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SOME TREMATODES AND CESTODES FROM AMPHIBIANS AND REPTILES IN EGYPT

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Abstract: The present paper comprises a systematic survey of digenetic trematodes and cestodes collected from 97 specimens of amphibians and reptiles of the families Ranidae, Bufonidae, Geckonidae, Lacertidae, Scincidae and Chamaeleontidae in Egypt. This material includes 8 species of digeneans (*Plagiorchis (Metaplagiorchis) momplei, Anchitrema sanguineum, Lecithodendrium hirsutum, Lecithodendrium* sp., *Prosthodendrium (Paralecithodendrium) obtusum, Pleurogenoides tener*, Lecithodendriidae gen. sp. and metacercariae of *Echinostoma revolutum*) and 1 species of cestodes (*Oochoristica tuberculata*); redescriptions of 6 species of adult digeneans and cestodes extend the present knowledge of their morphology and intraspecific variability. *Plagiorchis momplei* and *Oochoristica tuberculata* have been found in Egypt for the first time. The species *Plagiorchis africanus* (Dollfus, 1950) is synonymized with *P. momplei* Dollfus, 1932.

Despite the fact that the first papers dealing with the helminths of amphibians and reptiles in Egypt date back to the end of the last century and the beginning of this century (Sonsino, 1896; Looss, 1896, 1898, 1899; Odhner, 1910), the present knowledge on the helminth fauna of these hosts is rather poor; in many cases the only available data are those almost one hundred years old. It concerns, for example, some species of digenetic trematodes described by Looss (1896) from chameleons in Lower Egypt (Alexandria) which have not been recorded in their reptilian hosts since. Little attention has so far been paid to the study of the helminth fauna of amphibians and reptiles also in neighbouring African countries.

From September 1971 until March 1972, during his stay in Egypt, the second author had an opportunity to examine helminthologically a certain number of amphibians and reptiles from the vicinity of Cairo. Results of the systematic evaluation of digenetic trematodes and cestodes found are presented in this paper.

MATERIALS

From Cairo and its vicinity, a total of 97 amphibians and reptiles were examined, belonging to several species of the families Ranidae (28 specimens), Bufonidae (12), Geckonidae (15), Lacertidae (3), Scincidae (34) and Chamaeleontidae (5); of these, only 3 species of amphibians (*Rana mascareniensis* Dum. et Bibron*), *Rana esculenta* L., and *Bufo regularis* Reuss.) and 5 species of reptiles (*Hemidactylus turcicus* L., *Ptyodactylus hasselquisti* Donndorff., *Scincus scincus* L., *Chalcides ocellatus* Forsk., and *Chamaeleo chamaeleon* L.) harboured digenetic trematodes and cestodes. All materials of trematodes and cestodes were studied as stained total mounts, now deposited in the collections of the Institute of Parasitology, Czechoslovak Academy of Sciences, Prague.

REVIEW OF SPECIES

Fam. Plagiochiidae (Lühe, 1901)

1. *Plagiorchis (Metaplagiorchis) momplei* Dollfus, 1932 (Fig. 1A, B)

(Syn.: *Glypthelmins africanus* Dollfus, 1950; *Lepoderma ramlianus* sensu Azim, 1935, nec Looss, 1896).
Hosts: *Rana mascareniensis* Dum. et Bibron, *Bufo regularis* Reuss.
Location: intestine.
Localities: Ouseim — Estable drain (13. 9. 1971), Cairo — Imbaba (12. 10. 1971).
Incidence: in 1 out of 4 *R. mascareniensis* (intensity of infection 2 specimens) and in 1 out of 12 *B. regularis* examined (intensity 2 trematodes).

Description (3 specimens): Body elongate-oval, rather plump, 1.90—2.59 mm long and 0.75—0.81 mm wide; anterior part of body comparatively broad. Cuticle of anterior part of body densely covered with fine spines. Size of oral sucker 0.266—0.333 × 0.251—0.274 mm; acetabulum smaller than oral sucker, measuring 0.148—0.192 mm in diameter; size ratio of both suckers about 1:0.60. Size of pharynx 0.096—0.155 × 0.096—0.185 mm; size ratio of oral sucker and pharynx 1:0.47. Oesophagus indistinct; caeca long, wide, not extending to body end posteriorly. Testes somewhat diagonal, measuring 0.170—0.362 × 0.163—0.237 mm and 0.222—0.377 × 0.163—0.274 mm. Almost spherical ovary measuring 0.177—0.244 × 0.163—0.229 mm situated just below acetabulum, being or not being separated from it by basal part of cirrus sac. Size of cirrus sac 0.330—0.780 × 0.086—0.118 mm. Genital pore preacetabular. Follicular vitellaria in long lateral bands, but many vetelline follicles distributed in intracaecal, posttesticular space, somewhat exceeding caecal ends posteriorly. Main uterine coils in posttesticular, intercaecal space, particularly in posterior body end; upward branch of uterus passing between testes to genital pore. Size of eggs 0.038—0.040 × 0.019—0.021 mm.

Comments: — Yamaguti (1971) divides members of the genus *Plagiorchis* Lühe, 1899 into three subgenera; the subgenus *Metaplagiorchis* (Timofeeva, 1962), to which our specimens belong, includes at present 7 species parasitizing amphibians and reptiles: *P. (M.) ramlianus* (Looss, 1896), *P. (M.) himalayai* (Jordan, 1930), *P. (M.) momplei* Dollfus, 1932, *P. (M.) molini* Lent et Freitas, 1940, *P. (M.) lenti* Freitas, 1941, *P. (M.) africanus* (Dollfus, 1950) and *P. (M.) biloborchis* Fischthal et Thomas, 1968. Except for *P. lenti*, described from *Leptodactylus ocellatus* from Brazil and differing markedly by its morphology from other members of *Metaplagiorchis*, the remaining six species are very close to each other in their morphology and measurements and, accordingly, it is difficult to distinguish them: *P. ramlianus*: — it was described by Looss (1896) from a single specimen found in *Chamaeleo basiliscus* in Egypt. Later Azim (1935) assigned to this species the adult trematodes obtained from experiment-

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*) For species identification of the host amphibians and reptiles our thanks are due to Dr. J. Čihař of the National Museum at Prague.

ally infected frogs "*Bufo vulgaris*" (probably *B. regularis*) which had been fed with the metacercariae developed from the xiphidiocercariae found in the snail *Bulinus contortus* (= *B. truncatus*). *P. ramlianus* was redescribed in detail only by Capron et al. (1961) who had recovered a large number of these trematodes from various species of chameleons in Madagascar.

P. himalayai: — it was originally described from an unidentified frog in India; later it was reported from India also by Mehra (1937), Kaw (1950) and Simha (1958) from *Bufo, Rana* and *Chamaeleo.*

P. momplei: — it was described (Dollfus, 1932) on the basis of two specimens from *Rana mascareniensis* and *Bufo regularis* from Maurice Island.

P. molini: — it is the only species of this group, occurring in various lizards *(Lacerta, Eremias)* in Europe.

P. africanus: — it was originally described as *Glypthelmins africana* from *Rana mascareniensis* from central Africa (Zaire). Later it was assigned to different genera (see Fischthal and Thomas, 1968); according to Yamaguti (1971) it belongs to the genus *Plagiorchis.* Beverley-Burton (1963) reported this species from *Rana adspera* and *Mabuya striata* from South Rhodesia.

P. biloborchis: — it was described as *Metaplagiorchis biloborchis* from the frog *Dicroglossus occipitalis* (Ranidae) from Ghana. Its description is based on a single specimen and according to the authors (Fischthal and Thomas, 1968) the "species appears closest to *M. ramlianus* but differs from it and other species of the genus in having both its testes deeply bilobed".

Capron et al. (1961) have reported that it is very difficult to separate the species *P. ramlianus, P. himalayai* and *P. molini* on the basis of the morphological and metrical features; however, it is necessary to assign to this group of species also *P. momplei, P. africanus* and *P. biloborchis.* It is probable that subsequent studies will prove identity of at least some of these species.

A detailed comparison of our specimens with the above mentioned species has shown that these are closest to the species *P. momplei* and *P. africanus;* while the specimens from *R. mascareniensis* resemble more *P. africanus* by their morphology (Fig. 1B), the specimens from *B. regularis* remind rather *P. momplei* (Fig. 1A). Both these species were described from geographically close areas from the same host species *(Rana mascareniensis* and *Bufo regularis)* and, as suggested by the present material, they were evidently based on specimens at different degree of development but belonging to the same species. Consequently, we have assigned our specimens to the species *P. momplei* Dollfus, 1932, considering *P. africanus* (Dollfus, 1950) to be its synonym. Also the trematodes from *Bufo vulgaris* (? *B. regularis*) from Egypt, assigned erroneously to *Plagiorchis ramlianus* by *Azim* (1935), belong apparently to this species; it is suggested by its illustration. Also Capron et al. (1961) have expressed their doubts as to the conspecificity of Azim's specimens and the species of Looss. In contract to *P. momplei* from African amphibians, *P. ramlianus* parasitic in African chameleons is noted for a somewhat different shape of body (forebody is narrower), presence of distinctly developed oesophagus and narrower caeca (see Looss, 1896; Capron et al., 1961); by these features *P. momplei* differs as well from *P. himalayai* from amphibians of India and *P. molini* from European lizards (see e. g. Jordan, 1930; Dollfus, 1932; Mehra, 1937; Lent and Freitas, 1946; Moravec, 1963; Sharpilo, 1976).

Fam. Anchitrematidae (Mehra, 1935)

2. ***Anchitrema sanguineum*** (Sonsino, 1894) Looss, 1899 (Fig. 1C)

Host: *Chamaeleo chamaeleon* L.
Location: intestine.
Locality: Wadi Natrun (6. 10. 1971).
Incidence: in 2 out of 5 chameleons examined (intensity of infection 3—63 specimens)

Description (10 specimens): Body tongue-shaped, 2.68—4.05 mm long and 0.78—1.17 mm wide, spinose. Almost spherical oral sucker measuring 0.265—0.390 × 0.281—0.390 mm; acetabulum smaller than oral sucker, preequatorial, size 0.218—0.327 × 0.202—0.327 mm; size ratio of both suckers 1 : 0.73—0.97, not being dependent on body size. Measurements of pharynx 0.140—0.218 × 0.156—0.203 mm. Oesophagus very short or indistinct; caeca long, ending near posterior body end, coming near to each other in testicular zone. Cirrus sac absent; seminal vesicle convoluted, just in front of acetabulum. Genital pore preacetabular. Testes symmetrical, extracaecal, just below acetabulum; size of left testis 0.296—0.499 × 0.187—0.395 mm, of right one 0.296—0.530 × 0.218—0.374 mm. Ovary median, posttesticular, 0.156—0.256 × 0.140—0.218 mm. Follicular vitellaria laterally and dorsally from caeca, immediately posttesticular. Uterus in posterior half of body, uterine coils overlapping caeca laterally. Eggs numerous, size 0.023—0.025 × 0.013—0.015 mm.

Comments: — The species *A. sanguineum* (Sonsino, 1894) was first described from *Chamaeleo chamaeleon* from Gabes in Tunisia and later it was found as well by Looss (1896) in *Chamaeleo basiliscus* in Egypt. After Yamaguti (1971) this species has also been reported from various species of bats in Egypt and India. Our data, based on specimens from the type host, extend the knowledge of the metrical variability in this species.

