend schlank: Uncus der Pro- und Mesotibiae deutlich länger und schlanker als bei der Typusart (Fig. 11). Der konkave Basalteil des 1. Tergits nur in der Mittelpartie verschwommen chagriniert, Punktierung fein, scharf eingestochen, aber auffallend spärlich und weitläufig, mit mehrfach punktbreiten Zwischenräumen. Punktierung der Tergite scharf eingestochen.

Körperlänge ca. 12 mm; Länge des Vorderflügels 9 mm.

Färbung der Cuticula: Schwarz. Leuchtend gelblichrot sind die Mandibulae (mit einem ca. dreieckigen schwarzen Fleck an der Basis und dunkel rotbraunem Saum am Kaurand), laterale Partie des Labrum, ein kleiner ventroapikaler Fleck der Meso- und Metacoxae, eine schmale medioapikale Partie der Trochanteren (die mehr ins Gelbliche getönt ist) und die restlichen Segmente aller drei Beinpaare; Femora schmal basal geschwärzt, die Profemora nebstdem mit einem schwarzen Längswisch an der Aussenseite, der die basalen 2/3 deren Gesamtlänge einnimmt. Tibiae-Sporen hellgelb; Klauen in mehr als distaler Hälfte dunkel rotbraun. Tegulae hell ockergelb, nur am Innenrand geschwärzt. Sternite 1—5 mit rötlichgelb aufgehelltem Apikalsaum (am markantesten und breitesten beim 1. Sternit, bei den nachfolgenden graduell schmäler, am schmalsten beim 5. Sternit). — Membran der Vorderflügel fast wasserhell, Apikalfeld (infolge der angehäuften Papillae) geringfügig dunkler; ein hellbrauner Längswisch am Flügelvorderrand in der Radialzelle. Geäder pechbraun, nur direkt an der Flügelbasis heller, bräunlichrot bis gelbrot.

Behaarung: Ziemlich lang und struppig. Kopf abstehend satt bräunlichgelb, Nebengesicht und Schläfen weiss (Skulptur der Clypeus-Scheibe und des Stirnschildchens sehr gut sichtbar). Thorax weisslich, Mesoscutum schmutziggelb. Coxae, Trochanteren und Femora weisslich, Tibiae und Tarsen gelb. Die dichte abstehende weisse Behaarung an der Aussenfläche der Profemora länger als die Femur-Breite. Tergit-Behaarung sehr ähnlich wie bei *Ch. mongoliae* sp. n. Scopa-Haare recht kurz, weisslich, gegen das Abdomen-Ende gelblich.

Chalicodoma (*Chalicodoma*) *pyrenaica asiae* ssp. n.

Holotypus: ♀ (f) 1) „Elazig As. Türkei 28.—29. V. 1975 leg. J. Heinrich", 2) „*Chalicod. pyrenaica* Lep. ♀ J. Heinrich det. 1977"; coll. Autor.

Paratypus: ♀ (ea) „Armenia 18 km E. Erevan 11—VII—03 A. G. Soika"; coll. Mus. Nat. d'Hist. Nat. Paris.

Morphologie (einschliesslich der Körpergrösse) und die Färbung der Cuticula wie bei der Nominatrasse.

Behaarung: Deutlich etwas kürzer als bei der Nominatrasse. Clypeus, Nebengesicht, Stirnschildchen und untere Stirnpartie weisslich (ohne Beimischung dunkler Haare). Frontovertex schwärzlich, Schläfen weisslich mit einzelnen schwärzlichen Haaren am Komplexaugenrand, Hinterwangen schmal bräunlich; Setae der Mandibulae honiggelb. Thorax weisslich (oben leicht gelblich getönt), Mesoscutum bis auf die ganz schmalen peripheren hellen Partien gänzlich schwarz. Beine wie bei der Nominatrasse. Tergite 1—4 einfarbig weisslich mit einem Stich ins Gelbliche; 5. Tergit mit kombinierter Behaarung: Neben den normalen schwarzen Borstenhaaren befinden sich vielfach kürzere, beiderseits kurz und dicht gefiederte weissliche Haare, die am Apikalrand eine deutliche Haarfranse bilden (ähnliche Haarfransen auch bei den Tergiten 3 und 4). Scopa leuchtend rötlichgelb.

Von allen bisher bekannten Populationen dieser stark polytypischen Art durch die Behaarung des 5. Tergits markant verschieden.

Chalicodoma (*Chalicodoma*) *cressa* sp. n.

Holotypus: ♀ (f) „Gr Kreta Ierapetra-Myrtos 24—4—84 (4) Westrich leg."; coll. Rijksmuseum van Natuurlijke Historie Leiden.

Morphologie: Wangen fast nur linienschmal (in der Mitte 50 µm lang), die glatte Stelle am vorderen Mandibelgelenk sehr gut entwickelt. Kaurand der Mandibulae ähnlich wie bei der Typusart, Dorsalfläche zum Teil chagriniert. Clypeus-Vorderrand Fig. 4; Skulptur der Clypeus-Scheibe ähnlich wie bei der Typusart. Abstand des Oberrandes des seitlichen Ocellus vom Kopfhinterrand wie der doppelte Ocellus-Durchmesser. Punktierung der lateralen Partie des Vertex oberhalb der OOL noch ein wenig dichter als bei der Typusart, Durchmesser der gröbsten Punkte 80 µm. Verhältnis der drei proximalen Geisselglieder Fig. 9. Punktierung des Mesoscutum ähnlich wie bei der Typusart. Unbehaarte Partie der Tegulae weitläufig, scharf eingestochen punktiert, Zwischenräume mehrfach punktbreit, stark glänzend, stellenweise mit undeutlicher mikroskopischer Riefung. Propodeum sehr gedrängt, fast wabig, scharf eingestochen punktiert, Zwischenräume gratartig, nur stellenweise breiter, chagriniert. Der konkave Basalteil des 1. Tergits poliert, nur basal leicht chagriniert; die relativ dicht punktierte Partie sehr ausgedehnt, Punktierung ziemlich scharf eingestochen, Zwischenräume rippenartig bis punktbreit. Tergite stark glänzend, Punktierung weniger dicht als bei der Typusart, scharf eingestochen.

Körperlänge 12 mm; Länge des Vorderflügels 9 mm.

Färbung der Cuticula: Schwarz. Mandibulae am Kaurand mit rötlich aufgehelltem Saum. Tegulae schwarz, nur eine schmale Partie am Aussenrand bräunlichrot angelaufen. Uncus der Pro- und Mesotibiae leuchtend bräunlichrot. Tarsenglieder 2—4 aller drei Beinpaare und der Metabasitarsus (ausgenommen basal) mehr oder weniger dunkel bräunlichrot; alle Klauenglieder rötlichgelb; Klauen in ihrer distalen Hälfte dunkler, bräunlichrot. Tibiae-Sporen dunkel honiggelb. — Membran der Vorderflügel hell bräunlich, mit einem (nicht nur infolge der angehäuften Papillae) dunkleren Apikalfeld. Geäder dunkel pechbraun, nur direkt an der Flügelbasis zum Teil heller.

Behaarung: Mittelmässig dicht und lang. Clypeus und Stirnschildchen nur ganz kurz (Skulptur überall sehr gut sichtbar), Nebengesicht und untere Stirnpartie länger und dicht weiss; Frontovertex schwärzlich; Schläfen weiss, mit schwärzlichen Haaren am Komplexaugenrand, Hinterwangen dunkel honiggelb. Setae des Labrum und der Mandibulae dunkel honiggelb. Thorax weisslich, Mesoscutum (bis auf die diffus begrenzten schmalen peripheren Partien) sowie das Scutellum (ausgenommen die Partie am Hinterrand) schwärzlich; Mesepisternum weisslichgelb. Beine kurz weisslichgelb, Tarsen leuchtend satt honiggelb. 1. Tergit abstehend weisslich mit lockerer Haarfranse am Apikalrand, die nur lateral dichter wird. 2. Tergit fast abstehend, schmal basal weisslich, sonst hell honiggelb (diese Partie von oben betrachtet infolge der abstehenden und lockeren Behaarung scheinbar kahl erscheinend (Skulptur überall sehr gut sichtbar), am Apikalrand mit aus kurzen plattgedrückten, reichlich kurz gefiederten weisslichen Härchen bestehenden anliegenden Binde, die median nur schmal und locker, lateral dagegen sehr dicht und deutlich breiter erscheint. 3. Tergit sehr ähnlich behaart, aber etwas kürzer und ohne die weissen Haare basal, median auf der Scheibe mit ganz geringer Beimischung schwärzlicher abstehender Haare. 4. und 5. Tergit im allgemeinen ebenfalls ähnlich (ohne die weisslichen Haare basal und ohne Beimischung schwärzlicher Haare median), die schräg nach hinten abstehende Behaarung jedoch in Form dickerer, etwas gebogener Borstenhaare; die gelblichweisse anliegende Apikalbinde auch in der Mitte dicht und breiter als bei den davorliegenden Tergiten, ihre Basalgrenze aber unscharf, einzelne kurze plattgedrückte, reichlich kurz gefiederte gelblichweisse Härchen auch auf der davorliegenden Tergit-Scheibe eingestreut. 6. Tergit basal mit dickeren halbabstehenden hell honiggelben Borstenhaaren, die apikalwärts kürzer und sparsamer werden, darunter dicht mit kurzen anliegenden plattgedrückten, reichlich gefiederten gelblichweissen Härchen befilzt, in der Apikalpartie dicht mit kurzen (einfachen) honiggelben Härchen bedeckt (Skulptur zum Teil noch sichtbar). Scopa honiggelb.

Von *Ch. albonotata* Radoszkowski, 1886 verschieden durch die gleichmassigere, weniger grobe Punktierung des Vertex oberhalb der OOL, mit nur schmalen Zwischenräumen, durch die gleichmässigere Punktierung des Propodeum an der Spitze des herzförmigen Raumes mit nur ganz schmalen Zwischenräumen, durch die dunkleren Tegulae und durch die honiggelben (nicht tiefschwarzen) abstehenden Borstenhaare der Tergite 4—6; von *Ch. pyrenaica* (Lepeletier, 1841) verschieden durch die deutlich dunklere Färbung der Cuticula aller Tarsen und durch das absolute Fehlen der tiefschwarzen Borsten der distalen Tergite sowie durch das hell behaarte 6. Tergit; von *Ch. rufescens* Pérez, 1879 verschieden durch die etwas gleichmässigere und weniger grobe Punktierung des Vertex oberhalb der OOL, durch die schwarzen (am Aussenrand nicht breit gelblichbraun halbtransparenten) Tegulae, durch die dunklere Behaarung des Mesoscutum, durch das absolute Fehlen der schwärzlichen Behaarung der distalen Tergite sowie durch das dicht hell behaarte 6. Tergit.

Chalicodoma (*Chalicodoma*) *palaestina* sp. n.

Holotypus: ♀ (nf) „Israel Wadi el Kelt 2. 6. 1953"; coll. Autor.

Morphologie: Wangen in der Mitte nicht entwickelt. Kaurand der Mandibulae ähnlich wie die der Typusart, Dorsalfläche poliert. Clypeus-Vorderrand (Fig. 5) ohne die übliche Krenulierung; Scheibe sehr gedrängt und feiner als üblich punktiert, Punktdurchmesser durchschnittlich 50 µm, Zwischenräume rippenartig, poliert. Punktierung des Stirnschildchens ähnlich. Abstand des Oberrandes des seitlichen Ocellus vom Kopfhinterrand so gross wie der Ocellus-Durchmesser. Punktierung der lateralen Partie des Vertex oberhalb der OOL mit chagrinierten Zwischenräumen; Durchmesser der gröbsten Punkte 65—80 µm. Verhältnis der drei proximalen Geisselglieder Fig. 10. Punktierung des Mesoscutum sehr gleichmässig, wabig, Durchmesser der penta- bis hexagonalen Punkte 60—65 µm, die Punktkonkavitäten als glänzende Kreischen mit dunklem Mittelpunkt erscheinend; Zwischenräume überall nur gratartig. Ähnliche Punktierung auch auf dem Scutellum und den Mesopleuren. Unbehaarte Partie der Tegulae mitten dicht, unscharf eingestochen punktiert, Zwischenräume rippenartig bis punktbreit, am Rand jedoch nur vereinzelt punktiert, überall mattglänzend, unscharf chagriniert. Propodeum oben sehr gedrängt rundlich grob und scharf eingestochen punktiert, Zwischenräume gratartig; unten feiner, unscharf eingestochen und weitläufiger punktiert, Zwischenräume bis punktbreit, glänzend, verschwommen chagriniert. Der konkave Basalteil des 1. Tergits gänzlich chagriniert, Punktierung ziemlich dicht, unscharf eingestochen. Punktierung der Tergite sehr gedrängt und gleichmässig, dichter und feiner als bei der Typusart, nicht scharf eingestochen, alle Tergitscheiben chagriniert.