Fam. Lecithodendriidae (Lühe, 1901)

3. *Lecithodendrium hirsutum* (Looss, 1896) Looss, 1899 (Fig. 2A)

Host: *Chamaeleo chamaeleon* L.
Location: intestine
Locality: Wadi Natrun (6. 10. 1971)
Incidence: in 2 out of 5 chameleons examined (intensity of infection 3—75 specimens)

Description (10 specimens): Body oval or ovoid with smooth cuticle; length of body 0.75—1.26 mm, maximum width 0.58—1.07 mm. Size of oral sucker 0.099—0.156 × 0.072—0.144 mm; acetabulum substantially smaller (0.057—0.084 × 0.054—0.078 mm) than oral sucker, located at testes level; size ratio of both suckers 1 : 1.4—1.6. Measurements of muscular pharynx 0.030—0.051 × 0.030—0.039 mm; length of oesophagus 0.111—0.150 mm, caeca short. Almost spherical testes preequatorial, lateral, size 0.150—0.240 × 0.141—0.195 mm. Genital pore median, just preacetabular; cirrus sac oval-shaped, preacetabular, size 0.090—0.165 × 0.075—0.090 mm, containing coiled seminal vesicle. Oval or spherical ovary substantially smaller (size 0.105—0.171 × 0.081—0.135 mm) than testes, situated near acetabulum. Vitellaria consisting of two lateral groups of 6—10 follicles, located in mid-body just below testes. Body space posterior to testes and acetabulum filled up with uterine coils containing numerous eggs. Size of eggs 0.024—0.025 × 0.012—0.015 mm.

Comments: — *L. hirsutum* was described by **Looss** (1896) from the intestine of *Chamaeleo basiliscus* from Egypt and after **Skarbilovich** (1948) it has also been known as the parasite of bats in Europe. Specimens of the present material are noted for a somewhat shorter and plumper body than illustrated by Looss (1896), this being apparently caused by compressing the specimens under a cover slip during their fixation. The size ratio of both suckers is approximately identical with that in the specimen illustrated by Looss (1896).

By its morphology, *L. hirsutum* resembles two other congeneric species, *L. linstowi* Dollfus, 1931 and *L. granulosum* Looss, 1907, reported from Egyptian bats, differing from them principally in the ratio of suckers, while both suckers are approximately equal in size in the first species and the acetabulum is larger than oral sucker in the second species, in *L. hirsutum* the acetabulum is always considerably smaller than the oral sucker. Another congeneric species from Egyptian bats, *L. urna* Looss, 1907, in which the sucker ratio is similar to that in *L. hirsutum*, differs markedly from the latter by the location of the vitellaria which are pretesticular.

The genus *Lecithodendrium* Looss 1896 includes mostly the parasites of bats; *L. hirsutum* is a single member of the genus reported from reptiles.

4. *Lecithodendrium* sp. juv. (Fig. 2B)

Host: *Hemidactylus turcicus* L.
Location: intestine.
Locality: Cairo (23. 10. 1971).
Incidence: in 1 out of 5 *H. turcicus* examined (intensity of infection 7 specimens)

Descriptin (2 most advanced specimens): Body elongate oval with smooth cuticle; body length 0.71—0.84 mm, maximum width 0.29—0.37 mm. Size of oral sucker 0.075—0.084 × 0.063—0.069 mm; acetabulum distinctly smaller, 0.054—0.060 × 0.048—0.051 mm, situated approximately in mid-body; size ratio of both suckers 1 : 1.3—1.4. Size of pharynx 0.030—0.033 × 0.021 mm, length of oesophagus 0.135—0.165 mm; short caeca extending almost to middle of body. Cirrus sac oval-shaped, preacetabular, size 0.090—0.099 × 0.045—0.075 mm. Testes oval-shaped, large (0.150 × 0.093—0.105 mm and 0.138—0.144 × 0.114—0.126 mm), situated laterally below caeca. Oval-shaped ovary (size 0.090—0.105 × 0.060—0.075 mm) median, at testes level. Vitellaria forming two lateral groups of 7—11 big follicles each, located posteriorly to testes. Excretory vesicle V-shaped. Eggs in uterus hitherto not present.

Comments: — By their shape of body, sucker ratio, length of oesophagus and situation of testes and vitellaria, these trematodes resemble some species occurring in bats (e. g. *L. macrostomum*, *L. elongatum*). However, regarding the fact that only immature specimens are available, it is not possible to exclude their conspecificity with the foregoing species; it is suggested by the sucker ratio.

5. *Prosthodendrium (Paralecithodendrium) obtusum* (Looss, 1896) Bhalerao, 1936 (Fig. 2C)

Host: *Chamaeleo chamaeleon* L.
Location: intestine.
Locality: Wadi Natrun (6. 10. 1971).
Incidence: in 1 out of 5 chameleons examined (intensity of infection 2 specimens)

Description (2 specimens): Body broad-oval, 1.56—1.68 mm long and 1.40—1.56 mm wide, with nonspiny cuticle. Size of oral sucker 0.259—0.273 × 0.244—0.259 mm; acetabulum slightly smaller (0.207 mm in diameter) than oral sucker, situated approximately at mid-body; size ratio of both suckers 1 : 1.2. Size of pharynx 0.111 × 0.111—0.118 mm, length of oesophagus 0.045—0.075 mm; caeca narrow, reaching by their ends to testes. Testes oval-shaped, 0.244—0.273 × 0.185—0.222 mm, lateral, just in front of acetabulum level. Genital pore median, preacetabular; spacious seminal vesicle (0.313 × 0.163—0.204 mm) situated in median line between acetabulum and caeca. Transverse ovary (size 0.476—0.490 × 0.163—0.177 mm) located at site of caeca bifurcation; its anterior margin divided into 7—9 lobes. Vitellaria formed by two lateral groups of follicles located in space anterior to testes and caeca. Body space below testes and acetabulum filled up with uterine coils containing numerous eggs; size of eggs 0.023—0.026 × 0.010—0.012 mm.

Comments: — The subgenus *Paralecithodendrium* Odhner, 1910 includes several species parasitic in bats and reptiles. The species *P. (P.) obtusum,* which is a type species of this subgenus, was described by Looss (1896) from *Chamaeleo basiliscus* from Egypt (Alexandria). The present description of this species, being based on materials from the related host of the same geographical area, provides new data on this hitherto little known parasite species.

6. *Pleurogenoides tener* (Looss, 1898) Travassos, 1921 (Fig. 3A, B)

Hosts: *Chamaeleo chamaeleon* L., *Rana esculenta* L., *Rana mascareniensis* Dum. et Bibron.

Location: intestine.

Locality: Wadi Natrun (6. 10. 1971), Ouseim — Estable drain (24. 10. 1971), Hanadwa drain II (8. 11. 1971).

Incidence: in 4 out of 5 *Ch. chamaeleon* examined (intensity of infection 7—23 specimens), in 2 out of 24 *R. esculenta* (intensity 2—4 specimens) and in 1 out of 4 *R. mascareniensis* (intensity 23 trematodes).

Description (10 specimens from *Ch. chamaeleon;* measurements of 4 specimens from *R. esculenta* given in brackets): Body short, oval-shaped, 0.75—1.26 (0.64—1.09) mm long and 0.67—0.90 (0.65—0.90) mm wide, with cuticle densely spinose. Size of oral sucker 0.144—0.180 × 0.120—0.174 (0.120—0.126 × 0.102—0.105) mm; acetabulum approximately in mid-body, usually somewhat larger or, exceptionally, equal or even slightly smaller than oral sucker; its size 0.135—0.171 × 0.117—0.156 (0.114—0.126 × 0.114—0.126) mm. Pharynx 0.057—0.090 × 0.045—0.066 (0.045—0.048 × 0.036—0.039) mm, oesophagus indistinct, intestinal caeca reaching by their ends to testes. Oval-shaped testes lateral, located preequatorially; their size 0.180—0.326 × 0.120—0.190 (0.120—0.165 × 0.075—0.081) mm. Genital pore lateral, at oral sucker level; large cirrus sac lateral, size 0.272—0.448 × 0.122—0.136 (0.245—0.258 × 0.081—0.095) mm, crossing intestinal caecum and containing large seminal vesicle, prostatic part and ductus ejaculatorius. Ovary 0.150—0.210 × 0.105—0.135 (0.105 × 0.075) mm, located in space delimited by caeca, cirrus sac, acetabulum and testes. Follicular vitellaria precaecal, reaching anteriorly middle of oral sucker. Body space below testes and acetabulum filled up with uterine coils. Size of eggs 0.030—0.033 × 0.015—0.018 (0.030—0.033 × 0.015) mm. Excretory pore Y-shaped, its unpaired basal part being much shorter than both anterior branches.

Comments: — The species *P. tener,* which is a type species of the genus *Pleurogenoides* Travassos, 1921, was found for the first time in *Chamaeleo* *basiliscus* in Egypt by Looss (1896) who assigned it erroneously to *Distomum tacapense* Sonsino, 1894 (= *Sonsinotrema tacapense)*; only later he (Looss, 1898) determined it as a new independent species. Later on, this parasite was recorded from the same host from Egypt by Odhner (1910) and from *Ch. vulgaris* (= *Ch. chamaeleon*) from the surroundings of Cairo it has been reported by Khotenovskiy (1970) who redescribed it. *P. tener* was recorded as well from *Chamaeleo paradalis* from Madagascar (Capron et al., 1961). The development of this parasite was studied in Egypt by Macy (1964) who had found as the experimental definitive hosts of *P. tener* the scink *Chalcides ocellatus* and the frog *Rana mascareniensis*.

Our specimens from *Ch. chamaeleon* are more or less in agreement with the description of *P. tener* given by Khotenovskiy (1970); however, the latter author had at his disposal only 2 specimens and, accordingly, the found morphometrical variability of trematodes of the present material is somewhat wider. Besides other features it concerns the ratio of the oral sucker and the acetabulum that is usually taken for the very important specific feature of members of this genus. According to Khotenovskiy (1970), *P. tener* is characterized by having the acetabulum always larger than the oral sucker; our material indicates, however, that it need not be so and, especially in younger specimens, the acetabulum may be even slightly smaller than the oral sucker. Also the shape and extent of the Y-shaped excretory vesicle is somewhat variable and its anterior branches need not by far reach the acetabulum level. Our specimens from frogs are morphologically identical with those from chameleons and we assign them, therefore, to the same species. The ability of *P. tener* to attain maturity in amphibians has been confirmed experimentally by Macy (1964).

7. Lecithodendriidae gen. sp. juv. (Fig. 3C)

Host: *Ptyodactylus hasselquisti* Donndorff.
Location: intestine.
Locality: Abu Rawash (18. 9. 1971).
Incidence: in 1 out of 7 *P. hasselquisti* examined (intensity 2 specimens).

Description (2 specimens): Body ovoid, 0.38—0.61 mm long and 0.23—0.25 mm wide, cuticle covered with fine spines. Size of oral sucker 0.063—0.072 × 0.060—0.063 mm; acetabulum (size 0.051 × 0.045 mm) situated approximately at mid-body. Measurements of muscular pharynx 0.030 × 0.021 mm, length of oesophagus 0.015 mm; intestinal caeca short. Oval testes lateral, situated at acetabulum level, their size being 0.096—0.120 × 0.075 mm; ovary indistinct. Large, coiled seminal vesicle (? inside cirrus sac) present in space between caeca and acetabulum. Two lateral groups of vitellary follicles present in front of testes. Eggs not developed.

Comments: — Since the trematodes found have been insufficiently developed, their closer identification is problematic. Some features (spiny cuticle, distribution of organs, ratio of suckers, etc.) suggest that the specimens might be juvenile members of the genus *Pleurogenoides* with the hitherto little developed cirrus sac.

Fam. Echinostomatidae Poche, 1926

8. *Echinostoma revolutum* (Froelich, 1802) Looss, 1899 — metacercariae

Host: *Rana esculenta* L.
Location: kidneys.

Locality:Ouseim — Estable drain (24. and 31. 10. 1971).
Incidence: in 2 out of 24 *R. esculenta* examined (intensity of infection 6—11 metacercariae per frog).

Comments. — The encysted metacercariae found in *R. esculenta* correspond to the description of *E. revolutum* metacercariae given in the paper by Moravec et al. (1974); the latter authors studied the life cycle of this parasite under the conditions of Egypt, where the freshwater snail *Biomphalaria alexandrina* serves as the first intermediate host, while the second intermediate hosts are various species of freshwater snails and frogs; the adults of *E. revolutum* were obtained experimentally from some rodents (golden hamsters, white rats, white mice, rabbits) and birds (domestic ducks, chickens, herons). In the given locality (Estable drain), the larval stages of *E. revolutum* were found to occur very frequently in snails.

Fam. Anoplocephalidae Cholodkovsky, 1902

9. *Oochoristica tuberculata* (Rudolphi, 1819) Lühe, 1898 (Fig. 3D, E)

Hosts. *Chalcides ocellatus* Forsk., *Scincus scincus* L.
Location intestine.
Locality Abu Rawash (18. 9. 1971).
Incidence: in 2 out of 11 *Ch. ocellatus* examined (intensity of infection 1—2 specimens) and in 3 out of 5 *S. scincus* (intensity 1—3 cestodes)

Description (1 mature specimen from *Ch. ocellatus*): Length of body 20.5 mm, maximum width 0.86 mm. Scolex rounded, 0.340 mm wide, provided with four spherical suckers 0.111—0.120 mm in diameter; length of neck about 1.3 mm. 31 segments can be distinguished on strobila; mature segments elongate, their length being 0.784—1.720 mm and width 0.680—0.857 mm. Genital openings alternating irregularly on both sides of strobila, being situated always near anterior third of lateral margin of segment. Genital atrium rather deep, expanded at base, with muscular walls. Length of cirrus sac 0.120—0.165 mm, its width 0.060—0.072 mm. Testes spherical, 0.045—0.060 mm in diameter, *forming one group in space posterior to female genital glands; testes 26—36* in number per segment. Ovary, forming two wings, situated at middle part of segment: width of ovary 0.258—0.354 mm, its length 0.190—0.231 mm. Vitellarium of irregular shape, size 0.136—0.163 ×0.095 mm, close to posterior end of ovary. Eggs regularly distributed in parenchyme of gravid segments; eggs spherical, some 0.060 mm in diameter, containing inside spherical oncosphera (0.021—0.024 mm in diameter); length of embryonal hooks of oncosphera 0.021 mm.

Comments: — The mature specimens of *O. tuberculata* containing eggs in segments were found in the host *Ch. ocellatus* only; from *S. scincus* were obtained only the young cestodes the morphology of which suggests, however, that they are members of the same species: this is also supported by the fact that both the hosts are closely related and the cestodes occurred in the same locality. The morphology of adults corresponds to the description of *O. tuberculata* given by Sharpilo (1976).

The species *O. tuberculata* is a frequent parasite of various reptiles, particularly lizards (Sauria), being widely distributed over Europe, Central Asia and northern Africa.

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THE CASE OF MACROCEPHALUS IN THE WILD CAT

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Abstract: The skull with an extraordinarilly large braincase, belonging to an adult male Wild cat (*Felis silvestris* Schreber, 1777) is referred to in the present paper. Measurements and rations of the skull are compared with analogous data given for various samples of *Felis silvestris* and *Felis catus* in order to find out what is the reason of such formation of the neurocranium. No pathologic causes have been registered and the skull in question is supposed to be a case of macrocephalus

In a sample of 130 specimens of the West-Carpathian Wild cat (*Felis silvestris* Schreber, 1777), one skull has been found with an unusually formed large braincase. The skull belongs to an adult male specimen shot near Suchá-Brezovo, Central Slovakia in March 27, 1964 (body length 670 mm, tail 340 mm, hind foot 150 mm, ear 60 mm, weight 5150 g). The skull is middle-sized (Cb--length 90.6 mm) and its dimensions, for the most part, are well within the limits of the variability established for this species. The only differences getting rather markedly over the respective limits have been found in measurements of the braincase, namely in its breadth (53.9 mm) and capacity (55.8 cm^3). Besides, a certain increase of the values was stated also in the postorbital breadth (figures on plate). A slight decrease of the bone thickness occurs especially in parietalia.

Following conclusions have been made according to the formation of the skull referred to after comparing its characters with analogous data given for various samples of *Felis silvestris* and *Felis catus* in literature (Figs. 1—5).

A very marked deviation in the braincase capacity of the present skull follows from the absolute values of this character. Accordingly to Schauenberg (1969), the average values of the braincase capacity in the Wild cat and the Domestic cat are 41.25 cm^3 and 27.50 cm^3, respectively. Although somewhat higher values were stated in the material of both *Felis silvestris* and *Felis catus* from the territory of Czechoslovakia (43.9 cm^3 and 29.0 cm^3 respectively; see Sládek, Mošanský and Palášthy, 1971 and Heráň and Porkert, 1976), the braincase capacity of the skull examined (measured by using the fine sand) is by about 2 cm^3 larger than the highest limit of the theoretical variation ($x + 3s$) found in the respective samples of *Felis silvestris*. Besides, since the skull in question is not the largest the actual extent of the present deviation, in fact, is rather higher provided that its capacity is compared with the average values of likely sized male skulls of *Felis silvestris* (Fig. 4)

An analogous situation occurs if the breadth of the braincase is regarded (Fig. 3). A degree of the deviation, in this case, can be expressed also by the use of relative values which represent the percentage ratio breadth of the braincase to condylobasal length. Whilst in the skull examined this ratio is 59.5, in the other comparable sized skulls of *Felis silvestris* it is represented by an average value 51.1 and by limits of variation ranging from 47.7 to 53.2. An enlarging of the postorbital breadth coincides very closely with the size of the neurocranium.

In order to find out whether such enlarging of the braincase might be caused by an intensified function of masticatory muscles the breadths of the braincase and of the zygomatic arch have been compared with each other (cf. Heráň 1981). In the skull examined, however, a zygomatic breadth itself, even if somewhat higher than the respective breadth in the other comparable sized skulls, is wholly in limits of variation stated in this character (Fig. 2). Hence a ratio zygomatic breadth to breadth of the braincase is markedly lower in the present skull not only if compared with average values of the likely sized skulls but also in relation to the general course of the respective character in the both species (Fig. 5). So it can be concluded that the large braincase does not coincide with any function of masticatory muscles. In the opposite case, however, the necessary inserting area should be probably compensated rather by arising superficial bony structures (crests) than by an enlarged braincase volumen.

Except for the slight decrase of the bone thickness in the region of parietalia, no indications have been found in the skull examined,, which might give reasons for the opinion that the forming of it is of pathological origin. There are also no characters indicating that the present state of the skull is caused by a hybridization with a Domestic cat. The authors conclude that the described enlarging is only a matter of an extremely outstanding fluctuation of the values in certain skull characters, which might be considered for the case of macrocephalus.

The skull is deposited in the collections of the College of Forestry and Woodprocessing in Zvolen.

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The figures 1—5 and the plate I will be found at the end of this issue.

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NOTE ON THE CLOWN LOACH BOTIA MACRACANTHA (PISCES, COBITIDAE)

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Received April 28, 1982

Abstract: Plastic and meristic characters were examined in 14 specimens (31.8 —73.0 mm (ave. 38.2) of the body length) of the clown loach *Botia macrantha* (Bleeker, 1852) originating from the tanks of Czechoslovak fanciers. Meristic characters well agree with the original description by Bleeker (1852), plastic ones show some differences.

INTRODUCTION

Bleeker (1852) described the new species *Cobitis macracanthus* from Sumatra based on three specimens. Later, he transfered this species into the genus *Hymenophysa* (1860, after Weber and de Beaufort, 1916) and *Botia* (1863, after Weber and de Beaufort, 1916).

Due to its apparently vivid coloration the fish was imported into the tanks of fish fanciers in 1936 (Sterba, 1977), but up to now no records have appeared on its natural reproduction in the captivity without the use of hormonal injections (Petrovický, 1976). Details concerning breeding in aquaria are given, e. g., in Arnold (1936), McInerny and Gerard (1974), Sterba (1977).

MATERIAL AND METHODS

All measurements were made using dividers with accuracy ± 1 mm. The number of scales, rays and gill rakers were counted using binocular microscope. All material preserved at first in formalin was later deposited in 80 % spirit.

RESULTS AND DISCUSSION

The body of my own examined specimens is laterally compressed. The head is deep, pointed, with small eyes being situated in the posterior half of the head. The suborbital spine length is on the basis ramified. The mouth opening is horse-shoe-shaped, the upper jaw is longer than the lower one. Barbel eight: four barbels together on upper lip, two longer (outer) and two shorter (inner) mandibular ones. Lips thick, lamellated.

The origin of the dorsal fin is somewhere in the middle between the end of the shortest caudal rays, before the origin of ventrals. On the outer side of the first gill arch there are badly developed gill rakers, on the inner side I have counted 15 small gill rakers. Scales are very small, oviform, in specimen with 31 mm of the body length the size of the scale from the middle of the side (oral-caudal axis) was 0.26 mm. In another specimen with 73 mm of the body length the size of the scale was 0.80 mm. Radial canals are visible around

Table 1. Comparison of author's values concerning plastic characters with Bleeker (1852), Weber and de Beaufort (1916), ranges in brackets.

	Weber and de Beaufort (1916)	Bleeker (1852)	Own values
in % of the body length			
head length	30	21 – 23	32 (31 – 35)
body depth		25	29 (26 – 36)
predorsal distance			58 (53 – 61)
preventral distance			60 (56 – 64)
length of the caudal fin		27	26 (24 – 28)
in % of the head length			
head depth	less than 100	more than 100	79 (70 – 91)
eye diameter	17 – 25	22 – 25	23 (19 – 25)
head width		50 – 60	48 (53 – 56)
interorbital distance		36 – 57	37 (34 – 44)
length of the pectoral fin		less than 100	64 (53 – 74)
length of the snout			51 (43 – 60)
length of the suborbital spine			33 (29 – 37)
length of longer mandibular barbels			18 (8 – 27)
length of the basis of the anal fin			27 (21 – 35)
postorbital distance			39 (33 – 43)
length of the basis of the dorsal fin			54 (44 – 61)
longest ray in the anal fin			66 (54 – 73)
longest ray in the dorsal fin			79 (71 – 87)
length of the ventral fin			51 (39 – 61)
length of the caudal peduncle			40 (29 – 47)
biggest depth of the caudal peduncle			55 (48 – 67)
minimum depth of the caudal peduncle			52 (45 – 62)
in % of the eye diameter			
length of the suborbital spine	150	more than 100	148 (133 – 160)
length of the snout		about 200	218 (173 – 278)
mouth width			60 (52 – 65)
length of shorter mandibular barbels			43 (11 – 78)
in % of the biggest depth of the caudal peduncle			
its length	75		72 (63 – 97)

the whole margin of the scale. The basis of the caudal fin is scaled. According to Frank (1980), male of the clown loach is smaller and slimmer than the female and has deeper and more pronounced colours. Background coloration in preserved specimens is yellow to ochre with three broad brown bands, the first through the eye, the second in the middle of the body, the third between the posterior end of dorsal and anal fin, including both fins in the biggest specimen (73 mm of the body length). All fins lightly yellow in smaller specimens (31.3—42.0 mm of the body length), in biggest specimen there is a brown spot on ventrals, pectorals are yellow-brown. Bleeker (1852) describes the background coloration as orange-red with three very broad black transverse bands. Pectorals red, ventrals red (in the middle of fins brown), dorsal and anal nearly whole black. Klausewitz (1955) had 312 specimens of the clown loach from Sumatra, he found specimen and interruption of the middle transverse band in one. Weber and de Beaufort (1916) stated the biggest size of clown loach as 300 mm of the total length.