Körperlänge ca. 12 mm; Länge des Vorderflügels 9 mm.

Färbung der Cuticula: Schwarz. Hell rötlichgelb sind die Mandibulae (mit etwas dunklerem Saum am Kaurand), das Labrum, die Fühler (das terminale Geisselglied apikal geschwärzt), das Pronotum einschliesslich der Schulterbeulen und sämtliche Beinsegmente aller drei Beinpaare; Apikalhälfte der Klauen rotbraun. Tibiae-Sporen honiggelb. Etwas dunkler und zugleich mehr rötlich getönt als die Beine sind ein breiter lateraler Streifen des Mesoscutum, 1. Tergit (mit bilateralen schwarzen Flecken an der Basis des konkaven Basalteiles), 2. und 3. Tergit (mediobasal diffus schwärzlich gefleckt); 4. Tergit noch geringfügig dunkler, bräunlichrot, mit einem diffusen schwarzen Querstreifen in der Mitte, medioapikal diffus schwarz gefleckt und lateral schwarz; 5. Tergit grösstenteils schwarz, am Apikalrand mit bräunlichrot aufgehelltem Saum. 1. Sternit grösstenteils gelblichrot, basal deutlich geschwärzt, am Apikalrand heller gelblich, mit einem linienschmalen blassgelben Apikalsaum. Sternite 2—5 dunkel (schwärzlich, stellenweise aber diffus rötlichbraun), am Apikalrand breit gelblichrot, mit einem linienschmalen blassgelben Apikalsaum. — Membran der Vorderflügel im allgemeinen deutlich zweifarbig: die Basalhälfte sehr hell, leicht gelb getönt, die Apikalhälfte braun verdunkelt; Raum zwischen der Costa und Subcosta, die Medial- und Submedialzelle hellgelb (ein Streifen an der Basalader fast wasserhell); Radialzelle proximal am Flügelvorderrand heller, bräunlichgelb, sonst dunkler braun, mit einem sehr intensiven dunkelbraunen undurchsichtigen Längswisch; 1. Cubitalzelle proximal hell gelblichbraun, distal dunkler, bräunlich; 2. Cubitalzelle dunkler, bräunlich (die Trübung noch im Apikalfeld am Aussenrand der 2. Cubitalquerader kenntlich); 1. Diskoidalzelle proximal sehr hell, distal bräunlich getrübt; 2. Diskoidalzelle bräunlich getrübt mit einer Y-ähnlichen Figur; Brachialzelle oben gelblich, mitten mit einem breiten bräunlichen Längswisch, unten sehr hell (nur leicht bräunlich getönt); Apikalfeld der Vorderflügel zwar bräunlich getrübt, aber im allgemeinen heller als die dunklen Partien der Radial- und der 2. Cubitalzelle. Geäder ebenfalls deutlich zweifarbig: In der Basalhälfte des Vorderflügels (einschliesslich des Pterostigma) hell rötlichgelb, in der Apikalhälfte pechbraun (einen Übergang in der Färbung bilden die 1. Cubitalquer- und die 1. Diskoidalquerader). Hinterflügel fast wasserhell, am Vorderrand gelblich, im Apikalfeld leicht bräunlich angeraucht. Geäder proximal hell rötlichgelb, ansonsten gelbbraun.

Behaarung äusserst kurz, wie geschoren (am längsten sind die weissen Haarfransen am Propodeum lateral), an den Schläfen und auf den Tergiten zu Schuppen modifiziert. Clypeus sehr kurz (190 μm), abstehend schmutziggelb (die meisten Haare terminal ein wenig nach vorn eingebogen), Skulptur überall gut sichtbar; Nebengesicht nur geringfügig länger, halbabstehend, schmutziggelb; Stirnschildchen und Frontovertex ebenfalls etwas länger, abstehend honiggelb. Behaarung der Schläfen modifiziert: Sämtliche Haare kurz (am längsten hinten, am kürzesten am Komplexaugenrand), plattgedrückt, beiderseits kurz und reichlich gefiedert, weiss, mit zahlreichen eingestreuten rostroten Haaren; Hinterwangen mit längeren schmutziggelben Borstenhaaren. Setae des Labrum und der Mandibulae schmutzig- bis honiggelb. Scapus kurz halbabstehend honiggelb. Pronotum sehr kurz, abstehend satt honiggelb; Mesonotum grösstenteils nahezu kahl, mit nur locker aufsitzenden kurzen (110 μm) abstehenden gräulichen Härchen (meist nur bei Profilansicht erkennbar). Mesonotum lateral auf der rötlich aufgehellten Partie, am Hinterrand und das Scutellum (ausgenommen der Hinterrand) mit kurzen (ca. 240 μm), recht dichten und fast anliegenden, nach vorn gerichteten satt honiggelben Borsten; Axillae und Scutellum-Hinterrand mehr abstehend, etwas länger, das Metanotum ebenfalls abstehend, lateral noch länger, sämtlich satt honiggelb. Mesopleuren halbabstehend kurz (190—240 µm) honiggelb, gleich unterhalb der Tegulae mit einem markanten reinweissen Fleck aus kürzeren, dicht und reichlich gefiederten Härchen. Propodeum median locker (480 µm) hell honiggelb, sublateral mit markanten langen (800 µm) reinweissen Haarfransen, lateral aber nur sehr kurz (190 µm) abstehend honiggelb. Behaarung der Beine äusserst kurz, honiggelb; Haarlänge am Hinterrand der Metatibiae nur 70—80 µm. Der konkave Basalteil des 1. Tergits locker abstehend honiggelb: der dorsale Teil kurz (unauffällig) honiggelb (Skulptur sichtbar), desgleichen der laterale, ventral umgeschlagene Teil; Apikalrand mit schuppenartiger honiggelber Behaarung, die eine Binde bildet; lateral ein grosser, ca. dreieckiger Haarfleck aus etwas längeren schuppenartigen reinweissen Haaren. 2. Tergit ähnlich, aber die apikale Binde in der Tergit-Mitte breiter, basal diffus begrenzt, der laterale reinweisse Haarfleck grösser. 3. Tergit sehr ähnlich, die ganz kurzen (65 µm), nach hinten gerichteten abstehenden Borsten in der Tergit-Mitte schwärzlich; 4. Tergit ebenfalls ähnlich, aber die reinweissen lateralen Haarflecke mehr diffus und kleiner (die schuppenartige Behaarung grösstenteils honiggelb). 5. Tergit bis auf eine laterale Partie fast gänzlich mit schuppenartiger honiggelber Behaarung bedeckt (nur am Apikalrand lateral schmal und diffus reinweiss), mit eingestreuten kurzen abstehenden, in der Tergit-Mitte schwärzlichen, ansonsten aber honiggelben (95 µm) Borsten. 6. Tergit gleichmässig mit kurzen, fast anliegenden schwarzen Härchen bedeckt (Skulptur noch gut sichtbar), in der Basalhälfte mit eingestreuten abstehenden, nach hinten gerichteten dicken reinschwarzen Borsten; sublateral in der Basalhälfte bilaterale diffuse Flecken aus einigermassen ungleichmässig aufsitzenden schuppenartigen honiggelben Härchen. Scopa-Haare relativ kurz, honiggelb.

Durch die relativ feine, sehr gedrängte und gleichmässige Punktierung des Thorax, das rötliche Zeichnungsmuster der Thorax-Cuticula, sowie durch die ungewöhnlich kurze, zum Teil schuppenartig modifizierte Behaarung weicht die Art auffallend von dem üblichen Habitus der meisten *Chalicodoma* s. str.-Arten ab.

Megachile (*Delomegachile*) *circumcincta numidica* ssp. n.

Holotypus: ♀ (a) „Gr. Kabylie: Djurdjura Africa sept.: Algeria A. Hoffer et J. Horák“; coll. Autor.

Körperlänge 12 mm; Länge des Vorderflügels 9 mm.

Kolorit der Behaarung von der Nominatrasse in folgenden Einzelheiten verschieden: Gesicht dunkelbraun, ohne Beimischung gelber Haare. Thorax-Rücken einschliesslich der oberen lateralen Partie des Propodeum und die Tergite 1—3 dunkelbraun (Apikalsaum des 3. Tergits sogar rein schwarz). Scopa sehr dunkel, in graduellen Übergang von einer gelbbraunen Färbung basal bis zu einer schwärzlichen terminal. Mesopleuren weisslich.

Megachile (*Delomegachile*) *willughbiella zeraldae* ssp. n.

Holotypus: ♀ (f) „Africa sept.: Algeria Alger-Zeralda 10. VI. 1972 A. Hoffer“; coll. Autor.

Körperlänge 12,5 mm; Länge des Vorderflügels 9 mm.

Kolorit der Behaarung von der Nominatrasse in folgenden Einzelheiten verschieden: Kopf und Thorax-Rücken dunkelbraun. Tergite 1—3 schmutziggelbbraun (Apikalrand des 3. Tergits schwärzlich). Thorax lateral und unten bräunlichgrau. Beine im allgemeinen dunkel. Helle Apikalfransen der Tergite weniger markant und nur lateral vorhanden; 5. Tergit überhaupt ohne apikale helle Haarfranse. Scopa der Sternite 2—4 dunkel, rötlichbraun.

Megachile (*Delomegachile*) *analis ulangomensis* ssp. n.

Holotypus: ♀ (nf) Mongolei 1) „78G12", 2) „78 Stat I 5.–22. 6. 78 MVR, Urs Aimag Charchira-ul 30 km S. Ulangom Umgeb. Kurort Steppe 1340 m NN"; coll. Martin-Luther-Universitat Halle Wittenberg.

Paratypi: 3 ♀ (1 nf, 2 f) mit denselben Angaben wie der Holotypus (davon 2 ♀ in coll. Autor.). Detto, VI. 1978, 3 ♀ (a, nf, f), 1 ♂ (nf) (♂ in coll. Autor). Detto, 15. VII. 1977, 1 ♀ (a), lgt. Dorn, samtlich coll. Martin-Luther Universitat Halle Wittenberg. Oase Echingol, 16. VI., 1 ♀ (nf), Mongol. Deutsch. Exp. 1962. Urs-Aimak, Tarialen, Staatsgut „Charchiraa", 5.–12. VII. 1986, 3 ♀ (ea) lgt. Dorn (1 ♀ in coll. Autor); coll. detto.

Erganzungsmaterial (nicht als Paratypen bezeichnet): 3 ♂ wie der Holotypus bezeichnet, 16 ♂ detto, vom V. 1978 (ohne Bezeichnung der Meereshohe). Oase Echingol, 16. VI., 1 ♂ (a), Mongol. Deutsch. Exp. 1962; samtlich coll. Martin-Luther-Universitat Halle Wittenberg.

Megachile (*Delomegachile*) *analis turgensis* ssp. n.

Holotypus: ♀ (nf) Mongolei „MVR Turgen 135 km Ulan Bator Juni 1981 Grosse"; coll. Martin-Luther-Universitat Halle-Wittenberg.

Paratypi: 2 ♀ (ea nf) detto (1 ♀ in coll. Autor).

Erganzungsmaterial (nicht als Paratypen bezeichnet): 2 ♂ (a) detto.

Megachile (*Delomegachile*) *analis batsumberensis* ssp. n.

Holotypus: ♀ (ea) Mongolei „MVR Tov-Aimak Batsumber leg.: Dorn 2. 7. 86" (an *Medicago*); coll. Martin-Luther Universitat Halle-Wittenberg.

Paratypus: ♀ (ea) MVR, Ulan-Bator Šarga-Mort, 3. VII. 1986, lgt. Dorn, coll. Autor.

Von der ssp. *chionura* Cockerell, 1924 vor allem durch das Fehlen schwarzer Haare auf der Scheibe der Tergite 4 und 5 und durch die weit weniger zahlreiche dunkle Behaarung des Vertex und des Mesoscutum verschieden.

Gegenuberstellung der drei neuen Rassen:

M. analis *ulangomensis* ssp. n.	*M. analis* *turgensis* ssp. n.	*M. analis* *batsumberensis* ssp. n.
	♀	
Kopf satt gelb behaart.	Kopf schwarz behaart.	Kopf weiss, Vertex mehr oder weniger schwarzlich behaart.
Thorax-Rucken satt gelb, Pleuren und Unterseite weisslich behaart.	Thorax-Rucken gelb, Pleuren und Unterseite schwarz behaart.	Thorax weiss behaart (Mesoscutum median mit Beimischung dunkler Haare).
Beine weisslich behaart	Beine schwarz behaart.	Beine grosstenteils weisslich behaart
Tergite 1–5 satt honiggelb behaart, mit dichten apikalen gelben Haarbinden.	Tergite 1–5 satt honiggelb behaart, mit dichten apikalen gelben Haarbinden.	Tergite 1–5 weiss behaart, mit dichten apikalen weissen Haarbinden.
6. Tergit dicht weisslich befilzt.	6. Tergit vorwiegend dunkel, basal mit weisslichen Filzhaaren.	6. Tergit dicht weiss befilzt.

Scopa fuchsrot, nur auf dem 6. Sternit zum Teil dunkelbraun.	Scopa fuchsrot, nur auf dem 2. und 6. Sternit meistens schwärzlich.	Scopa auf dem 2. Sternit schmutziggelb, auf den Sterniten 3 und 4 schmutzig honiggelb (bei dem Holotypus lateral schwarz, bei dem Paratypus nur auf dem 4. Sternit lateral schmal schwarz), auf den Sterniten 5 und 6 schwarz.
	♂	
Gänzlich hell behaart (ohne Beimischung schwarzer Haare:) Vertex und Thorax-Rücken sattgelb, Gesicht, Thorax-Seiten, Thorax-Unterseite und Beine weisslich. Tergite grell honiggelb bis fuchsrot.	(Die zwei vorliegenden abgeflogenen Exemplare mit verschossenem Kolorit der Behaarung scheinen keine wesentlichen Unterschiede von der Vergleichsrasse aufzuweisen.)	

Megachile pilicrus sogdiana ssp. n.

Holotypus: ♀ (ea) „USSR – Asia c. Kirgisia Kadamžoj Fergana env. 600 m 22.–23. 6. 1980 P. Tyrner leg."; coll. Tyrner

Paratypus: 1 ♀ detto.

Zutreffende Beschreibung in Alfken (1930 : 838), Bestätigung der Existenz in Popov (1967 : 76), sämtlich aber ohne einen subspezifischen Namen.

Die Färbung der Scopa ist bei den beiden vorliegenden Exemplaren weisslich, nur auf den Sterniten 5 und 6 hell ockergelb.

Bisher bekannte Verbreitung: Kirgisien, Umgebung von Fergana; Usbekistan, Taschkent (Alfken, l. c.); Tadshikistan, Duschanbe (Popov, l. c.).

Die Art ist in den subgenerischen Merkmalen mit *Megachile* s. str. in beiden Geschlechtern übereinstimmend, bis auf das Fehlen des charakteristischen Zahnes in der Basalpartie des Aussenrandes der Mandibulae der Männchen (cf. Alfken, 1931 : 162) (In der Nearktis fehlt dieser Zahn bei *Neomegachile* und *Cresoniella*, die Weibchen dieser beiden Untergattungen weisen jedoch 4-zähnige Mandibulae auf.)

Megachile (Neoeutricharaea) jakesi sp. n.

Holotypus: ♀ (ea) 1) „Wahi-Namak Šor 16. 6. 1964 400 m (27)". 2) „N. Afghanistan Prov. Herat coll. O. Jakeš", coll. Mährisches Museum Brno.

Paratypi: 21 ♀ (1 *a*, 8 *ea*, 8 *nf*, 4 *f*) detto (davon 3 ♀ in coll. Autor).

♀ – **Morphologie:** Mandibula Fig. 12; Mittel- und Randkiel nur in der Apikalhälfte der Dorsalfläche entwickelt, wulstig (Randkiel sogar breit wulstig), kahl, fast poliert; der dazwischen liegende Sulcus sehr deutlich. Basalhälfte der Dorsalfläche poliert, eine Partie direkt an der Mandibel-Basis dicht, sehr fein (15–30 μm), aber etwas ungleichmässig punktiert, Zwischenräume rippenartig, stellenweise punktbreit; die übrige Partie der Basalfläche mit dichter und grober Skulptur: Punkte länglich, mit länglichen polierten, schmal wulstigen Zwischenräumen: Skulptur in dem vom Kaurand, Basal- und Mittelkiel begrenzten Dreieck noch gröber, die spiegelglatten Wulsten breiter. Labrum poliert, mit sehr zerstreuten ungleichmässigen Punkten (40–50 μm), nur direkt an den Seitenrändern und am Vorderrand dicht und sehr fein (ca. 10 μm) punktiert. Punktierung der Clypeus-Scheibe lediglich in der Mittellängspartie gut sichtbar, hier dicht, mittelmässig grob (30 bis 55 µm), rundlich, scharf eingestochen; Zwischenräume rippenartig, poliert, eine unregelmassig begrenzte punktfreie, ca. von einem bis zu doppeltem Punktdurchmesser breite polierte Mittellängslinie vorhanden. Clypeus-Vorderrand fast geradlinig, wulstig, mit einem mittleren und je zwei seitlichen kleinen abgerundeten Höckern. Punktierung des Stirnschildchens ahnlich wie die der angrenzenden Basalpartie des Clypeus in der Mitte mit einer unregelmässig begrenzten punktfreien und stark glanzenden Stelle. Oberrand der seitlichen Ocelli etwas unterhalb der gedachten Supraorbitallinie liegend. OOL = 800 µm. Abstand der Aussenränder der seitlichen Oceli = 1340 µm. Abstand des mittleren Ocellus vom Kopfhinterrand = 960 µm. Vertex fast dreifach so breit wie der Durchmesser des seitlichen Ocellus. Punktierung des Frontovertex an der OOL sowie der mittleren Vertex-Partie zwischen dem Ocelli Dreieck und dem Kopfhinterrand sehr dicht, scharf engestochen meist hexagonal (30—50 µm); Zwischenräume nur ripponartig. stark glänzend: Punktierung der Vertex-Seiten markant grober (bis zu 80 µm), mehr rundlich. grubig; Zwischenräume breit, stellenweise zwar nur rippenartig, vielfach aber auch punktbreit, sehr fein und scharf chagriniert. mit stellenweise verstreuten winzig kleinen Pünktchen von ca. 10 µm. Verhaltnis der drei proximalen Geisselglieder Fig. 13. Punktierung des Mesoscutum überall sehr dicht, meist hexagonal, mittelmässig grob (30—65 µm). grubig. scharf eingestochen: Zwischenräume nur als feine glanzende, dennoch chagrinierte Grate. Punktierung des Scutellum ähnlich, in der Mittelpartie geringfügig gröber. Zwischenräume aber ohne Chagrinierung. Tegulae seidenglänzend. fein chagriniert. mit dichter, gleichmässiger, nur unscharf eingestochener Punktierung von ca. 10—15 µm. Skulptur der Mesopleuren (unter der dichten und langen Behaarung schwer sichtbar) ähnlich wie auf dem Mesoscutum. Zwischenraume poliert. Metanotum dicht, fein (15 µm) punktiert, Zwischenraume punktbreit. chagriniert. Herzförmiger Raum ganzlich matt, mit feiner retikularer Mikroskulptur. Punktierung des Propodeum am herzformigen Raum dicht, fein (15 µm), recht gleichmässig, Zwischenraume ca. punktbreit, scharf chagriniert, matt. Uncus der Protibia Fig 14. Strigilis Fig. 15 Metabasitarsus so breit wie die Metatibia, Vorderrand gleichmässig bogig (maximale Breite in der Mitte), Hinterrand gerade; Aussenfläche der Metatibiae und Metatarsi poliert. recht dicht und gleichmässig punktiert. Der konkave Basalteil des 1. Tergits kahl, glänzend. bei starker Vergrösserung äusserst fein und unscharf mikroskopisch quergerieft; Konfiguration der Punktierung nur in der mediobasalen Partie (näheres cf. weiter unten im Absatz „Behaarung"). Der dorsale Teil des 1. Tergits ziemlich dicht und relativ gleichmässig. seicht und unscharf eingestochen punktiert (ca. 20 µm), Zwischenräume punktbreit bis zu doppelter Punktbreite. chagriniert. ziemlich stark glänzend. Der praegradulare Teil des 2. Tergits dicht. scharf eingestochen, rundlich grubig punktiert (ca. 30 µm), Zwischenraume bis punktbreit, chagriniert, glänzend; Gradulus scharf; eine schmale, tief eingesenkte quere Konkavitat direkt hinter dem Gradulus stark glänzend, punktfrei: Mittelpartie der 2. Tergit-Scheibe ähnlich wie der Dorsalteil des 1. Tergits punktiert: Tergit-Scheibe sublateral mässig vorgebeult. mit einem grossen transversalen. ganzlich matten, äusserst fein. aber etwas verschwommen chagrinierten „Samtfleck": Punktierung am Apikalrand dieser Partie zum Teil grober. Der praegradulare Teil des 3. Tergits wie der des 2. Tergits punktiert, Gradulus und die Querrinne ebenfalls ähnlich; Tergit-Scheibe aber gröber (ca. 30 bis 50 µm) und schärfer eingestochen punktiert, lateral massig vorgebeult und an der oralen Grenze der apikalen Haarbinde markant weitläufig punktiert; Apikalsaum des 2. Tergits median von der davorliegenden Tergit-Scheibe nur undeutlich, ansonsten aber sehr deutlich kantig abgesetzt und sehr fein (ca. 15 µm) und dicht, scharf eingestochen punktiert (die Skulptur dieses Apikalsaumes der Tergit-Scheibe normalerweise mit dichter anliegender Haarbinde bedeckt und unsichtbar); Zwischenraume samtlich chagriniert, doch stark glanzend. Skulptur des 4. und 5. Tergits ähnlich wie beim 3. Tergit, Gradulus beim 4. Tergit aber in der Mite nur unmerklich wulstig (nicht kantig) angedeutet. Skulptur des 6. Tergits unter der sehr dichten Behaarung kaum sichtbar. Sternite 2—5 bis auf den aufgehellten Apikalsaum gleichmässig, sehr dicht, seicht und unscharf eingestochen punktiert, ganzlich chagriniert. 6. Sternit scharf chagriniert, stark glanzend, in einer breiten Mittelpartie nur weitlaufig und ungleichmässig, nur lateral dichter punktiert.

Körperlange ca. 14 mm; Länge des Vorderflügels 10,5 mm.

Färbung der Cuticula: Schwarz. Fühlergeissel braunschwarz. Mandibulae mit dunkel rotbrauen Partien. Tegulae braunlichgelb, halbtransparent, am Innenrand schmal schwarz. Beine braunschwarz bis dunkel rötlichbraun: Uncus der Protibia leuchtend bräunlichgelb; Klauenglieder gelbbraun, Basalhälfte der Klauen gelbbraun, Apikalhälfte dunkler, rötlichbraun. Tergite 1—5 mit einem (beim 2. Tergit lateralen, bei den Tergiten 3—5 durchgehenden) schwach rötlichbraun aufgehellten eingedrückten Apikalsaum. 1. und 2. Tergit mit kaum erkennbarem Metallanhauch; Scheibe der Tergite 3—5 zwischen dem Gradulus und dem eingedrückten Apikalsaum jedoch deutlich metallisch (abwechselnd goldgelb, grünlich, blau und violett) schillernd. Sternite 2—5 mit bräunlichrot aufgehelltem Apikalsaum. — Membran der Vorderflügel fast wasserhell, nur sehr leicht hellbräunlich getrübt in der 2. Cubitalzelle und der 2. Diskoidalzelle, mit einem hellbräunlichen Längswisch in der Radialzelle; Apikalfeld nur infolge der Anhäufung der Papillae mit unbewaffnetem Auge beobachtet unmerklich dunkler. Geäder pechbraun, nur die Costa in ihrer Basalhälfte gelbbraun.