Table 2. Comparison of author's values concerning meristic characters with Bleeker (1852), Günther (1868), Weber and de Beaufort (1916), Sterba (1977).

	Bleeker (1852)	Günther (1868)	Weber and de Beaufort (1916)	Sterba (1977)	own values
in the dorsal fin	11	3/8 (3/9)	1/10	1/10	3/8
in the anal fin	8	3/5 (4/6)	2/6	2/6	3/5
in the pectoral fin	14–16	1/13 (1/14)	1/13	1/13	1/14–15
in the ventral fin	9	1/8	1/8	1/8	1/8
scales in the lateral line					124 (120–132)
number of gill rakers					15

My account of plastic and meristic characters compared with other authors is given in Tables 1 and 2. Concerning meristic characters my findings agree with those of Bleeker (1852), Günther (1868), Weber and de Beaufort (1916) and also Sterba (1977).

Concerning plastic characters, I found some differences probably due to a smaller size and a larger number of specimens examined. Bleeker (1852) had only 3 specimens 60–132 mm of the length (?, he cited 60'''–132''') at his disposal. Therefore I found higher values in comparison with Bleeker's (1852) description in head legth in % of body length, body depth in % of body length and lower values in head depth in % of head length. Weber and de Beaufort (1916) also found head depth in % of head length less than 100 %, the same as I did in my material, but they cited no details as to the size of specimens examined.

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SUMMARY

In his paper, plastic and meristic characters of the clown loach (*Botia macracantha* (Bleeker, 1852) are given. Examined material, originating from aquaria, was compared with original Bleeker's (1852) description and with data by further authors (Günther, 1868; Klausewitz, 1955; Weber and de Beaufort, 1916: Sterba, 1977). The meristic characters agree with the data in literature, plastic ones show some differences due probably to a smaller size and a larger number of specimens examined in comparison with the original description.

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CONSUMPTION AND EXCRETION OF GRIT IN CAPERCAILLIE, BLACK GROUSE AND WILLOW GROUSE (TETRAO UROGALLUS L., TETRAO TETRIX L., LAGOPUS LAGOPUS L.) UNDER EXPERIMENTAL CONDITIONS

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Abstract: Factors influencing the grit excretion and consumption were explored in experiments including capercaillie (4 ♀♀), black grouse (1 ♂ + 3 ♀♀) and willow grouse (1 ♂ + 3 ♀♀) in order to find out what is the role of gastroliths in food crushing and in maintaining the body condition of individuals, especialy during the winter season. The following questions are discussed: 1. Influence of the availability of grit on the excretion of gastroliths, 2. Influence of the consistency of food on the excretion of gastroliths, 3. Differences in the excretion of grit in dependence on bird activity and the period of the day, 4. Interspecific differences in the excretion and consumption of grit. The availability of stones, the consistency of food and movement of birds seem to be the most important factors influencing the turnover of grit in tetraonids. Internal, homeostatic, mechanisms of retention have a limited, and in the three species, different effect. In this respect, capercaillie is better equipped for facing conditions when the grit is not available in the winter than are black grouse and willow grouse. An inefficacy of ability of retention of gastroliths under normal conditions with satisfactory food resources appears to cause little harm to tetraonids in the winter.

1. INTRODUCTION

Gastroliths in the gizzard of gallinaceous birds serve as a grinding agent assisting in the crushing of hard food and in this facilitating its better utilization. The importance of grit has frequently been discussed in literature, and has been confirmed in experiments with domestic fowl and game birds of the family Phasianidae (for review see Porkert 1972). Rajala (1958) made an experimental study on the size of stones selected for consumption by three tetraonid species, but failed to examine the excretion of these stones (Rajala, personal communication 1967). Other experimental studies were concerned with the regulation of the quantity and size of gastroliths with regard to the diet of the Norwegian willow grouse, and grinding properties of different kinds of grit in a artificial gizzard (Tindall 1973, Norris et al. 1975). Porkert (1972 and unpublished data) made a field study on the excretion of grit in capercaillie, hybrids "rackel-fogel", black grouse and hazel hen.

1.1 Mechanical and physiological function of grit

The importance of hard grit, made up of silica and other hard elements, in the crushing of hard food in the gizzard has generally been acknowledged, while that of soft grit composed of calcium and other soft elements has been recognized by a limited number of authors. Porkert (1972), Tindall (1973), Norris et al. (1975) and Voronin (1978) suggested in their study on gastroliths in tetraonids that soft grit constitutes a source of important mineral substances (Ca, P etc.) in the food. Literary data are contradictory (cf. Porkert 1972) So far, there has been no experimental evidence that differences in the consumption of Ca grit are conditioned by the season, sex and age. At all events, the results obtained by Voronin (1978) indicate that the grit consumption is higher in female willow grouses as compared with the male individuals, during the reproductive period. On the contrary, the proportion of the quartz in the total amount of gastroliths is higher in males than in females.

1.2. Regulation of grit contents in the gizzard

The disagreeing views on a regulation of grit in the gizzard of tetraonids have been discussed in detail by the second author (Porkert 1972). E. g. Semenov-Tjan-Šanskij (1959), Porkert (1972), Tindall (1973), Myrberget et al. (1975), Norris et al. (1975), Romanov (1979) found a relationship between the size and or amount of gastroliths on the one hand and both food and snow conditions, on the other. Porkert (1972) concluded that Tetraonids tend to retain an optimal amount of grit of an optimal quality throughout the year in dependence on the consistency of food in their gizzard. Thereby the amount of grit in the gizzard can always be regulated by excretion, but not the consumption of grit which depends on its availability. This means that the excretion of grit is under a constant influence of the consistency of food in the gizzard. Internal stimuli provoked either by a supra or suboptimal quantity of grit in the gizzard can either increase or, to a certain degree, restrict grit excretion. Similarly, Tindall (1973) and Norris et al. (1975) suggest that the quantity and composition of grit can partly be regulated by environmental conditions.

2. APPROACH TO THE PROBLEM

The present experiment was designed in order to confirm, under controlled conditions, Porkert's (1972) observations in the field, and to examine several problems conected with the turnover of grit, because an understanding of these problems might be an important contribution to the knowledge of the ecology of tetraonids in the winter.

Specially we have raised the following questions which are of apparent importance in the survival of tetraonids in the snow period, when grit is not available.

1) How efficient are the tetraonid species examined in regulating grit contents in their gizzard under different conditions, i. e., are they capable of compensating actively objective disproportions such as an inavailability of grit for consumption, a mechanical excretion of grit with food remnants, a surplus of grit?

2) To what degree is the excretion of grit dependent on the consistency of the food?

3) To what degree can the excretion of grit be restricted under debased conditions, e. g., a high snow cover preventing grit consumption?

4) Is the consumption of food increased if both the quality and quantity of grit in the gizzard is suboptimal regardless of other factors such as a weather —

Tab. 1: Weight changes of birds during the experiment (stated in the period 4.00–5.30 p.m.)

sex	No.	February 27	March 13	March 24 1975
Tetrao urogallus				
♀	Sv. j. 050156	2.200 g	2.075 g	2.050 g
♀	Sv. j. 200286	2.000 g	1.925 g	2.100 g
♀	Sv. j. 050039	2.000 g	1.925 g	2.100 g
♀	Sv. j. 200287	2.000 g	1.925 g	1.900 g
	Mean value	2.050 g	1.962,5 g	2.037,5 g
Tetrao tetrix				
sex	No.	February 27	March 13	March 24 1975
♂	—	1.200 g	1.150 g	1.150 g
♀	Sv. j. 105806	1.000 g	900 g	850 g
♀	Sv. j. 105807	1.000 g	900 g	900 g
♀	—	1.000 g	900 g	850 g
	Mean value	1.050 g	962,5 g	937,5 g
Lagopus lagopus				
sex	No.	February 27	March 13	March 24 1975
♂	—	700 g	650 g	600 g
♀	Sv. j. 105805	600 g	585 g	550 g
♀	Sv. j. 105804	500 g	550 g	430 g found dead March 24, 8,00 a.m.
♀	Sv. j. 105913	500 g	575 g	500 g
	Mean value	575 g	590 g	520 g

or temperature – conditioned activity, or a preference of certain food components?

5) Is the frequently observed jerky and massive excretion of grit to be regarded as a consequence of an excessive intake of grit, and a reaction for reestablishing an optimal amount of grit as required by the prevailing consistency of food in the gizzard?

Tab. 2a: Diet of *Tetrao urogallus* in single periods of the experiment

Period	Date	Diet	Grit
I	Feb. 27, 6.00 p.m. to March 13, 5.00 p.m.	Pinus silvestris, needles Juniperus, Vaccinium myrtillus, stems, Avena, corn, pellets	not available
II	March 13, 5.00 p.m. to March 19, 5.00 p.m.	see period I	2–3 mm + 3–5 mm ad lib.
III	March 19, 5.00 p.m. to March 21, 5.00 p.m.	Vaccinium vitis-idaea, berries	not available
IV	March 21, 5.00 p.m. to March 23, 5.00 p.m.	Pinus silvestris, needles, Vaccinium myrtillus, stems, Juniperus	not available
V	March 23, 5.00 p.m. to March 24, 5.00 p.m.	see period I	2–3 mm + 3–5 mm ad lib.

Tab. 2b: Diet of *Tetrao tetrix* in single periods of the experiment

Period	Date	Diet	Grit
I	Feb 27, 6.00 p.m. to March 13, 5.00 p.m.	Betula, twigs with buds and and catkins, Vaccinium myrtillus, stems, Calluna vulgaris, Juniperus, Avena, corn, pellets	not available
II	March 13, 5.00 p.m. to March 19, 5.00 p.m.	see period I	2–3 mm + 3–5 mm ad lib.
III	March 19, 5.00 p.m. to March 21, 5.00 p.m.	Vaccinium vitis-idaea, berries	not available
IV	March 21, 5.00 p.m. to March 23, 5.00 p.m.	Betula, twigs with buds and catkins, Vaccinium myrtillus, stems, Calluna vulgaris, Juniperus	not available
V	March 23, 5.00 p.m. to March 24, 5.00 p.m.	see period I	2–3 mm + 3–5 mm ad lib.

3. MATERIALS AND METHODS

Our study on capercaillie, black grouse and willow grouse *(Tetrao urogallus, Tetrao tetrix, Lagopus lagopus)* took place at the Wildlife Research Station, Boda, belonging to the Swedish Sportsmens Association. The experiment lasted from February 27 to March 24, 1975.

The bottom of two coupled wooden cages (each sized 2 × 2 meter) was covered with a plastic sheath which was fastened to the side planks. Each coupled cage was reserved for one bird species. i. e., 4 capercaillie hens, 4 specimens of black grouse (1 ♂ + 3 ♀♀), 4 specimens of willow grouse (1 ♂ + 3 ♀♀). Capercaillie cocks were not used in the experiment, because at that time they were in an open run. Experimental birds were weighed three times during the experiment, always at the same hour of the day (Table 1).

3.1. Changes in the supply of grit and food

Food components and grit given to each bird species at various periods of our experiment are shown in Table 2 a, b, c.