Behaarung: einfarbig weisslich, nur die Setae des Labrum, der Mandibulae, die Beborstung der Innenfläche der Tarsenglieder, die einzelnen kurzen Borsten der vorgewolbten (scheinbar kahlen) mittleren Querpartie der Tergite 4 und 5 sowie eine schmale terminale Partie des 6. Tergits und des 6. Sternits honiggelb. Clypeus ziemlich dicht und lang behaart (Skulptur meist kaum sichtbar); Haare von der Naht zwischen dem Clypeus und dem Nebengesicht schrag nach vorn gerichtet, eine schmale Mittellangspartie der Scheibe freilassend, Nebengesicht und untere Stirnpartie bis zu den Ocelli hin ebenfalls dicht und ziemlich lang behaart, Skulptur kaum sichtbar. Frontovertex dagegen nur locker und kürzer abstehend behaart (400 µm), ausserdem mit sehr kurzen einfachen (lediglich bei bestimmtem Lichteinfall sichtbaren) anliegenden Harchen von ca. 80 µm bedeckt; Schlafen wieder dichter (Skulptur kaum sichtbar) und langer. Hinterwangen recht lang behaart. Basalhalfte der Dorsalflache der Mandibulae ziemlich dicht mit kurzen anliegenden Harchen bedeckt. Mesoscutum bis auf die peripheren Partien mit unbewaffnetem Auge betrachtet fast kahl und schwärzlich erscheinend, im Profil gesehen locker mit kurzen abstehenden Harchen von 400 ansonsten aber nur von 240 µm bewachsen; die peripheren Partien ringsum dagegen dicht anliegend behaart. Haare vom Rand des Mesoscutum im allgemeinen zur Mesoscutum-Mitte hin gerichtet. Scutellum und Axillae schmal am Vorderrand dicht kurz anliegend behaart, Haare des Scutellum nach vorn, die der Axillae nach aussen gerichtet; sonstige Oberfläche meist abstehend und ziemlich dicht, etwas langer (560 µm) behaart. Seiten und Unterseite des Thorax, das Metanotum sowie das Propodeum dicht und recht lang behaart (Skulptur unsichtbar). Behaarung der Beine dicht und kurz, meist halbanliegend, Skulptur nur teilweise sichtbar. Der konkave Basalteil des 1. Tergits mit zwei grossen bilateralen, aus kurzen, fast anliegenden Haaren bestehenden Flecken; freigelassen ist nur eine schmale Mittellangslinie, eine dreieckige Partie mitten am Gradulus und eine laterale, etwas diffus begrenzte Partie; der dorsale Teil des 1. Tergits dicht und recht lang behaart (die längsten Haare ca. 1100 µm lateral), mit anliegender Haarbinde am Apikalrand. Behaarung der Tergite 2–5 von einheitlichem Schema: Vorn am Gradulus eine ziemlich dichte anliegende, etwas diffuse Haarbinde (Haarlänge 190 µm), die mittlere (scheinbar kahle) vorgewölbte Querpartie locker mit fadendünnen Härchen (80–160 µm), die aber besonders auf dem 5. Tergit dicker und länger werden, bewachsen; Apikalsaum der Tergite 2–5 mit dichten und breiten, aus beiderseits reichlich kurz gefiederten Härchen bestehenden Binden, der laterale quere „*Samtfleck*" des 2. Tergits *mit winzig* kurzen, fadendünnen, ganz anliegenden Härchen von ca. 65 µm locker aber gleichmassig bewachsen. 6. Tergit gänzlich sehr dicht mit anliegenden, beiderseits reichlich gefiederten Härchen bedeckt, darunter mit zahlreichen eingestreuten halbanliegenden Borsten. Scopa sehr dicht und auffallend lang (die längsten Haare auf dem 2. Sternit 1 mm); Apikalränder der Sternite 2–5 mit für die Untergattung charakteristischen reinweissen dichten anliegenden Zilien; Scheibe des 6. Sternits mit einigen wenigen verstreuten schwärzlich gefärbten Borsten, Apikalrand dicht honiggelb befilzt.

Derivatio nominis: Zu Ehren des Sammlers, des mährischen Lepidopterologen Herrn O. Jakeš benannt.

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AGE DETERMINATION AND THE POPULATION STRUCTURE IN CROCIDURA SUAVEOLENS (MAMMALIA: INSECTIVORA) IN PRAGUE, CZECHOSLOVAKIA

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Abstract. A material consisting of 255 specimens of *C. suaveolens* caught in the course of years 1969–1987 in the territory of the city of Prague was, basing on the root length of I^1 in combination with the date of catch, dividet into the current year's individuals and into the overwintered ones In a part of the material (183 specimens) a more detailed analysis of the age structure of the population was made and the sex ratio was examined The following scheme of the population cycle of the species under study was suggested. In the course of a year, *C. suaveolens* forms two generations under the conditions of Prague, the first of which (descendants of the overwintered individuals) is quickly involved in the reproduction and mostly dies out in the autumn, the other one (for the main part descendants of the current year's specimens) survives successfully the winter and reproduces only in the next year. The survival of the second winter was not ascertained. In the total *material (n = 183) the sex ratio is rather well*-balanced (♂♂ – 51.4%, ♀♀ – 48.6%) but if the material is divided according to the age, in *the group of the current year's animals (n = 111) females predominate* (53.2%), while in the overwintered ones (n = 72) it is males (58.3%).

INTRODUCTION

The information on the sex ratio and age composition in the population of the Lesser white-toothed shrew, *Crocidura suaveolens* (Pallas, 1811) under natural conditions are very scarce in the literature. It is due not only to the relatively low representation of this species in the mammal collections, but also to the fact that no method enabling a reliable determination of age in the white-toothed shrews has been know as yet.

The only paper devoted to the population structure of *C. suaveolens* under natural conditions is the study by Rood (1965) who dealt with the population of this species inhabiting the Isles of Scilly, Great Britain. Some remarks relating to these problems are also to be found in the papers by Humiński & Wójcik-Migala (1967) and Spitzenberger (1985).

Thus, the aim of the present paper is to contribute to the knowledge of the problems given above, basing on the studies of the material collected in the territory of the city of Prague.

MATERIAL AND METHODS

The material of *C. suaveolens* used in the present study was collected during the years 1969 to 1987 in 27 localities lying in the territory of the city of Prague, Czechoslovakia. In total it includes 255 specimens, about a half of which (131 spec.) come from one locality. In all cases either purely anthropogeneous or at least strongly anthropically influenced habitats were involved. None of the sampling sites was more than 250 m far from permanently or temporarily inhabited buildings or from sheds, store houses or something like that. The altitudes of the individual localities range from 180 m (Zoological Garden) to 370 m (Hvězda).

Apart from a few exceptions, the whole material was collected by means of snap traps. The material is deposited in the collection of the Department of Systematic Zoology, Charles University, Prague, under inventory numbers Pr – 1 to 1181.

Survey of the material:

1. Hvězda, Praha 6 (walls surrounding an old park) — 1969: Nov. 1 ♂ 2 ♀ (leg. M. Slavíček), 1981: June 1 ♂, Aug. 1 ♂, 1982: Aug. 2 ♂ 1 ♀ (leg. D. Frynta).

2. Davídkova 74, Praha 8 (hedgerow along a garden, in the winter months sheds and lofts) — *1971: Sept. 1 ♂, 1974: June 1 ♂ 1 ♀, Nov. 3 ♂ 5 ♀, Dec. 1 ♀,* 1975: Sept. 2 ♂ 2 ♀, Oct. 2 ♂ 4 ♀, 1976: Apr. 1 ♀, Sept. 1 ♂ 1 ♀, 1977: July 5 ♂ 5 ♀, Aug. 10 ♂ 9 ♀, Sept. 6 ♂ 8 ♀, 1978: Apr. 2 ♂ 2 ♀, May 1 ♂ 1 ♀, Aug. 1 ♂, Sept. 13 ♂ 13 ♀, Oct. 1 ♂ 1 ♀, 1979: Apr. 1 ♂ 1 ♀, Aug. 1 ♀, 1980: May 1 ♂, July 1 ♂ 2 ♀, Aug. 2 ♂ 1 ♀, 1982: June 2 ♂, Aug. 1 ♀, Sept 4 ♂ 1 ♀, Oct. 1 ♂ 1 ♀, 1983: Feb. 1 ♂, June 1 ♂, 1985: Jan. 1 ♂, Feb. 1 ♂ 1 ♀, March 1 ♂, 1986: Dec. 1 ♀, 1987: Jan. 1 ♀ (in total *131* spec., leg. V. Vohralík).

3. U Ledáren, Praha 4 (grassy stands, thicket and ruderal sites on the bank of the Vltava river) — 1970: Nov. 1 ♂ 1 ♀ (leg. P. Zbytovský), 1986: Apr. 2 ♂, May 1 ♂ 1 ♀ (leg. V. Vohralík et D. Koblicová).

4. Zoological Garden, Praha 7 (thicket, ruderal sites, surroundings of pavillons and the animals cages) — 1974: July 1 ♀ (leg. R. Horbowyjová), 1975: Nov. 2 ♂ 1 ♀ (leg. H. Burda), 1976: Feb. 1 ♂, Apr. 1 ♂ 1 ♀, May 1 ♂ 1 ♀, June 1 ♀, July 1 ♂ 1 ♀, Sept. 1 ♂ 1 ♀, Nov. 1 ♂, 1977: Nov. 1 ♂, 1978: March 1 ♂, May 2 ♂ 2 ♀, June 1 ♂ 3 ♀, Sept. 1 ♀, 1980: May 1 ♂, June 1 ♂ (leg. I. Řeháková), 1982: June 2 ♂, Aug. 4 ♂ 1 ♀, Oct. 2 ♀, 1983: July 1 ♂ 2 ♀, 1984: Feb. 1 ♀ (leg. V. Vohralík et D. Dámcová), 1985: Dec. 1 ♂ (leg. D. Frynta).

5. Výzk. ústav živočišné výroby, Uhříněves, Praha 10 (poultry houses) — 1977: Sept. 4 ♂ 5 ♀ (leg. J. Červený).

6. Na Chodovci, Praha 4 (a permanently inhabited building) — 1982: Dec. 1 ♂ (leg. Z. Špinar).

7. Troja — slopes north of the Zoo, Praha 7 (grassy plot) — 1974: Aug. 1 ♂ (leg. H. Honcová).

8. Pod Hrabovkou, Praha 5 (garden) — 1979: Jan. 1 ♀ (leg. M. Špinka et J. Pykal).

9. Stromovka, Praha 7 (old park) — 1980: June 1 ♂, Aug. 1 ♂ 1 ♀, Sept. 1 ♂ 1 ♀, Nov. 2 ♂ 1 ♀, 1981: June 1 ♀, Aug. 1 ♂, 1982: Aug. 1 ♂ (leg. D. Frynta).

10. Vítkov, Praha 3 (dense thicket) — 1980: Sept. 3 ♀ (leg. D. Frynta).

11. Petřín, Praha 5 (thicket, grassy stands) — 1981: Sept. 1 ♀ (leg. D. Frynta).

12. U Vojtěšky, Praha 6 (grassy balks along an orchard) — 1982: March 5 ♂ 2 ♀, Aug. 1 ♀ (leg. D. Frynta), 1986: Apr. 1 ♀ (leg. D. Koblicová).

13. Židovské hřbitovy, Praha 3 *(ivy stands under high trees on an abandoned cemetery)* — 1982: Aug. 5 ♂ 3 ♀ (leg. D. Frynta).

14. Práčská, Praha 10 (grassy plot between inhabited buildings) — 1982: Sept. 2 ♀ (leg. D. Frynta).

15. Přesličková, Praha 10 (grassy plot between inhabited buildings) — 1982: Sept. 1 ♂ 1 ♀ *(leg. D. Frynta)*.

16. U Vltavy, Praha 7 (grassy plot) — 1984: Jan. 1 ♀ (leg. D. Dámcová).

17. U letohrádku královny Anny 5, Praha 6 (permanently inhabited building) — 1984: Feb. 1 ♂, March 1 ♀ (leg. B. Křepelová).

18. Thomayerova nemocnice, Praha 4 (ruderal sites and grassy stands in vicinity of the *hospital) — 1984: Nov. 2 ♀ (leg. J. Kulich), 1985: Sept. 1 ♂ (leg. V. Vohralík).*

19. Rybničná 17, Praha 6 (permanently inhabited building) — 1985: Feb. 1 ♂ 1 ♀ (leg. E. Pokorný).

20. Jodasova 1077, Praha 8 (grassy plot along inhabited building) 1985: Dec. 1 ♂ (leg. V. Henzal).

21. Císařský ostrov, Praha 7 (dust-heap) — *1980: Feb. 1 ♂* (leg. Z. Hodková).

22. Nad Vinicí, Modřany, Praha 4 (garden) — 1980: March 1 ♀ (leg. Z. Hodková).

23. Kunratický mlýn, Praha 4 (thicket along the stream) — 1980: May 2 ♂ (leg. Z. Hodková).

24. Obora, Uhříněves, Praha 10 (transition from the ruderal site to the wood edge) — 1986: Oct. 1 ♂ (leg. Z. Hodková).

25. Radotín — left bank of the river Berounka, *Praha 5 (ruderal site,* dust-heap) — 1986: Nov. 2 ♂ (leg. Z. Hodková).

26. Hodkovičky — bank of the river Vltava, Praha 4 (ruderal and grassy sites) — 1986: Nov. 1 ♂, Dec. 1 ♂ 1 ♀ (leg. Z. Hodková).

27. Saudkova, Praha 4 (catched on the street) — 1987: Jan. 1 ♀ (leg. I. Horová).

The length of the visible part of the incisor root in the upper jaw (dimension *a*) was measured with the aid a stereomicroscope (SMXX, made by Carl Zeiss, Jena). A micrometric eyepiece (magnification 12.5×) and an objective magnifying 2.5× were used. The dimension values are given as the portions of the eyepiece scale (1 portion of scale = 0.029 mm).

Value *a* was measured on the buccal side of the left I^1. During the measurement the skull was orientated in such way that its median plane was situated in the horizontal position. Measured was the greatest distance between cingulum of I^1 and the edge of intermaxilla taken in parallel line with the anterior flat of the root of I^1 in the way illustrated in Fig. 1b. In the older individuals the anterior part of the root of I^1 is denuded more strongly, and the mutual position of I^1 and of the intermaxillar edge also change to a certain degree. In order to obtain comparable results (the maximum length of the visible part of the root was measured), the measurement way as illustrated in Fig. 1c was used.

All skulls used were prepared and cleared by means of the dermestid beetles (*Dermestes haemorrhoidalis* and *D. vulpinus*).