Tab. 2c: Diet of *Lagopus lagopus* in single periods of the experiment

Period	Date	Diet	Grit
I	Feb 27, 6.00 p.m. to March 13, 5.00 p.m.	Betula, twigs with buds and catkins, Vaccinium myrtillus, stems, Calluna vulgaris, Juniperus, Avena, corn, pellets	not available
II	March 13, 5.00 p.m. to March 19, 5.00 p.m.	see period I	2–3 mm + 3–5 mm ad lib.
III	March 19, 5.00 p.m. to March 21, 5.00 p.m.	Vaccinium vitis-idaea, berries	not available
IV	March 21, 5.00 p.m. March 23, 5.00 p.m.	Betula, twigs with buds and catkins, Vaccinium myrtillus, stems, Calluna vulgaris, Juniperus	not available
V	March 23, 5.00 p.m. to March 24, 5.00 p.m.	see period I	2–3 mm + 3–5 mm ad lib.

3.2. Collection and analysis of excrements

Faecal samples of experimental birds were collected twice a day, dried at room temperature and weighed with the accuracy of 0.1 g. The dry weight of the individual samples shown in Fig. 1. gives an approximate idea of the amount of food consumed. Faecal samples of night droppings were collected each morning from 8.00 — 9.00, day droppings at about 17.00 and at this time, the plastic sheaths covering the floor of the cages were cleaned and food remnants removed from them. The dried faecal samples were softened with water and crushed by hand in order to determine a distribution of the grit in the individual faecal pellets. The samples were dissolved in water (800 ml vessels) and grit separated as sediment from undigested food remnants. Dry grit from each sample was weighed exactly to 0.5 mg, screened with a series of calibrated sieves and divided in these size groups: <2 mm, 2—3 mm, 3—5 mm, >5 mm. From the size of 2 mm onwards, the number and total weight of stones were determined for each size group of samples (comp. Fig. 2, Table 3).

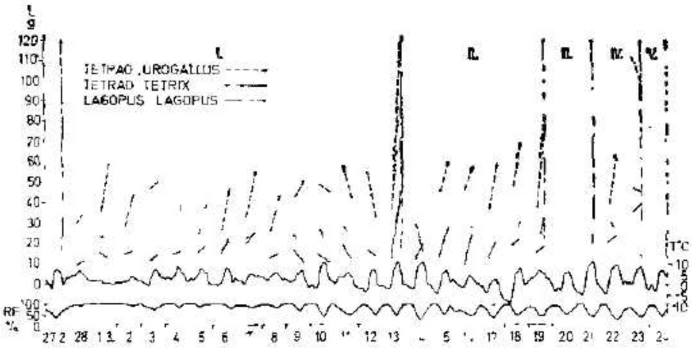


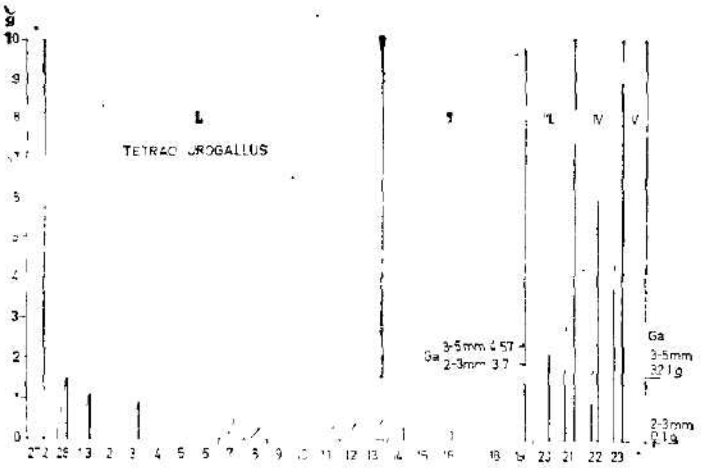
Fig. 1: Dry weight of faeces (L), air temperature (T) and relative humidity (RF) during experiments. Lines belonging to respective species connect with each other values of night- and day droppings in each day. Abscise — days of months (February 27 to March 24).

Within the course of the experiment, air temperature and relative air humidity were measured with a thermohygrograph set up outside the cages.

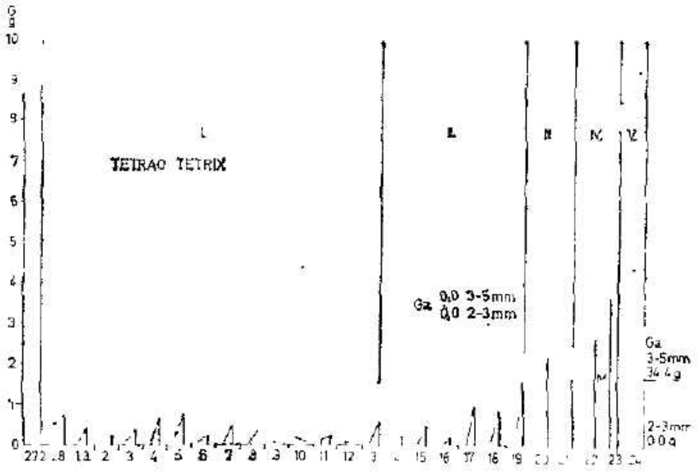
3.3 Conditions to be determined in the individual experimental periods

In Period I, experimental birds were expected to get rid of a possible surplus of grit in the gizzard and to establish either a negative or, if they possessed such perfect retention properties, an optimal grit balance in relation to the consistency of food. To show this, Period II was intended for a compensation of a deficiency in grit and was to indicate the degree of this compensation and the quantity of grit excretion at its unlimited supply. Period III was to show the effect of soft food digestible without a grinding agent, and the release of a surplus of grit. In Period IV we intended to test the ability of the birds to retain grit in the gizzard under conditions of a sudden change in the diet, from berries to cellulose-rich food (buds, needles, twigs), as this has been known to occur frequently if snowfall was heavy in autumn. Period V was to test if the birds were able to compensate in a single day their negative grit balance under conditions of an unlimited grit supply in order to obtain an idea about the importance of a short-term opportunity

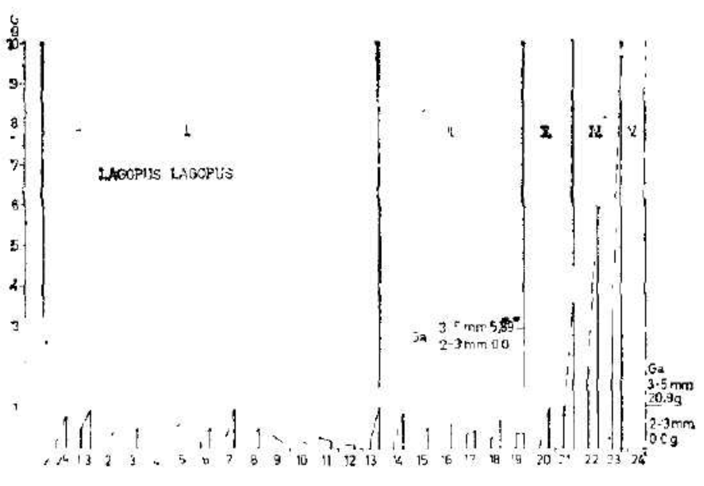
Fig. 2: Weight of excreted grit (G) and of consumed stones (Ga). Weak lines connect with each other values grit excreted in night and day sample, stout upright lines indicate presence of gastroliths sized at least 2 mm in diameter.



G
10
9
8
5
3
2
0
I
II
III
IV
V
TETRAO UROGALLUS
Ga 3-5mm 4.57
2-3mm 3.7
Ga
3-5mm
32.1 g
2-3mm
0.1 g
27.2 29 1.3 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 18 19 20 21 22 23



G
g
10
9
8
7
6
5
4
3
2
1
0
I
II
III
IV
V
TETRAO TETRIX
Ga 0,0 3-5mm
0,0 2-3mm
Ga
3-5mm
34.4 g
2-3mm
0.0 g
27.2 28 1.3 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24



G
g
10
9
8
7
6
5
4
3
1
I
II
III
IV
V
LAGOPUS LAGOPUS
Ga 3-5mm 5,89
2-3mm 0.0
Ga
3-5mm
20.9 g
2-3mm
0.0 g
2 24 1.3 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24

Tab. 3a: Grit excretion in *Tetrao urogallus* stated in single periods of the experiment (weight in g, n — night, d — day, s — total, p — pieces)

Period			Amount of grit excreted in faeces								Dry weight
Nr	Days		< 2 mm	2—3 mm		3—5 mm		> 5 mm		Total	of faeces
			weight	p	weight	p	weight	p	weight	weight	
I	14	n	1,147	2	0,072	1	0,054	0	0	1,273	533,9
		d	6,645	14	0,377	1	0,045	2	0,482	7,549	698.5
		s	7,792	16	0,449	2	0,099	2	0,482	8,822	1232,4
II	6	n	0,125	0	0	0	0	0	0	0,125	241,7
		d	1,030	6	0,145	3	0,955	0	0	2,130	347,4
		s	1,155	6	0,145	3	0,955	0	0	2,255	589,1
III	2	n	1,410	14	0,285	0	0	0	0	1,695	
		d	7,055	39	0,835	30	1,415	0	0	9,305	
		s	8,465	53	1,120	30	1,415	0	0	11,000	
IV	2	n	3,590	22	0,355	0	0	1	0,700	4,645	151,4
		d	12,925	80	1,405	14	0,500	0	0	14,830	162,3
		s	16,515	102	1,760	14	0,500	1	0,700	19,475	313,7
I—IV	24	s	33,927	177	3,474	49	2,969	3	1,182	41,552	2135,2

for grit consumption, as this is sometimes made possible by changes in the snow cover.

3.4. Methodical imperfections

Since wire-bottomed cages were not available at the time of setting up the experiment, the bottom of the cages, on which there was a layer of sand, was covered with a sheath made of plastic. Grit consumption was impended by this uncommon floor cover, and the birds could not care so well for their plumage on it. This negative influence on their daytime activity evidenced itself in their changed behaviour mainly during and after the cranberry diet.

Unfortunately, Period IV lasted for too short a time to assess the moment at which a normal grit excretion would be re-established. The daytime when dropp-

Tab. 3b: Grit excretion in *Tetrao tetrix* stated in single periods of the experiment (weight in g, n — night, d — day, s — total, p — pieces, 1* — one piece of brass wire)

Period			Amount of grit excreted in faeces								Dry weight
Nr	Days		< 2 mm	2—3 mm		3—5 mm		> 5 mm		Total	of faeces
			weight	p	weight	p	weight	p	weight	weight	
I	14	n	1,535	2	0,062	0	0	0	0	1,597	301,2
		d	4,216	24	0,529	4	0,198	0	0	4,943	328,5
		s	5,751	26	0,591	4	0,198	0	0	6,540	629,7
II	6	n	0,226	1	0,025	0	0	0	0	0,251	114,8
		d	2,228	42	0,965	8	0,417	2	0,570	4,180	184,5
		s	2,454	43	0,990	8	0,417	2	0,570	4,431	299,3
III	2	n	0,610	2	0,035	0	0	0	0	0,645	
		d	2,835	25	0,500	15	0,525	0	0	3,860	
		s	3,445	27	0,535	15	0,525	0	0	4,505	
IV	2	n	3,675	40	0,630	0	0	1*	0,065	4,370	79,0
		d	7,110	151	2,745	15	0,525	1	0,075	10,465	70,5
		s	10,785	191	3,375	15	0,525	2	0,140	14,825	149,5
I—IV	24	s	22,435	287	5,491	42	1,665	4	0,710	30,301	1078,5

Tab. 3c: Grit excretion in *Lagopus lagopus* stated in single periods of the experiment (weight in g, n — night, d — day, s — total, p — pieces)

Period			Amount of grit excreted in faeces								Dry weight of faces
Nr	Days		< 2 mm	2—3 mm		3—5 mm		> 5 mm		Total	
			weight	p	weight	p	weight	p	weight	weight	
I	14	n	3,042	4	0,105	2	0,150	0	0	3,297	204,0
		d	6,825	23	0,650	4	0,215	0	0	7,690	236,6
		s	9,867	27	0,755	6	0,365	0	0	10,987	440,6
II	6	n	0,503	12	0,292	5	0,254	0	0	1,049	79,4
		d	2,145	25	0,785	7	0,445	0	0	3,375	133,0
		s	2,648	37	1,077	12	0,699	0	0	4,424	212,4
III	2	n	0,655	9	0,190	0	0	0	0	0,845	
		d	3,535	47	0,885	3	0,150	0	0	4,570	
		s	4,190	56	1,075	3	0,150	0	0	5,414	
IV	2	n	5,055	19	0,320	3	0,095	0	0	5,475	55,0
		d	12,515	89	1,870	6	0,350	6	0,875	15,610	64,3
		s	17,570	108	2,190	9	0,445	6	0,875	21,080	119,3
I—IV	24	s	34,275	228	5,097	30	1,659	6	0,875	41,906	772,3

ings were collected was not wholly identical with that of the birds' activity so that it is possible that a part of the diurnal pellets has been collected also with a nocturnal sample of droppings.