RESULTS AND DISCUSSION

Age determination

At present, no determination method of the absolute age in the white-toothed shrews of the genus *Crocidura* is known. Individual authors mostly tried only to establish the relative age classes according to the stage of tooth abrasion. As regards *C. suaveolens*, they were, e.g., Humiński & Wójcik-Migala (1967) who used three age classes. In *C. russula*, Saint Girons (1965) distinguishes five age classes according to the abrasion of I^1. Analogously, Gómez & Sans Coma (1976) and Sans Coma et al. (1976) elaborated a method of relative determination of age according to the molar abrasion for the same species. Their division into five age classes was then used by Vesmanis & Vesmanis (1979) in their proposal of the uniform age division in the genus *Crocidura* based on the schemes of abrasion of the whole set of teeth.

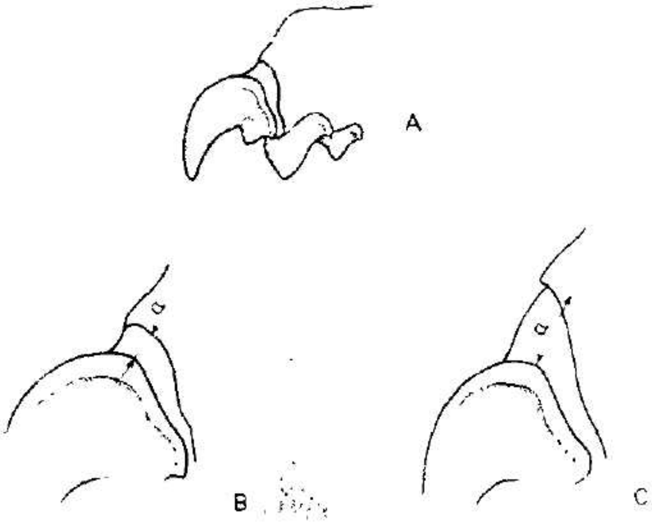

Fig. 1. Rostral part of the skull of *C. suaveolens* (A) and the mode of measuring of the length of the visible part of the root of I^1 (dimension a) in the young- (B) and in the older individuals (C), for details see text.

Of course, from the viewpoint of the practical use it is much more valuable to establish either the absolute age or at least to distinguish the natural age classes corresponding with the life cycle of the mammals under study. Under the European conditions, where in most free-living small mammals, as a rule, no winter reproduction occurs. these preconditions are best fulfilled by dividing the material examined into groups of the current year's animals and of the overwintered ones. Bishop & Delany (1963) tried for the first time to distinguish these two categories on the basis of a relatively extensive material collected all the year round, according to the stage of tooth abrasion, in *C. russula*, shortly after them Rood (1965) did the same in *C. suaveolens*. Bishop & Delany (l.c.), who evaluated the material collected during a one-year cycle, obtained rather convincing results. Rood (l.c.), on the contrary, who had materials from two subsequent years at his disposal, obtained satisfying results by evaluation of the material from the one year only, while in the second year, when the reproduction started as early as in January, his results were rather questionable. Recently López-Fuster (1985) and López-Fuster et al. (1985), combining the five age classes as proposed by Gómez & Sans Coma (1976) and by Vesmanis & Vesmanis (1979) with the catching date, tried to distinguish the current year's- and the overwintered individuals of *C. russula* from Spain. Also Spitzenberger (1985) divides the Austrian material of *C. suaveolens* into the current year's- and the overwintered specimens, however, without any information on the criteria she used.

In general, however, it may be stated that the stage of tooth abrasion is difficult to measure and that this feature also can be rather influenced, e.g., by a wrong occlusion of teeth, by food composition etc. The body- or skull dimensions cannot be used for the age determination either, because according to the results published by Vlasák (1972) who elaborated in detail the postnatal development in *C. suaveolens*, the growth of these dimensions is so rapid that their values attain as early as in the 20 to 30 days old young the average values found otherwise in the adults.

As a much more advantageous method appears to be the use of the so-called "compensation growth" of incisors in the upper jaw. With the fact that along with the increasing age a growth and position change of I^1 in North American shrews takes place, the American zoologists were familiar as early as in the forties (see Diersing 1980). As for the white-toothed shrews, this phenomenon was described in detail only by Dolgov (1971) in *C. lasiura*. Virtually, the matter is that the root of I^1 grows and the incisor deflects downward, by which its shortening resulting from abrasion is compensated. Its function in the food processing is preserved hereby. The above mentioned author recommends in his paper to make use of the feature for age determination in this white-toothed shrew species. In his next paper (Dolgov 1974) he used the compensation growth of I^1 as one of the criteria for distinguishing the current year's- and the overwintered individuals in a series of *C. suaveolens* collected in August in Armenia, USSR. He remarks that is was possible

Table 1. Total survey of the material used

	J	F	M	A	M	J	J	A	S	O	N	D	Σ
Males	1	6	7	6	9	10	8	29	35	4	12	4	131
Females	4	3	4	6	5	6	11	19	40	9	14	3	124
Σ	5	9	11	12	14	16	19	48	75	13	26	7	255

to distinguish both groups without overlapping in this character; however, he does not give any other details.

This method was elaborated in more detail by Diersing (1980) who, working with the length values of the part of the root of I^1 visible from outside, distinguishes the current year's- and the overwintered individuals of the North American shrew *Sorex hoyi*.

In the present paper an attempt has been made to divide in this way our material of *C. suaveolens*. The way of measuring the length of root I^1 (dimension **a**) is described on page 64.

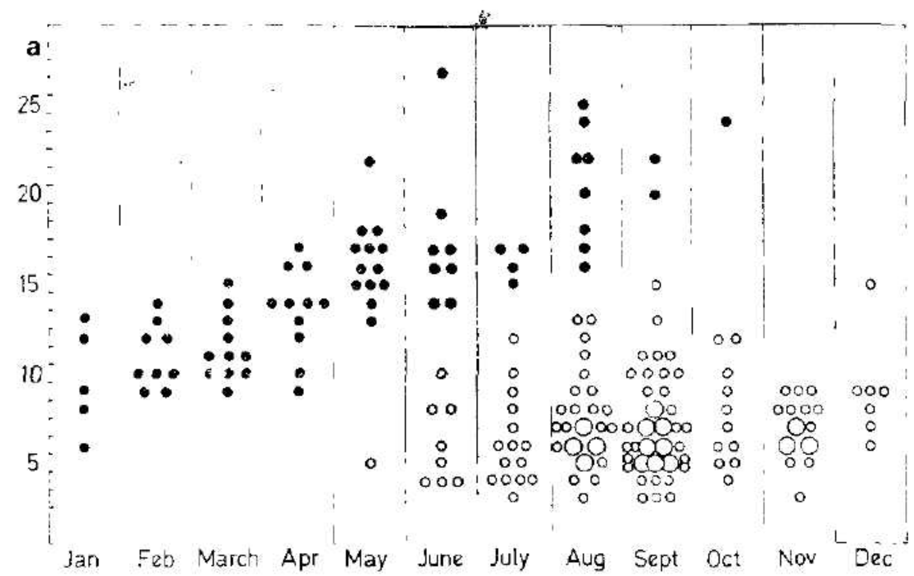

Fig. 2. Distribution of the values of the dimension **a** in all our material, arranged according to the month of collection. The individuals considered to be overwintered are indicated by closed rings, the current year's individuals by open ones. The large symbol indicates five specimens.

After plotting the values **a** in all our material, divided according to the month of collection (see Table 1) in a graph (Fig. 2), it becomes evident that the whole material is divided into two groups distinctly separated from each other.

In the period January—April, the whole material is very homogenous, a gradual increase of the value **a** being evident. All those animals belong evidently to the overwintered individuals born in the past year. Only in May the first specimen (a male, collected on May 21) with a conspicuously low value **a** = 5 appeared which can be even according to other features (teeth without any marks of abrasion) classified as an individual born in the current year. In the material collected in June, more individuals of this kind are to be found, and the whole material is thus divided into two relatively well separated groups. These groups are then ascertainable in our material also in the subsequent months till October. As the occurrence of individuals with a low value **a** corresponds from the viewpoints of both time and quantity with the known facts on the reproduction in the Prague population of *C. suaveolens* (occurrence of pregnant females from April till August — for details see **Vohralík & Řeháková**, in print), we assume that it may be rightly supposed that the above mentioned animal groups differing by their values **a** correspond with the current year's- and the overwintered part of population.

It is self-evident that the values **a** ascertained by us, which enable to divide the monthly collections into the current year's- and the overwintered specimens need *not be absolutely valid for the whole area of distribution of the species*. Therefore it will be necessary to verify our results on sufficiently extensive samples collected from other localities before introducing this method into practical use. Especially it will be interesting to know whether a similar difference of the value **a** between the current year's- and the overwintered specimens persist even in those regions where the pause between the successive reproduction periods is shorter.

A certain influence upon the growth rate of the root I^1 may be also exerted by the abrasion rate of this tooth. The following observations indicate that this assumption may be right. In two individuals from our material which have had one from their I^1 broken, we found that the value **a** in the broken incisor was considerably greater than in the intact one. Thus in the current year's male trapped in August the value **a** was 17 in the broken and 11 in the intact incisor, in the current year's female trapped in October it was 16 and 10 respectively. We suppose that the greater length of the visible part of root found in the broken incisors has been caused by the more rapid rate of the "compensation growth" of the afflicted teeth. Therefore, in the estimation of the age in animals possessing damaged incisors, the results should be evaluated with caution. In this connection we should like to remark that with the trapping of *C. suaveolens* in live-traps (especially in the metallic ones) an enormous abrasion of the incisors takes place as the trapped animal struggles to escape by gnawing from the trap. That is why, evidently, in the individuals trapped repeatedly by live-traps a considerably increased length of the visible part of the root of I^1 is to be expected, which may result in the overestimation of their age.

Age structure of the population

By the division of the material into the current year's- and the overwintered specimens, the evaluation of age composition in the population of *C. suaveolens* in the course of the year is also enabled. However, as in two of our localities (Davídkova street and the Zoological Garden) in several years the catches were made repeatedly, several times on the identical plot, it may be supposed that the composition of samples obtained in this way will be strongly misrepresenting. After the catch of a part of local population, the vacant area is, namely, occupied by immigrants from the neighbourhood within a short time. It may be assumed that they will be first of all the young, current year's individuals which migrate trying to find a suitable place for establishment of their own territory. The sex ratio in the immigrants may be influenced, too, by different vagility of males and females. For this reason the samples obtained by repeated catches in the same plot or in its immediate vicinity were eliminated from the evaluation of the age composition in the population as well as from the evaluation of sex ratio. The following material is involved (cf. Survey of the material). 1) Davídkova street — 1977: Aug. 10 ♂ 9 ♀, Sept. 6 ♂ 8♀. 1978: Aug. 1 ♂, Sept. 13 ♂ 13 ♀, Oct. 1 ♂ 1 ♀. 1982: Sept. 4 ♂ 1 ♀, Oct. 1 ♂ 1 ♀. 2) Zoological Garden — 1976: Sept. 1 ♂ 1 ♀. 1978: Sept. 1 ♀.

After elimination of 72 specimens mentioned above, a total of 183 animals collected in the years 1969—1987 from 27 localities are at disposal (Table 2).

A survey of the age composition in the population in the course of a year is presented in Table 3. From January till April the collected material consists ex-

Table 2. The reduced material used for the evaluation of the age structure and the sex ratio

	J	F	M	A	M	J	J	A	S	O	N	D	Σ	%
Males	1	6	7	6	9	10	8	18	11	2	12	4	94	51.4
Females	4	3	4	6	5	6	11	10	16	7	14	3	89	48.6
Σ	5	9	11	12	14	16	19	28	27	9	26	7	183	–

clusively of overwintered specimens born in the previous year. The first young appear as late as in May (a male, trapped on May 21), in June the ratio of overwintered- and the current year's animals is already balanced. In the three successive months a rapid replacement of the overwintered part of population by the current year's individuals sets in, in October no overwintered specimen was found among the 9 trapped animals. However, it is to be remarked here that in the total of our material (see Table 1) among 13 individuals trapped in October one overwintered specimen occurred (a male, trapped on October 22).

Owing to the rather rapid decrease of overwintered individuals during the summer as well as to their absence in the samples from November and December, it is evident that in the territory under study the species *C. suaveolens* does not survive the second winter. Thus, with respect to the reproduction period (pregnant females were found from April till August), it can be estimated that the maximum longevity of *C. suaveolens* in the Prague population amounts to 18 months at the most. Our findings are in a strong contradiction to the knowledges obtained from captivity, where **Vlasák** (1972) in his laboratory breeding founded from individuals also caught in Prague found that 36–53% of individuals survive the second winter of their life. Also **Hanzák** (1966) reports that in his breeding a part of *C. suaveolens* specimens attained the age of two years.

In the graph illustrating the root length of the upper incisor (a) in *C. suaveolens* in the course of the year (Fig. 2) it is conspicious that the maximum values of a *in current year's individuals in the period October–December are substantially* lower than during the foregoing period. Surprising is first of all the fact that – apart from a single specimen – the individuals with the value a > 9 are missing

Table 3. Age structure in samples of C. suaveolens from Prague in the course of the year

	J	F	M	A	M	J	J	A	S	O	N	D	Σ
Current year's individuals	–	–	–	–	1	8	15	20	25	9	26	7	111
Overwintered individuals	5	9	11	12	13	8	4	8	2	–	–	–	72
% of overwintered	100	100	100	100	93	50	21	29	7	0	0	0	–

in the period November—December, although they are quite common in the samples collected from June till October. This phenomenon may be explained either 1) by the *temporary shortening of the visible part of the root of* I^1, which is very improbable, or 2) by the selective dying out of a part of the current year's individuals.

As this phenomenon appears to be very interesting and can be of a great importance for the understanding of the population dynamics of the shrew species under study, we decided to subject the course of changes of the value **a** in our material to a more detailed analysis. In order to exclude the possibility that an artefact caused by trapping-out of the older current year's individuals as result of repeated catches in the same locality is responsible for this phenomenon, another graph was constructed (Fig. 3), where animals obtained by repeated catches were excluded (see also p. 68).

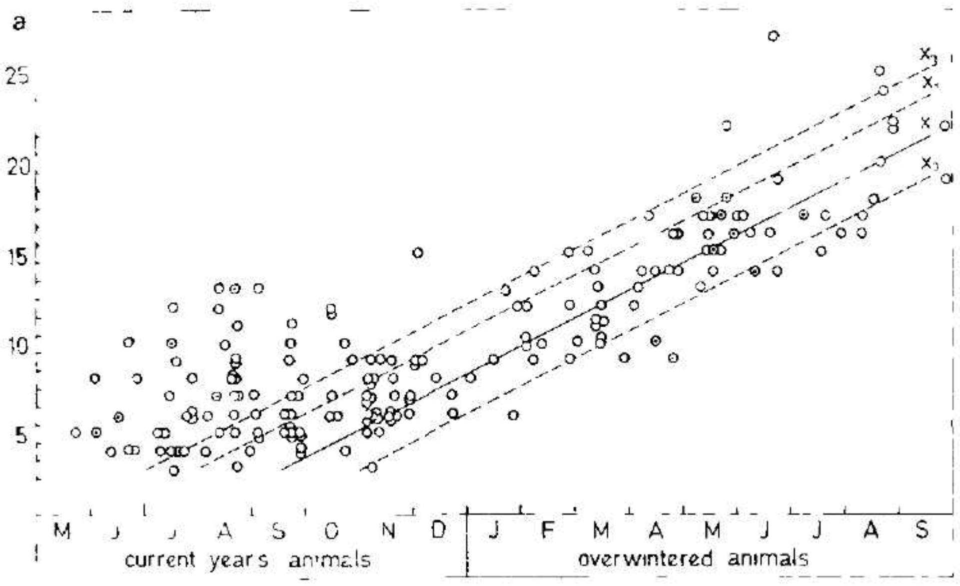

Fig. 3. Distribution of the values of the dimension **a** in the reduced material, arranged to the age and the date of collection. Rings with a dot indicate pregnant females, for additional explanations see text (pp. 70—71).

From Fig. 3 it is evident that even after the reduction of the material the general character of changes of the value **a** in the course of the year has been preserved. Even if it were admitted that the growth rate of the root of I^1 could be retarded *or even stopped during the winter months, it would not be possible to explain in* this way the almost absolute absence of individuals with value **a** > 9 in our material collected in the period November—December (only 1 specimen of the total number of 33, i.e. 3%). As in the foregoing time period (May—October) there were 14 specimens of this kind found among 78 specimens collected (i.e. 18%), the decrease of them can be explained only by the selective dying-out.

Starting from the assumption that the root length of I^1 is directly proportional to the age of an individual which coincides both with our results (Figs. 2, 3) and with the conclusions of other authors (Dolgov 1971, 1974, Diersing 1980, etc.), the facts given above indicate that the dying-out affects the oldest part of the current year's individuals.

As the growth of the root length of I^1 in the overwintered specimens seems to be linear and shows also a relatively low dispersion, the gradient of line interpolated through the points marking the overwintered individuals (Jan.—Sept.) in Fig. 3 was calculated. In total, the coordinates of 71 points were used for calculation, the correlation coefficient $= 0.79$. Assuming that the root length of I^1 increases linearly also during the time before overwintering, the line constructed (line X in Fig. 3) can be extrapolated into the group of current year's animals, too. Here lies an important point where the line intersects the value $\mathbf{a} = 3$, which represents the least root length of I^1 found in our material. We suppose therefore that this is the root length of I^1 in the youngest individuals which are to be found outside the burrows.

The given value $\mathbf{a} = 3$ attains the line X to the date of September 22, which should be, *consequently, the average date of the first attempts to leave the breeding* burrow in that part of population which will then survive successfully the winter. According to the data published by Vlasák (1972), it may be concluded that the young white-toothed shrews leave the breeding burrow for the first time at the age of 18—20 days. Thus, it would concern the young born at the turn of August and September, which is — owing to the presence of pregnant females in our material collected in August — still well possible.

Analogously, also other lines parallel to line X can then be constructed. On the basis of their course it would be possible to estimate that, e.g., of the total of 71 overwintered specimens, 50 (= 70%) left the burrow for the first time in the period August—October (the individuals in the area between lines X_1 and X_2 in Fig. 3), or that 68 (= 96%) of the overwintered animals left the burrow for the first time after June 30 (individuals in the area right of line X_3).

On the basis of the same assumption, the individuals which had left for the first time the burrow before June 30 (left of the line X_3 in Fig. 3), would disappear in the absolute majority until the end of October from the population and in the next year they would represent only an insignificant part (4%) of the overwintered animals.

If these problems are considered from the viewpoint of reproduction, it is interesting to observe the distribution of pregnant females in our material. From Fig. 3 it is evident that all current year's pregnant females (in total 7) belong to the group of animals which had left the burrow for the first time already before June 30, and which consequently has very little hope to survive the winter. On the contrary, all overwintered pregnant females (in total 10) belong to the group which left the burrow for the first time after June 30.

Although the reproduction cycle of males has not been evaluated for the time present, it is possible to suggest on the basis of findings given above at least a preliminary outline of the population cycle in the Prague population of *C. suaveolens*:

The overwintered animals start the reproduction in the end of March. The young from the first litters leave the breeding burrow for the first time during the period from the end of May until the end of June, they become adult relatively quickly and join to the reproduction process. In the course of autumn they disappear from the population and survive the winter in an insignificant percentage only. On the contrary, the individuals which left the breeding burrow after June 30 do not attain the sexual maturity within the year of their birth. However, they are able to survive successfully the winter. They are mostly descendants of the current year's females belonging to the animal group mentioned above (details see in **Vohralík & Řeháková**, in print). In this way, *C. suaveolens* produces under the conditions of Prague two generations within a year; the first of which joins quickly to the reproduction and dies out, the other one survives successfully the winter and reproduces as late as in the next year.

However, to the above mentioned method of determining the date of leaving the breeding burrow it must be remarked that the increase of the root length of I^1 need not be inevitably the same in both generations of *C. suaveolens*. Certain deviations may be expected already on the basis of values as found in the oldest current year's individuals in the period June—August, which would in the case of the same growth rate, as it was found in the overwintered specimens, correspond with the first leave of the burrow as early as in March. However, this is in contradiction with the results of our catches, in which the first current year's individual was collected as late as in May. Though the concrete values obtained by the above-mentioned calculations need not be consequently quite precise, we wish first of all, using this example, to point to the possibility of using the root length of I^1 in the more detailed studies of the population dynamics of *C. suaveolens* and of the representatives of the family Soricidae in general. Before introducing a wider use of this character in the practice, however, its verification will be necessary, if possible in marked individuals under natural conditions.

Sex ratio

For the evaluation of the sex ratio a material was used from which the samples obtained by repeated catches in the same plot were eliminated (see p. 68). The total sex ratio in thus reduced material (Table 2) is rather well-balanced — 94 ♂♂ : : 89 ♀♀, which corresponds with the ratio of 1 : 0.95.

However, if this material is divided into the current year's and the overwintered animals (Table 4), it becomes evident that the situation is rather more complicated. While in the group of the current year's animals the females predominate (♂♂ : ♀♀ = = 1 : 1.13), in the overwintered ones there is a considerable prevalence of males (♂♂ : ♀♀ = 1 : 0.71). Although the difference from the theoretically supposed ratio of 1 : 1 is in both cases statistically insignificant (current year's animals — $\chi^2 =$ $= 0.44$, overwintered animals — $\chi^2 = 2.0$, $\chi^2_{0.05} = 3.8$), in the case that the difference in the sex ratio between both age groups is tested, it is highly significant ($\chi^2 = 13.6 > \chi^2_{0.05} = 3.8$). From this reason we consider as necessary in the evaluation of the sex ratio in populations of *C. suaveolens* from the natural conditions to divide the material into the group of the current year's and the overwintered individuals.

A conspicuous prevalence of males among the overwintered animals can be most probably explained by their increased activity during the reproduction period. In the recent year's animals this phenomenon is not so much distinct, because a considerable part of the recent year's individuals are not sexually active. Unfortunately, a relatively small material does not enable to evaluate the fluctuations of the sex ratio in the course of the year in more detail.

The literary data on the sex ratio in *C. suaveolens* under natural conditions are rather sparse. The most extensive material was at disposal to **Rood** (1965) who collected from January 1961 till August 1962, on the Isles of Scilly, Great Britain, 307 specimens in total. In the whole material the males predominate over the

Table 4. Sex ratio in the individual age groups of C. suaveolens in the course of the year

		J	F	M	A	M	J	J	A	S	O	N	D	Σ	%
Current year's individuals	♂♂	–	–	–	–	1	5	6	11	11	2	12	4	52	46.8
	♀♀	–	–	–	–	–	3	9	9	14	7	14	3	59	53.2
Overwintered individuals	♂♂	1	6	7	6	8	5	2	7	–	–	–	–	42	58.3
	♀♀	4	3	4	6	5	3	2	1	2	–	–	–	30	41.7

females at the ratio 173 : 134 (i.e. 1.3 : 1), the difference being statistically significant. A more detailed analysis of the the sex ratio, however, has not been given by the author, but on the basis of the graphical survey of his catches in individual months (Rood 1965 – Fig. 1), which are arranged according to the stage of tooth abrasion, this analysis can be done. In total, 298 individuals have been plotted in the graph, i.e., less by 9 than his total material includes. If Rood's way of division into the current year's- and the overwintered individuals based upon the stage of tooth abrasion is used, the ratio of 90 ♂♂ : 49 ♀♀ = 1 : 0.54 for the overwintered animals, and the ratio of 77 ♂♂ : 82 ♀♀ = 1 : 1.06 for the current year's ones are obtained. Though the concrete values are somewhat different, it is evident that the general trend, i.e., the high prevalence of males among the overwintered animals and a moderate prevalence of females among the current year's ones, is the same both in our and in Rood's (l.c.) material.

Also Humiński & Wójcik-Migala (1967), who had at their disposal 75 specimens of *C. suaveolens* collected mainly in the end of summer and in autumn in southern Poland, mention the predominance of males (54.7%).

The predominance of males was also found in the young born under the laboratory conditions. Vlasák (1972) found in the material coming from the territory of Prague the ratio of 61 ♂♂ : 56 ♀♀ (i.e. 1 : 0.92). Similarly, Hellwing (1971) found in the material coming from Israel and determined at time as *C. russula monacha* (but which is nowadays classified with *C. suaveolens*, see Catzeflis et al. 1985) 53.6% of males among 507 young.

Whereas the data on the sex ratio in the young from the laboratory breedings present a relatively reliable information, the data obtained from the field catches are always somewhat deformed by the trap type, by the activity of animals etc. Also the possibility cannot be excluded that the sex ratio in the population can differ in individual years in connection with the long-term population cycle of the species, as it was found by Pucek (1959) on an extensive material of the Common shrew (*Sorex araneus*). At present, however, a sufficiently numerous material for a more detailed study of the course of changes of the sex ratio in the population of *C. suaveolens* is not at disposal.

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FOVEACHELES (SPELAEOCHELES) TROGLODYTA SP. N., SUBGEN. N. (ACARI: PROSTIGMATA: RHAGIDIIDAE) FROM STRATENSKÁ CAVE, THE WESTERN CARPATHIANS, SLOVAKIA

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Abstract. *Foveacheles (Spelaeocheles) troglodyta* sp. n., subgen. n., is described as a new species from Stratenská Cave, the Western Carpathians, East Slovakia.

INTRODUCTION

In December 1972 Slovak speleologists discovered a new cave in a Triassic limestone massif of the Stratenská vysočina Highlands, the Western Carpathians, East Slovakia, approximately 30 km south of the town of Poprad. The cave has been named Stratenská and its entrance is located at the altitude of about 1000 m. To date, about 17 km of mostly horizontal subterranean passages have been discovered. The average annual temperature inside the cave ranges from 5.4 to 5.8 °C. Since the cave's discovery, a biospeleological research programme has been carried out which has resulted in collections of various Arthropoda, mostly Collembola, mites (Mesostigmata, Prostigmata and Oribatei) and Diptera.