4. RESULTS AND DISCUSSION

Our experimental results have been shown in the figures and tables.

4.1. Influence of the availability of grit on the excretion of gastroliths

As evident from Fig. 2 and Table 3, a gradual reduction in the excretion of grit occured in Period I, during which the birds were on a normal diet, but without a supply of grit. Faecal samples contained mainly sand or small splinters of disintegrated stones, larger gastroliths remained in the gizzard. This was most noticeable in the capercaillie whose diet, in contrast to that of the black— and willow grouse, consisted mainly of conifer needles without *Betula* twigs with buds. As stated earlier by Semenov-Tjan-Šanskij 1959 (comp. Porkert 1972 — Table 2B 59, H 5 and Norris et al. 1975), the release of thicker twig fragments by the pylorus-sphincter from the gizzard can be accompanied by that of larger gastroliths. This explains an irregular excretion of gastroliths observed for willow- and black grouse during Period I (Fig. 2.).

In Period II, with an unchanged diet and grit ad lib., gastroliths started to be excreted with the faeces by all experimental birds from the first day of this period onwards (March 14, see Fig 2). Differences in the release of gastroliths between capercaillie on the one hand, and both willow— and black grouse on the other, were found in these features: 1) a mechanical, concommitant release of gastroliths and hard twig fragments; 2) a less negative grit balance in capercaillie than in willow grouse (in relation to food consistency).

This was shown by the determined consumption of stones of the two bird species (Tables 4,7) and their behaviour. Converted to body weight bird, the quantity of grit consumed by *Lagopus lagopus* over a period of 6 days was 2.494 g/kg, in *Tetrao urogallus* — ♀♀ 1.05 g/kg. In the latter species, a more noteworthy excretion of stones occurred as late as on day 6 (March 19) of grit supply, which might have been due to a compensation of an excessive grit consumption made by one of the hens. By contrast to willow grouse, who had not yet replaced the lost quantity of grit (comp. Table 7), an increased intake of food by capercaillie an black grouse on the same day (March 19) might also have contributed to an increase in their grit excretion.

4.1.1 Discussion

The availability of grit might influence its excretion in this way: if grit is not available for consumption. there occurs an early check in the excretion of larger gastroliths (comp. Fig. 2a, *Tetrao urogallus* — ♀♀) unless this is counteracted by other factors such as the consistency of food (comp. *L. lagopus* and *T. tetrix)* and motility conditioned by stress (Period IV) etc. (see 4.3). An internal regulation of grit excretion depends mainly on its consumption, but also the consistency of the food plays its part in it as suggested by Semenov-Tjan-Šanskij (1959), Porkert (1972) and Norris et al. (1975). An increase in grit excretion in Periods III and IV independent of a lacking grit consumption, should evidently be ascribed to the cranberry diet (see 4.2 and 4.3).

Tab. 4: Grit consumption of birds explored in single periods of the experiment

Species	Period	Days	Size of stones 2—3 mm weight in g	 3—5 mm weight in g	Total weight in g
Tetrao urogallus					
4 ♀♀	I	14	—	—	—
	II	6	3,700	4,570	8,270
	III	2	—	—	—
	IV	2	—	—	—
	V	1	0,100	32,100	32,200
Tetrao tetrix					
1 ♂ + 3 ♀♀	I	14	—	—	—
	II	6	0,0	0,0	0,0
	III	2	—	—	—
	IV	2	—	—	—
	V	1	0,0	34,400	34,400
Lagopus lagopus					
1 ♂ + 3 ♀♀	I	14	—	—	—
1 ♂ + 3 ♀♀	I	14	—	—	—
	II	6	0,0	5,890	5,890
	III	2	—	—	—
	IV	2	—	—	—
1 ♂ + 2 ♀♀	V	1	0,0	20,900	20,900

Tab. 5: Weight of cranberries *(Vaccinium vitis-idaea)* consumed by respective species during 24 hours in period No III (March 20, 5.00 p.m. — March 21, 5.00 p.m.)

Species	Consumed amount in g		
	total	per bird	per kg body weight
Tetrao urogallus 4 ♀♀	623	155,75	75,44
Tetrao tetrix 1 ♂ 3 ♀♀	577	144,25	153,86
Lagopus lagopus 1 ♂ 3 ♀♀	322	80,50	154,80

4.2. Influence of the consistency of food on the excretion of gastroliths

To assess how the consistency of food influences the excretion of gastroliths, we removed all grit and food remnants from the experimental cages (March 19 at 18.00 hr) and put the birds on a pure cranberry diet (stored in the deep-freeze). This highly digestible diet (85 % for *L. lagopus* — see Pulliainen et al. 1968) which does not require the presence of grit in the gizzard, was readily consumed by the birds. Data on the mean weight of cranberries consumed during 24 hr by bird kg of each experimental group, are shown in Table 5.

As a result of a sudden, unnatural, change in the diet, all birds suffered from diarrhoea with a massive excretion of grit, which continued and increased in *T. urogallus* — ♀♀ and *L. lagopus* — ♂♀♀ the following day (March 21), but decreased slightly in *T. tetrix* (Fig. 2). During both nights, the air temperature was below 0 °C (March 19—20 for 10 hr, minimum —4.0 °C; March 20—21 for 13 hr, minimum —5.5 °C — see Fig. 1), the frozen food could not melt and had to be consumed as such. Both the frozen food and the cold plastic sheath on the floor of the cages were responsible for a considerable loss in body heat (comp. Volkov 1970, Porkert 1975), and in the morning, the plumage of all birds was fluffed (cf. cold responses, e. g. Andreev 1980).

The condition of the birds started to improve in the warm hours of March 20 (maximum 6.5 °C) and March 21 (maximum 11.0 °C), and they became more active. An increasing aggressivity of *L. lagopus* — ♂ mainly towards one *L. lagopus* — ♀ resulted in its death on March 24 (subcutaneous haematoma in frontoparietal region) (for body weight and grit contents see Table 6). The grit balance in our experimental birds was apparently negative after the cranberry diet (comp. Tables 3,7, Fig. 2).

Tab. 6: Amount of the grit stated in alimentary tract of the dead female willow grouse no Sv J. 105804, March 24, 8.00 a.m. (Body weight: 430,3 g)

Amount of grit	Total weight g	Weight g < 2 mm	Stones Weight g 2—3 mm		Stones Weight g 3—5 mm	
in gizzard	3.285	0.470	47	1.275	31	1.540
in guts	0.225	0.120	4	0.105	0	0.0

As a result of a lack in grit, the birds that had changed their diet to hard winter food, consumed more food (expressed by faecal weight because the correlation is good, Hoglund 1981) in Period IV than in Period II Food consumption per bird and day in the two periods was this *T urogallus* IV— 39 21 g, II — 24 55 g, *T tetrix* IV — 18 69 g, II — 12 47 g, *L lagopus* IV — 14 92 g, II — 8 85 g Our data indicated that more food was consumed by tetraonids under conditions of a deficiency in grit (negative grit balance) in comparison with conditions of an optimal amount of grit in the gizzard Although the soft consistency of the cranberry diet increased the excretion of grit, it had also a shock-like effect on the birds They behaved abnormally and most nervously during the warm period of the day The course of Period IV was influenced by the changed behaviour of the birds in that all three species further increased their grit excretion If Period IV could have been prolonged for at least 14 days, internal mechanisms of retention might have started to function again at least in the capercaillie feeding on hard food such as needles and blueberry stems as this been shown to occur in Period I Anyhow, for *L lagopus* and *T tetrix*, an increased intake of food was always associated with an increase in the number of stones excreted with the faeces together with twig fragments see March 13 and Period IV Figs 1 2) On the other hand, a heavy excretion of grit in Period IV might have been influenced by an increased motility and nervousness of the birds (see later unter 4 3), too

4 2 1 Discussion

In tetraonids, the excretion of gastroliths is influenced by the consistency of their food Our results are in favour of the suggestion made by Semenov-Tjan-Šanskij (1959) that in willow and black grouse, gastroliths together with fragments of hard twigs are passaged mechanically through the pylorus sphincter In capercaillie, this mode of grit excretion is absent, because the species feeds almost exclusively (in our experiment to a major part) on needles of conifers Also we found that soft food such as berries increases the excretion of grit Grit as a grinding agent appears to be inessential for this kind of food, because grinding is assisted by hard grains inside the berries A similar situation occurs in the field (Porkert 1972 and unpublished data) In addition our recent experimental evidence has shown that a sudden change in the diet (from berries — *Vaccinium* — to hard twigs) has a stressing effect on birds This situation occurs, if it starts unexpectedly to snow heavily in autumn It needs further experimental evidence to assess whether an increased excretion of grit in Period IV should be ascribed merely to the effect of stress and to the extremely agitated state of the captive experimental birds Nemcev et al (1973) maintain that unrest and a greatly reduced consumption of food of captive tetraonids under conditions of an insufficient supply of grit should be ascribed to their adaptation to a diet consisting mainly of cereals *(Avena, Triticum, Zea mays)* However, according to Allen and Myhre (1975), a sudden check in the supply of stems of *Vaccinium myrtillus*, under a retention of hard components in the diet (twigs of *Betula* and *Salix)*, affects the behaviour of captive *Lagopus lagopus* The study does not give data on grit supplies By contrast Porkert (1972 and unpublished data) observed in the field that a similar change in the diet of tetraonids was not followed by an increased excretion of grit, but this might have been due to a simultaneous reduction in the motility of birds (comp 4 3 1)

43 Differences in the excretion of grit in dependence on bird activity and the period of the day

As evident from Fig 2 and Table 3, a major part of grit is excreted during the day Almost all gastroliths (except those collected from March 21—23) have been obtained from daytime excrements independent of the availability or inavailability of grit Therefore, there must be a relationship between the excretion of gastroliths and the motility of the birds, in which case the unrest of birds and their increased motility during Period IV might have been the primary cause for an increased excretion of grit

431 Discussion

Tetraonids excrete grit mainly in daytime as this has also been confirmed in the field, where a very limited number of droppings released during the night contained a few stones (Porkert 1972 and unpubl data)

A greatly reduced excretion of grit in mid winter, when this is not available might be also associated with a minimum of movements of tetraonids and long periods of rest even during the light hours of the day (comp, e g Semenov-Tjan Šanskij 1959, Potapov 1974 Andreev 1980, Hoglund 1980 1981, Porkert 1975 and unpubl data)

According to Voronin (1978) individual differences exist among members of the same flock of willow grouse as far as amount of gastroliths in the gizzard is regarded This may be connected with the social status of respective individuals

We have neither offered extremely large stones to our experimental birds, nor have these been force-fed to them Experimental evidence has shown for domestic fowl (Porkert 1972, Table 4, Tindall 1973) that gravitation plays a certain role in grit excretion Therefore, a reduced excretion of gastroliths at night and in the winter, when birds are resting motionless in their snow burrows, could be ascribed to this factor According to Porkert (1972 and unpublished data), an occasional gastrolith only was present in faecal samples (n=197) from brooding black grouse hens, although their diet consisted of soft food His examination of black grouse and capercaillie cocks disclosed that the majority of gastroliths, mainly the heaviest ones, were present in the caudal caecal sac of the gizzard located lowest in a bird resting in its normal position (Porkert unpublished) This part of the gizzard lies close to the end of the gizzard sac remotest from the pylorus Therefore, at an unchanged position of the gizzard, the excretion of larger gastroliths must be counteracted by their gravitation This might explain an earlier disappearance mainly of small stones, gravel splinters (comp Norris et al 1975 and Table 3), sand or light Ca-grit (comp Porkert 1972 — also bone chips, remnants of egg shells) *from the gizzard (Tindall 1973 while large stones remain there throughout the winter)* On the other hand, there is experimental evidence or domestic fowl (Porkert 1972, Table 4) force fed with oversize gastroliths that these might be released By contrast, Tindall (1973) found that the gizzard of several willow grouse specimens from a breeding stock at Tromsø was blocked with stones, but did not regard this as the death cause (Tindall, personal communication) A blockage of the gizzard with stones could hardly occur in the field as evidenced by frequent observations of a massive release of stones with the faeces (Porkert 1972 and unpublished data) This indicates that a mechanism regulating a surplus of grit in the gizzard must exist in the field

Tab. 7: Review of grit excretion and consumption in three groups of species explored, T.u. = *Tetrao urogallus*, T.t. = *Tetrao tetrix*, L.l. = *Lagopus lagopus*

The amount of grit excreted

Period	per bird per day (grams)			per kg body weight per day (grams)			percent grit of total dry weight of faeces		
	T.u.	T.t.	L.l.	T.u.	T.t.	L.l.	T.u.	T.t.	L.l.
I	0.158	0.117	0.196				0.716	1.038	2.492
II	0.094	0.185	0.184				0.383	1.480	2.083
III	1.375	0.563	0.677						
IV	2.433	1.853	2.635				6.205	9.916	17.670
I–IV	0.433	0.316	0.436	0.213	0.337	0.839	1.947	2.809	5.426
	per bird (grams)			per kg body weight (grams)					
I–IV	10.384	7.575	10.477	5.098	8.080	20.147			

The amount of stones consumed per bird per day (grams)

	T.u.		T.t.		L.l.	
	grams	per kg body w.	grams	per kg body w.	grams	per kg body w.
II	0,347		0,0		0,245	
V	8,050	3,951	8,600	9,173	6,967	12,667
I–V	10,118	4,966	8,600	9,173	6,698	12,879

An explanation of a heavy cumulation of stones in faecal samples might be offered by results of studies on the mechanism regulating the filling and emptying of caeca (e. g. Potapov 1974).

4.4. Interspecific differences in the excretion and consumption of grit

Interspecific differences in the excretion of gastroliths discussed earlier in the text have been shown to depend mainly on the assortment of food. In contrast to *Tetrao urogallus* (comp. 4.1. and Tables 3,7), *L. lagopus* and *T. tetrix* are unable to check effectively grit excretion, because hard twig fragments constitue a major part of their diet. Therefore, the turnover of grit is relatively quick in the two species (Table 7) or their grit balance might even be negative if grit is not available. Differences in the excretion of grit observed after the cranberry diet (unnatural for this time of the year) should rather be ascribed to the effect of shock caused by the heavy impact of frozen food (comp. temperatures in Fig. 1) on the thermo-energetic balance of the birds, than to its consistency. This effect of the diet was heaviest on *L. lagopus* which, apart from being the smallest of the experimental species, consumed twice as many cranberries (per kg body weight) than *T. urogallus* (Table 5).

As indicated by results obtained for Period V, *L. lagopus* was unable to replace within 24hr the quantity of grit lost during the experiment in spite of a heavy consumption (Tables 4,7). On the other hand, *T. tetrix* consumed more grit within 24 hr than the quantity lost in the foregoing 24 days, and *T. urogallus)*[*] replaced almost completely the quantity of grit lost (Tables 3, 4, 7, Fig. 2). The size of the stones consumed was identical in all three species. Among the stones offered to them, they picked up immediately those measuring from 3—5 mm. The same applied to *T. urogallus* (apart from 0.1 g 2—3 mm), although in Period II, the species consumed an appreciable quantity of 2—3 mm sized grit (3.7 g).

4.4.1. Discussion

Basing on results of our studies on grit excretion recorded of their different food enabled a comparison between the excretion of grit of *T. urogallus* on the one hand, and that of *T. tetrix* and *L. lagopus* on the other hand (Table 2, 3, 7). Our results were in agreement with Semenov-Tjan-Šanskij (1959) who suggested that *L. lagopus* and *T. tetrix* were poorly adapted to retain gastroliths in their gizzard. In *L. lagopus* grit excretion was relatively the highest throughout the course of our experiment, and the same applied to the intake of stones in Period II and Period V (Table 7). As regards the size of stones consumed by *L. lagopus*, it agreed with results obtained by Rajala (1958) and Norris et al. (1975). If the grit balance of the experimental birds was not to negative, *T. urogallus*-♀♀, by contrast to *L. lagopus*, consumed also numerous stones of size-group 2—3 mm (Period II. Table 4, Fig 2 a. c). Having regard to the fact that grit consumption during this experimental period was not established for *T. tetrix* (Tab. 4, Fig 2b), the different size of stones consumed by this species in Period V (3—5 mm in comparison with 2—3.5 mm recorded by Rajala (1958) for ♂♂) might have been associated with a strongly negative grit balance in *T. tetrix*.

Although the turnover of grit was quicker in willow — and black grouse than in capercaillie, it was difficult to asses to which of the species the lack of gastroliths was more harmful. Captive birds accustomed to a constant, satisfactory supply of grit, might feel a kind of stress if they are suddenly deprived of it (comp. Nemcev et al. 1973). On the other hand, several of the black — and willow grouse shot in the field were found to be in perfect condition although their gizzard contained no stones (Kolderup 1923, Semenov-Tjan-Šanskij 1959, Myrberget et al. 1975, Norris et al. 1975, Andreev 1980. Höglund unpubl. data). Thus it seems that, in *Lagopus lagopus*, both the hard food itself and the rough layer of the gizzard wall are sufficient enough as to bark the birch twigs, which is the same principle as that applied in a timber industry. The percentage ratio of intacted twigs in the faeces depends on the share of a soft food (e. g. *Salix* twigs with buds etc., Höglund 1981).

This fact together with the finding that several of our experimental birds (*L. lagopus*-♀♀, Table 1) increased even in body weight after a check in their grit supply indicate that an insufficient supply of grit in the period immediately preceding the start of winter cannot be regarded as a factor responsible for winter mortality (sensu Siivonen 1962, cf. Romanov 1979).

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[*]) According to Romanov (1979), a capercaillie can supply gastroliths in amount sufficient for all the winter period during a single visit of an arteficial place for the grit intake.

5 GENERAL DISCUSSION

As indicated by the results of our experiment, the quantity and quality of grit (size, or, in the field, the kind of rock) consumed and excreted by tetraonids, are influenced both by external and internal factors Internal factors are to maintain a homeostasis between both the optimal quantity and quality of grit, and the consumed food in the gizzard, but are counteracted by the mechanical effect of the food consumed by the three species, and by the influence of other external factors We agree with Tindall (1973) and Norris et al (1975) that external factors such as an availability of grit and the consistency of the type of food eaten which are climatically determined in the field and responsible for an apparent annual cycle in the turnover of grit (e g, Kolderup 1923, Semenov-Tjan-Šanskij 1959, Porkert 1972, Myrberget et al 1975) have a considerable influence both on the turnover and the efficacy of an internal regulation of grit contents in the gizzard A high snow cover acts as a factor impending the intake of grit By contrast to capercaillie feeding on conifer needles in the winter, coarse twig fragments in the diet of willow-and black grouse act in a purely mechanical way (4 1, 4 2, Semenov-Tjan-Šanskij 1959) to the effect of a very restricted function of retention mechanisms in the two species Because moving activities are another factor influencing the excretion of grit (see 4 3) and willow grouse feeds on harder and less nutritive food items which need a lot of moving around before food requirements of the bird are satisfied (see Andreev 1980, Hoglund 1980, 1981), this species evidently has to compensate its poor grit balance by a heavy intake of large stones (comp 4 4 and Rajala 1958, Norris et al 1975, and others)

6 CONCLUSIONS

The availability of stones, the consistency of the food, and the movement of birds seem to be the most important factors influencing the turnover of grit in tetraonids Internal, homeostatic, mechanisms of retention have a limited, and in the three species, different effect In this respect, capercaillie is better equipped for facing conditions when the grit is not available in the winter than are willow and black grouse

An inefficacy of internal factors (ability of retention) under normal conditions with satisfactory food resources appears to cause little harm to tetraonids in the winter Members of this family of gallinaceous birds have become adapted along different lines (for details see e g Andreev 1980, Potapov 1974, Moss 1974, Pulliainen 1976, Kuzmina 1977) to conditions in cold, snow-rich regions, and a deficiency in grit supplies does not seem to constitute one of the critical factors in winter

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GROWTH CAPACITY OF SOME FISH SPECIES IN DIFFERENT ENVIRONMENTAL CONDITIONS

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Abstract: The changes of the growth capacity of seven species of fish (roach, bream, chub, rudd, perch, pike, and pikeperch) in different environmental conditions with respect to their geographical distribution (i. e between the 48—58 parallel) are discussed. The ranges and also the mean values of the growth were stated empiricaly from overpopulated localities (minimum growth), newly filled reservoirs (maximum growth), or from the reservoirs after 10—15 years of their existence (mean growth). In general, the relation between the minimum, average, and maximum growth approaches the ratio of 1.4:3 It means that the examined species are able to accelerate their growth to 12 times in optimum conditions With roach, bream and perch the very similar values of growth were found in the defined area, their growth being above all density dependent. For other species it is above all temperature, i e geographical latitude of the given water body, which influences its growth. It is assumed that further growth studies will apparently not bring, inside the given area, other values of growth than the above limits

Except for a few cases growth studies started in our country in the middle of the 1950's. A huge quantity of data has been gathered ever since. In the first „Bibliography" (Čihař, 1968) 107 self contained growth studies out of the total number of 533 papers, in the second „Bibliography" (Pivnička, 1979) 90 growth studies out of the total number of 783 papers were presented. Consequently, the number of growth studies has lately rather fallen. The same situation, however, can be registered in the worldwide scale. One of the serious reason is also a high variability of acquired data. It considerably complicates their evaluation in connection with determining factors of the environment in such a way that prediction of expected changes of growth be possible within utilizable bounds. On the other hand most of the methods suggested for the evaluation of growth data were not used by ichtyologists (Mina, 1981). The reason was often in their complexity which usually was not in balance with the quality of the data obtained. The main aim of the study presented is to evaluate the growth tempo changes of some fish species with regard to the changes of the environment like constructions of new reservoirs, changes in species diversity here and/or changes of their abundance and biomass. The geographical position of selected localities is also respected.