Thanks to Dr. V. Košel, Department of Systematic and Ecological Zoology, Komenský University in Bratislava, I have had the opportunity to examine rhagidiid mites that he personally collected in the cave. A new troglomorphic representative of the genus *Foveacheles* has been discovered.

The type material of the new taxon is deposited in the Canadian National Collection, Biosystematics Research Centre, Agriculture Canada, Ottawa, as permanent microscopic preparations.

The morphological terminology is taken from Strandtmann (1971) and Zacharda (1980).

SYSTEMATIC PART

Genus *Foveacheles* Zacharda, 1980

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

Subgenus *Spelaeocheles* subgen. n.

Type species: *Foveacheles (Spelaeocheles) troglodyta* sp. n., monotypic, feminine gender.

Diagnosis: Chelicera long and slender with distinct dorsal saddle-shaped depression and elongated digits. Proximal cheliceral seta inserted distal to articulation of movable digit, distal cheliceral seta overlapping apex of fixed digit Rhagidial organ I consists of 5 rhagidial setae in separate pits, stellate seta between 1st and 2nd proximal rhagidial setae. Rhagidial organ II consists of 4 rhagidial setae in separate pits and 1 small spiniform proximal eupathidium. Dorsodistal rhagidial seta on tibia I in broad depression. Dorsodistal lanceolate seta on tibia II large, lying in broad pit. Spiniform solenidion on tibia I and II dorsomedial and medio-dorsolateral, respectively. Epimeral formula 3—1—5—3.

Affinities. *Spelaeocheles* subgen. n. differs from the other known subgenera of the genus *Foveacheles* by rhagidial organ I consisting of 5 rhagidial setae, rhagidial organ II consisting of 4 rhagidial setae, and by the distinct morphological adaptations to life in a cave habitat (Zacharda 1979, 1980)

The subgenus is named after the cave habitat (spelaeo) and the elongated troglomorphic cheliceral digits (cheles) of the type species

Foveacheles (Spelaeocheles) troglodyta sp. n.

(Fig. 1)

Description. Four females examined. Length of body 990—1310 µm, legs I 1.65—2.0 as long as body.

Dorsal body setal lengths — Internal verticals 70—80 µm, external verticals 50—66 µm, filiform trichobothria 145—155 µm, scapulars 185—225 µm, internal humerals 70—82 µm, external humerals 178—198 µm, dorsals I 73—79 µm, dorsals II 79 µm, internal lumbars 95—110 µm, external lumbars 70—80 µm, internal sacrals 160—165 µm, external sacrals 72—82 µm

Body venter — Epimeral formula 3—1—5—3, trochanteral formula 1—1—2—2. 5 pairs of both progenital and paragenital setae. Length of progenital lips 148—180 µm.

Gnathosoma — Hypostome slenderly oval, length to breadth 1.62—1.[illegible] Internal malae spiniform, external membranous and serrate.

Chelicerae slender with elongated digits Proximal cheliceral seta inserted distal to articulation of movable digit, distal cheliceral seta overlapping apex of fixed digit. Movable digit finely serrate along inner margin Length of chelicera 313—330 µm, breadth 105—125 µm, length of movable digit 115—125 µm, length of proximal and distal cheliceral setae 30—40 µm and 50—56 µm, respectively. Distance between insertion points of cheliceral setae 26—43 µm. Length of chelicera to breadth: 2.63—2.96, length of movable digit to cheliceral length 0.36—0.38, length of movable digit to breadth of chelicera 1.0—1.09.

Terminal pedipalpal segment slenderly oval, length to breadth 3.53—3.[illegible], and bearing 10 ciliated setae and 1 erect spiniform solenidion.

Legs and sensory setae — Tarsus I long and slender, slightly rounded distally, length to breadth: 5.25—7.0 Slender empodium overlapping tips of claws, no clawlets on claws.

Rhagidial organ I consists of 5 rhagidial setae lying obliquely in separate pits, stellate seta (famulus) between 1st and 2nd proximal rhagidial setae Rhagidial organ II consists of 4 rhagidial setae lying obliquely in separate pits and small proximal spiniform eupathidium.

Tibia I with 1 dorsomedial solenidion and small dorsodistal rhagidial seta lying in broad depression. Genu I with 1 ventrodistal solenidion. Tibia II with 1 medio-dorsolateral solenidion and elongated, enlarged laterodorsal, distal lanceolate seta in deep, broad depression. Genu II with 1 ventrodistal solenidion.

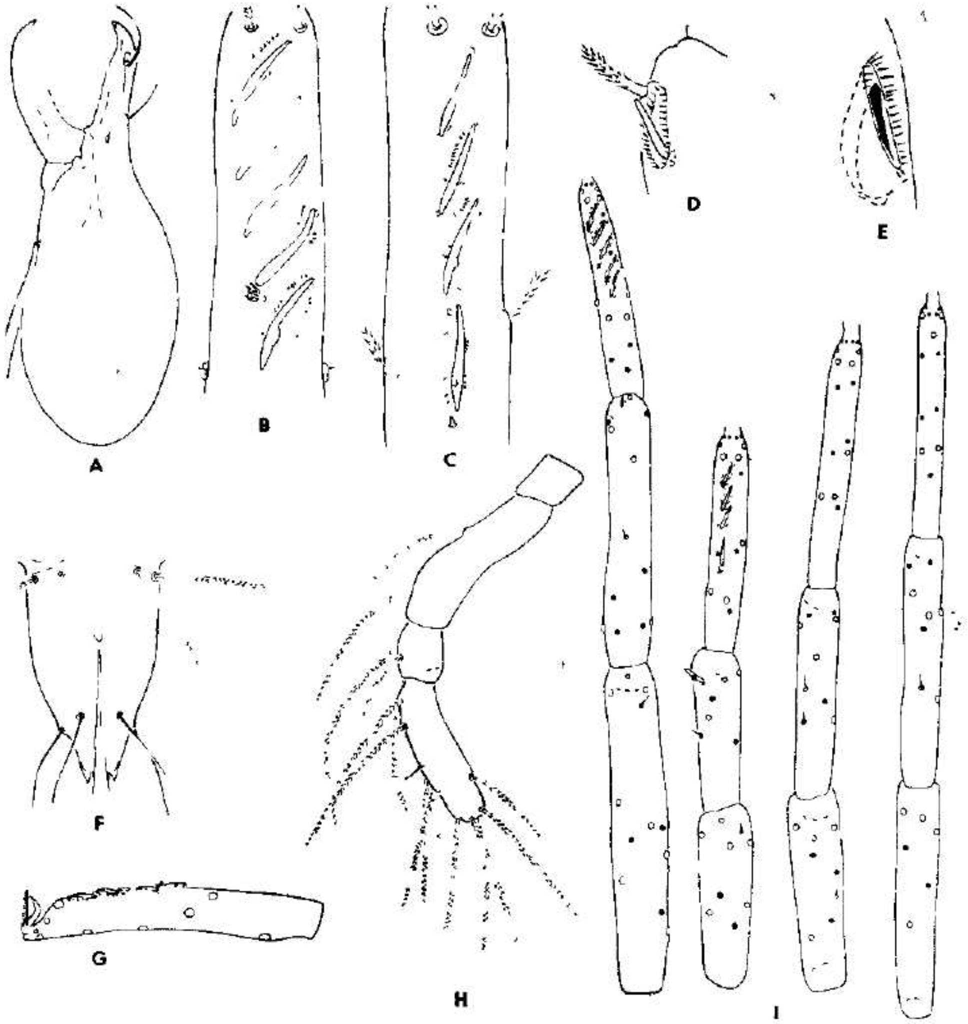

Fig. 1. ***Foveacheles* (*S.*) *troglodyta*** sp. n., ♀ (A) Chelicera. (B) Rhagidial organ I (C) Rhagidial organ II (D) Dorsodistal rhagidial seta on tibia I. (E) Lanceolate seta on tibia II (F) Hypostome. (G) Tarsus I in profile. (H) Pedipalpus (I) Solenidia and setae on legs I–IV

Tibia III with 2 laterodorsal, medioproximal solenidia lying in tandem. Genu III with 1 laterodorsal medial solenidion. Tibia IV with 1 dorsal, medioproximal solenidion. No solenidion on genu IV.

Male

One specimen examined. Length of body 1150 µm, leg I 1.82 as long as body. No external morphological differences from females were observed.

Material examined: Holotype, 1 ♀, Czechoslovakia, East Slovakia, the Stratenska vysočina Highlands, the Slovenské rudohorie Mtns (the West Carpathians), in Stratenská Cave (Triassic limestone) ,on a cave substratum, 22 August 1985. V. Košel leg., C.N.C. Type No. 19349; 2 ♀♀, with the same data as holotype; 1 ♀, 1 ♂, 11 July 1985, other data same as holotype.

Affinities. *Foveacheles (Spelaeocheles) troglodyta* resembles *F. (Propriorhagidia) mira* Zacharda, 1980. It differs by the 4 rhagidial setae in rhagidial organ II, by the location of the stellate seta (famulus) in rhagidial organ I, by the distinctly larger lanceolate seta on tibia II and by the more elongate appendages. *F. (S.) troglodyta* exhibits distinct morphological adaptations to life in a cave habitat (troglomorphisms, Zacharda 1979, 1980), but these adaptations differ from those troglomorphisms found in other cave inhabiting species such as *F. goffi* Zacharda, *F. tenorioae* Zacharda (Zacharda 1982) or *F. titanica* Zacharda and Elliott, and *F. auricularia* Zacharda and Elliott (Zacharda and Elliott 1985).

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Holčík, J. (edit.): *Petromyzontiformes*, contributions by P. G. Bianco, M. W. Hardisty, C. B. Renaud, ill. by M. Baradlai. *The freshwater fishes of Europe*, vol. 1, pt. 1, 313 pp., 48 ill., 49 tab. Aula-Verlag Wiesbaden, 1986, DM 236. –

In den 10 Einleitungskapiteln widmet sich M. W. **Hardisty** der allgemeinen Problematik der Ordnung. Dieser berühmte Autor der Biology of Cyclostomes hat seine eigenen Erkenntnisse mit den Angaben aus mehr als 120 Titeln der Fachliteratur ergänzt. In dieser Einleitung findet man die Grundrisse der Morphologie, Zoogeographie, Evolution, Ökologie, Onthogenese, Nahrungsbiologie, Wanderungen, Populationstruktur, sowie eine Besprechung der ökonomischen Bedeutung der Neunaugen. Unter anderem sind auch die Bestimmungsmerkmale (z. B. früheres und modernes morphometrisches Schema, die meristischen Artenmerkmale) erfasst, neben den oben erwähnten klassischen Artmerkmalen werden auch die in den 70.–80. Jahren entdeckten arttypischen morphologischen Kennzeichen berücksichtigt, sowie die neusten Erkenntnisse über den Karyotyp und, soweit bekannt ist, die Proteinspezifität. Jede Art ist in mehreren Details von diesen Kriterien in der systematischen Übersicht beschrieben. In den Einleitungskapiteln befinden sich einige Angaben für die nordamerikanischen Populationen der auch in Europa vorkommenden Arten; in der systematischen Übersicht ergänzen diese Erkenntnisse die bis heute noch fehlenden Informationen über europäische Populationen.

Den wesentlichen Teil der Monographie bildet die systematische Übersicht, in der die Taxa, mit der Klasse anfangend, bis zur Art charakterisiert werden. Die Bestimmungsschlüssel folgen der Charakteristik der Ordnung und aller unterordneten Taxa bis zur Gattung nach. Es fehlen leider zur Zeit verlässliche Angaben über die Bestimmungsmerkmale der Ammocoeten, sodass die Schlüssel der Familien, Gattungen und Arten von *Lethenteron* nur die Adulttiere betreffen. Alle Gattungen sind vom Editor charakterisiert, eine Art haben dabei höchstens 2 Autoren bearbeitet. Neben den gewöhnlichen taxonomischen Angaben ist ein Artvolksname im Englisch, Franzözisch, im Deutsch und im Russisch dem FAO-Lexikon (**Bănărescu** et al., 1971) entsprechend beigefügt. Nur für 2 *Eudontomyzon*-Arten empfehlen die Autoren die neuen, dem aktuellen Sprachgebrauch entsprechende Volksnamen. Aufmerksamkeit wird den taxonomischen Merkmalen unterschiedlicher Populationen gewidmet, und die Arbeit enthält viele diesbezügliche summarisierende Tabellen. Jede Unterart wird in einem Absatz im Rahmen des Artkapitels charakterisiert und es wird jede bisher bekannte Artenkreuzung notiert. Über Ökologie jeder Art gibt es in der Monographie ausführliche Angaben, u. a. über ökologische Bedingungen für die Ammocoeten, über Nahrungsbiologie und über Vermehrungsbiologie. Zahlreich sind die Angaben über das Geschlechtsreifen, die Fruchtbarkeit, das Ablaichen, über frühe Onthogenese und Morphologie der Metamorphose. Jedes Artkapitel ist mit einer ichthyopathologischen Übersicht, einer Bewertung der Wirtschaftsbedeutung und einem Literaturverzeichniss beendet.

Die Diskussion des Editors über Taxonomie der Gattung *Lethenteron*, die er ebenso wie **Vladykov** und **Follet**, im Unterschied zu den meisten Autoren, als eine selbstständige Gattung charakterisiert, ist von grosser Bedeutung, denn sie zeigt aktuelle Forschungsaufgaben bei der Bearbeitung dieser weit verbreiteten Gattung. Recht kritische Auswahl einer überraschenden Menge der Informationen ist mit aktuellen Bemerkungen ergänzt (z. B. ein notiertes Vorkommen von *Eudontomyzon mariae* in einem Donaunebenfluss). Daneben enthält die Arbeit viele morphometrische, sowie meristische Ergänzungsangaben des Editors über einige Arten. Genaue Abbildungen von M. Baradlai stellen je einen typischen Gattungsvertreter sowie jeden arttypischen Saugmund des Adulttiers dar.

Diese, dem Andenken des Gründers der modernen Neunaugenforschung V. D. **Vladykov** gewidmete Monographie, bildet eine für jeden Fachmann unentbehrliche Übersicht bisheriger taxonomischer, zoogeographischer und ökologischer Kenntnisse.

K. Lohniský

Cabela, A., Tiedemann, F. 1985: *Atlas der Amphibien und Reptilien Österreichs* (Stand 1984). Neue Denkschriften des Naturwissenschaftlichen Museums Wien 4, 80 pp., 2 Tabs., 3 Figs., 30 species distribution maps, Vlg. F. Berger + Söhne, Wien Horn; Bound, 290 öS.

In recent years, a number of mapping actions in various groups of vertebrates have proceeded in Europe. The intensively studied ones are amphibians and reptiles. Whilst the Paneuropean mapping of these animals is far from being complete, in many European countries local mappings develop successfully.

One of countries the herpetofauna of which has preliminarily been mapped has became Austria. Herpetologists in that country have chosen one of the two basic mapping modes for this purpose – the network mapping. Contrarily to the point mapping this method does not record particular localities but major areas only in which the species in question has at least once been evidenced. In Austria the network mapping of amphibians and reptiles took place experimentally in two federal countries during the period 1979–1982 and the experience obtained served to extend the mapping to the whole territory of the country under the financial support of the *Österreichischer Fonds für wissenschaftliche Forschung*.

In contrary to the approach in other countries the authors excluded participation of laymen and focused their endeavour to obtain data through a limited number of specialists to minimalize possible misdeterminations. All personally unverified findings originating from laymen were either excluded or indicated as questionable. Data were obtained from three sources, above all from field observations but from literature and museum collections too. Of course the level of processing in different areas as well as species is very different depending on the number of mapping persons, geographical position, ecology of the species and literature available. Resulted work can serve, therefore, above all as a survey elder data and as a basis for further intensive research.

As a base for mapping a map of Austria has served which has been divided into fields – parameters of 15′ × 15′ (524.7 km²). These fields have further been divided into nine lesser *fields of 5′ × 5′ each. The whole projection of the map has been idealized: it is nonrectangular* in order to prevent narrowing the fields northwards and at the same time to make possible computerized drawing of results. As a basic unit for computer input a field of 1′ × 1′ has been chosen. Thus the data are to be used to construct networks of different parameters as well.

The mode of record chosen has made possible also to express at least in part the temporal aspect of mapping: data before 1970 are differentiated from those more recent. Graphic output elaborated in the Interuniversitären Rechenzentrum in Vienna is still more illustrative because the boundaries of federal countries are indicated in red and the main rivers in blue, so that the orientation in maps is relatively easy. Each species distribution map is also supplemented with some general data for particular federal countries with evidenced occurrence (in temporal aspect again), activity period, altitudinal distribution and gross size of populations (percentage of single findings, that of small numbers of individuals, and of mass findings).

Including *Rana* **kl.** *esculenta the work has recorded the distribution of 31* amphibian and reptile species on the basis of 16.844 findings. Some species are very rare, e.g. *Bufo calamita* which reaches Austria from the Lužnice river basin only (totally 15 findings) or *Emys orbicularis* in Austria planted out in various localities but nowhere autochthonous. Other species to be held also for rare as e.g. *Pelobates fuscus*, *Rana arvalis*, *Natrix tessellata* or *Vipera ursinii* (each less than 1% of findings) can in fact be, however, far more frequent but they slip the attention owing to their hidden mode of life or mistaking for other species. Eventually, a number of species (12) is common in Austria (representing more than 3% of all findings each).

If one evaluates the reviewed work from the practical point of view, some imperfections are not to be omitted which result from the methods chosen. The most important one is creating of national mapping network which does not correspond to the internationally recommended one accepted by many countries as early as in 1979. It is even more surprising that the Austrian basic *computer input unit i.e. the square of 1′ × 1′ does not prevent to meet the international* demands. There is also another problem which, however, is mentioned even by the authors, i.e. the impossibility to state changes in distribution of species in the past and in Recent according to published data because earlier authors had often omitted common species. However if one keeps in mind the main aim of the work, i.e. not to register historical changes but to open up the hitherto reached knowledge of Austrian herpetofauna, it is to say that we have in our hands a presentable work of good quality which [illegible] model for similar enterprises in other countries, of course under the condition of the acceptance of the international mapping network.

I. Roth

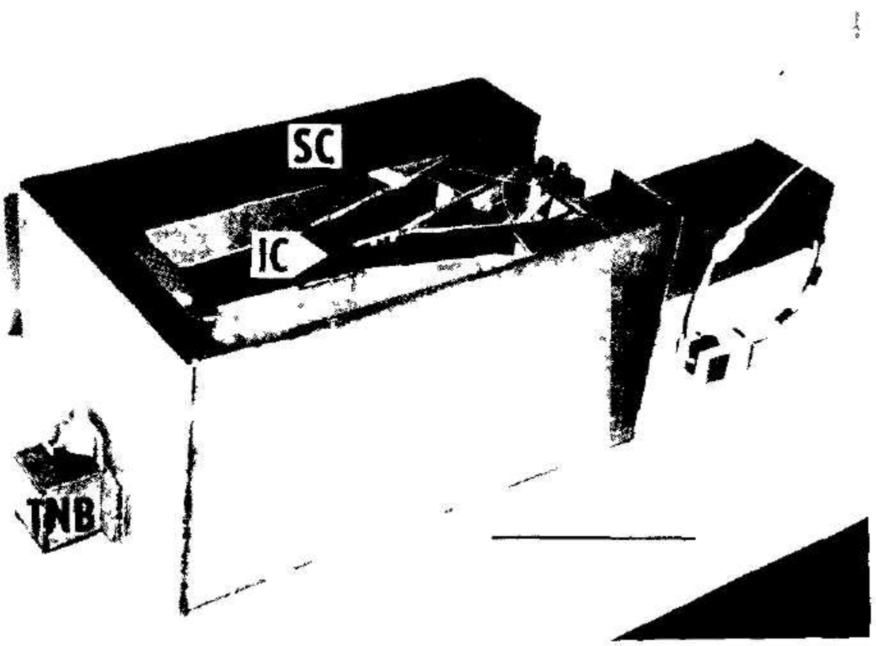

Fig. 1. The experimental apparatus. IC — inner corridor, SC — side corridor, TNB — transportable nest box. Bar — 0.2 m.

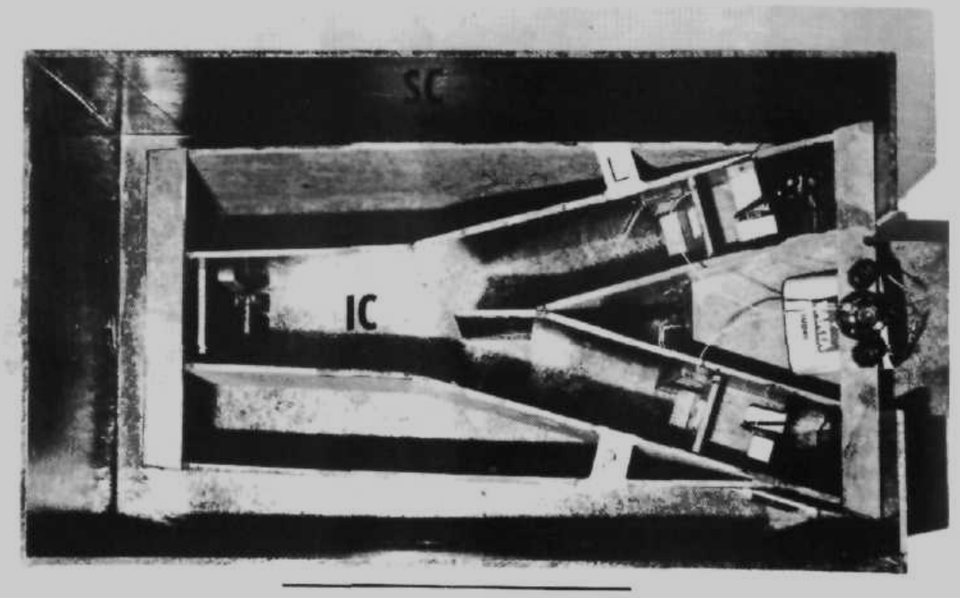

Fig. 2. The "bird's eye view" of the experimental apparatus. IC – inner corridor, SC – side corridor, BR – box of reward. Bar – 0.2 m.

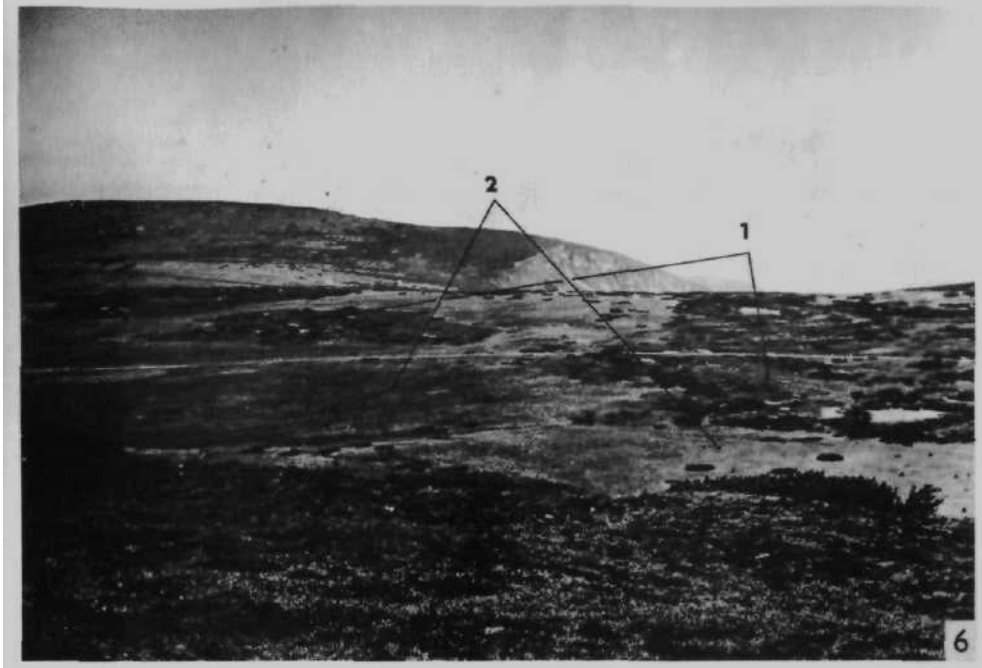

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Fig. 6. Total view of the western part of the study area, 1,410 – 1,440 m a. s. Photo Jan Štursa. (1: subarctic peatbog itself, Rhynchosporion albae × Oxycocco-Empetrion hermaphroditi, 2: *dry subalpine meadow*, Nardo-Caricion rigidae).

Fig. 7. Detail of the subarctic peatbog itself (plant community no. 1, see Material and Methods). Photo Jiří Bruník.

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Fig. 8. Dry subalpine meadow with dominant stands of *Nardus stricta* (plant community no. 2, see Material and Methods). Photo Jan Štursa.

Fig. 9. Stands of *Pinus mugo* in the study area (plant community no. 3, see Material and Methods). Photo Jan Vaněk

POKYNY PRO AUTORY

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

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

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

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Tabulky jsou tištěny jako otevřené, tj. bez svislých linek. V tabulkách oddělte vodorovnými linkami jen záhlaví tabulky a dolní okraj. Tabulky protokolárního charakteru nebo opakující údaje z textu, případně tak velké, že by je nebylo možné vytisknout na dvě protilehlé strany, nebudou *přijímány.*

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

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

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