MATERIAL AND METHODS

The growth data on 4252 roaches (3—10 age groups, AG for abbreviation), 952 rudds (3—8AG), 1431 chubs (3—10AG), 3284 perches (1—8AG), 70 pikes, 66 pikeperches, and 79 breams were altogether analyzed during the years 1967—1979. In all cases the R. Lee's method for back calculation of lengths had been used. When speaking about the growth rate we bear that in mind which appears in the value of increment at the end of the growing season. Simultaneously we measure the growth rate by the sum of weight increaments of respective age groups. Weight increments are calculated as products of the respective mean biomass always for one "mean" fish and instantaneous growth coefficient This sum of increaments of 4th—8th AG was already named as index of production (Pivnička, 1972, 1974). By growth capacity we understand the ability of population of individual species to react on the environment, and to keep or change the size of their increments according to the change of the conditions

Besides the growth data from the Klíčava reservoir additional values of growth of the above mentioned species were reevaluated from the localities covering the area between the 48—58 parallel. Selection of localities for the evaluation of growth capacity was such as to cover the waters in which minimum growth can be expected (localities with overpopulated fish stock — numbers per ha see in Tabs 1—5), or on the contrary, maximum growth (newly filled reservoirs, ponds with reduced stock, etc.). Another criterion was to select such localities where the growth of more species was simultaneously assessed As mean growth we had used the growth values from reservoirs after minimally 10—15 years of their existence In the tables summarising the values of the production indexes first of all the minimum, then maximum, and finally average values from our localities are shown. They are followed by the values from localities outside Czechoslovakia.

The collection of the material was carried out during my employment in the Department of Systematic Zoology I thank Dr Juraj Holčík CSc for his constructive comments

RESULTS

Growth capacity of individual species

Roach *(Rutius rutilus)* has been the most numerous species with the highest biomass and production in the Klíčava reservoir. The dominance of this species has dragged on since the first half of the 1960 's. Growth studies have been performed in greater detail and most completely of all existing species here. First of all we focused on the evaluation of the growth of roach in Czechoslovakia, where a number of data exist on the study of growth capacity (newly filled reservoirs, poisoned-out objects with abundant population before, longtermed studies waters, carp ponds with expected good growth). The growth from these types of waters has further been compared with the growth of roach in other localities covering the whole area of distribution of this species.

There was a striking coincidence of growth tempo of roach in reservoirs in the time after the balance between abundance of individual species and the number of species had been constituted (period with the dominance of cyprinids). The values of production index (Tab. 1) in the reservoirs of Slapy, Orlík, Klíčava, Želivka have fluctuated very closely around 200g. The growth from the Lipno reservoir has been much higher, because it had been evaluated before this period, i. e. only 5 years after filling Pivnička, 1974). A conspicuously low value of production of the roach from the Orava reservoir, after having been compared with the ones from other reservoirs, was unexpected. The minimum index of production has fluctuated within 30—50g, the maximum one within 600—700 g in just filled reservoirs or in ponds. The highest value has been observed in the Hamerský pond and in the Horka reservoir in Northern Bohemia thanks to a lower abundance of stocked carps, reaching record values of 700—800 g.

In Sweden Kempe (1962) studied throughly the growth of roach under various conditions. He discovered the maximum growth in a strongly eutrophised lake of Glanigen (P_I=740 g). The abundance of roach in this lake was

Table 1. The values of production index (P_I) (in g) of roach in different localities

Locality (reference)[a]	P_I	Note	Locality (reference)[a]	P_I	Note
Poltruba pool, 1 Labe r. mund. area	54	before poisoning	Poland lakes, 11	93	mean from 22 lakes
Poltruba pool, 2	56	6683 ex . ha^{-1}	lake Demenee, 12	73	n. w. of the USSR 3990 ex . ha^{-1}
Orava rs., 3	29		lake Glubokoe, 13	190	near Moscow
Želivka rs., 4	619	in the year of filling	Viljuj r. low part, 14	108	east Siberia
Lipno rs., 5	643	2 years after filling	Viljuj r., 14 central part	200	
Opatovický pond	570	this paper	Bratsk rs., 15	510	2 years after filling
Hamerský pond	≐750	this paper	Bratsk rs., 15	213	12 years after filling
Poltruba pool, 1	380	after poisoning	Ilmen lake, 16	145	
Orlík rs., 6	213	mean 1972–1973	Žemžučnoe lake, 17	154	n. w. of the USSR
Mácha rs., 6	291		Žarovskie lakes, 19	120	near Bajkal).
Želivka river	254	this paper, before filling	Bauntovskie lakes, 20	140	
Želivka rs., 6	208	mean 1977–1979	Humbie rs., 21	60	Scotland
Slapy rs., 8	203	mean 1957–1957	Duddingston Loch lake, 21	650	roach stocked into empty rs.
Klíčava rs.	203 ± 55	this paper 860 ex ± 360 ha^{-1}	Taton Mere lake, 22	825	year classes instability
Danube r. (arms), 9	119				
Záskalská rs., 10	327	low abundance			

[a]) References: 1, Balon, 1955; 2, Frank, 1959; 3, Holčík, 1967; 4, Pivnička, 1974; 5, Frank, Vostradovský, 1961; 7, Křížek, 1981, 8, Holčík, 1961; 9, Chitravadivelu, 1972; 10, Švátora, 1981; 11, Karpinska, Waluš, 1961, 12, Rudenko, 1971; 13, Šamardina, 1968; 14, Kirillov, 1972; 15, Mamontov, 1977; 16, Fedorova, Vetkasov, 1976; 17, Rudenko, 1966; 18, Kalašnikov, 1978; 19, Skrjabin, 1977, 20, Aldoori, 1971; 21, Goldspink, 1978.

very low (only pike, perch and roach were presented in the lake) and, therefore, their pressure on food was also low. In another lake, the production index amounted to 670 g, after the lake having been poisoned by rotenon (age structure of roach was as in the prevoius lake also unstable) The same author mentions a situation when a reservoir was built on an original river. The production index in the river amounted to 66 g, and in the reservoir it increased to 512 g. Differences in the growth of roach from the lake of Mälaren (P_I=158g) and Sarnasjön (P_I=56 g) were explained (Kempe, 1. c.) by a stronger food competition and a lower average temperature in the second lake (the lake of Malaren is just on the sea level, the lake of Särnasjon 422m above the sea level.

Roach in the lake of Tatton Mere in England (Goldspink, 1978) attains the highest production index (800–850 g). The population density of roach in this lake only attained the level of 63 roaches.ha^{-1} and a number of year classes were very low (in fact two have existed). Roach was a dominant species here, other stocked species – carp, tench, and bream did not form large populations.

In the Bratsk reservoir roach managed to attain the production index value of 510 g in the years directly after filling, and decreased to 213 g after 12 years, which is, in fact, the Czechoslovak reservoir average. An essentialy lower value, connected with the abudance (Pivnička, 1982), can be observed in

Table 2. Back calculated lengths of bream from the Klíčava reservoir (material from the years 1975—1980), l — length in the time of capture

AG	n	l	l_1	l_2	l_3	l_4	l_5	l_6	l_7	l_8	l_9	l_{10}
1	1	160	81									
2	2	153	60	153								
3	9	214	71	146	214							
4	11	269	71	156	226	262						
5	26	312	69	174	245	284	301					
6	23	328	69	163	241	283	307	328				
7	2	378	78	190	280	329	353	368	378			
8	3	433	69	193	266	320	358	390	415	432		
10	2	460	98	201	277	318	358	382	398	414	436	458
$\bar{x}$	79		74	172	250	299	335	367	397	423	436	458

$\log w = 2.804 \log l - 4.187$

the lake of Demenec (the NW of the USSR), on the other hand, roach from the lake of Glubokoe (near Moscow) is very close to the average of our reservoirs with its index of production of roach (190 g).

Bream *(Abramis brama)* has formed a considerable part of biomass and production in the majority of our reservoirs, and has been, therefore, the focus of interest of fishermen. In the Klíčava reservoir bream has occupied the second position in biomass and production (after roach) beginning in the middle of the 1970 's. Its growth has been intensively examined in our country since the beginning of the 1950's. From the published results those have been selected, which were obtained from numerous material which represented, as evenly as possible, all age groups (Tab. 2. and 3.)

Table 3. The values of production infex of bream in different localities

Locality (reference)[a]	P_I	Note	Locality (reference)[a]	P_I	Note
Kateřina, 1	123	mine abyss			
Finland, 2	128	south part	Brats rs., 10	1300—1400	10 years after filling
Orlík rs., 3	217				
Poltruba pool, 4	452	before poisoning	Tjeukemeer lake, 11	243	Netherlands 426 ex . ha^{-1}
Danube arm	634				
Apati, 5			Pripjat r., 12	1476	overfished population of bream
Nežárka r., 6	457				
Slapy rs., 7	415	from 1963	Glubokoe l., 13	508	
Slapy rs., 7	654	from 1965	Žemčužnoe l., 14	1140	
Lipno rs., 8	405		Eravnoe l., 15	1300	near Bajkal l., 10—15 years after stocking
Klíčava rs.	596	this paper			
Balaton lake, 9	676	> 100 ex . ha^{-1}			

a) References: 1, Zavěta, 1981; 2, Segestrale, 1932; 3, Matěnová, 1975; 4, Oliva, 1958; 5, Balon, 1963; 6, Liška, 1980; 7, Poupě, 1973, 8, Poupě, 1971; 9, Bíró, Garádi, 1974; 10, Mamontov, 1977; 11, Goldspink, 1978a; 12, Penjaz et al.; 13, Šamardina, 1968; 14, Rudenko, 1966; 15, Kalašnikov, 1978

A conspicuously bad growth was found out after several years of observation of bream from the Orlík reservoir (Mātěnová, 1975; Naiksatam, 1974; Závěta, 1981). The weight growth has quite evidently been influenced here by the period of collecting the fish (immediately after spawning), i. e. coefficient „b“ of the length-weight relationship was wery low. If we use the length-weight relationship of bream from the Klíčava reservoir for the bream from Orlík, production index value will increase by 20 %. In spite of that, however, the growth of the bream in this reservoir was very slow, above all in comparison with the neighbouring reservoir (Slapy), where it is 2–3 times as good. It is possible to suppose the presence of local, slowly growing population in the catching area which does not represent average growth conditions in the reservoir. Moreover it is necessary to take into account a considerable variability of growth of bream from the same locality. Thus the bream from the Slapy reservoir reached the production index values of 726 g and 489 g respectively in two successive years (Tab. 3.).

The growth of bream in the Klíčava reservoir approaches the growth of this species in the Slapy reservoir or Lake Balaton. In our country the slowest growth of this species was apparently recorded by Závěta (1981), in the mine abyss of Kateřina at Teplice in Bohemia, that does not reach even one third of the growth of the bream from the Poltruba pool, and one sixth of the growth of this species in the Klíčava reservoir. As regards the Kateřina abyss, we have found here a high abudance of bream through gill net catches, when in the course of 1–2 hour exposition about 100 breams per one gill net were captured. Cosidering that only single specimens can be captured in this way in other reservoirs ,a 100 times higher abundance of bream in this water can be taken into consideration.

Regarding the other localities, the growth of the bream in south Finland (Tab. 3.) is apparently influenced by population size, because in the localities of the same north latitude (the Žemžučnoe lake in the n. w. of the USSR) the growth of bream is markedly better. The best growth and simultaneously the highest value of the production index can again be expected in newly filled reservoirs, the same as with roach Thus Leontovyč (1974) mentions the growth of the bream from the Želivka reservoir from which production index within 1000–1500 g can be estimated. The data from the reservoirs of the USSR located far more to the north are interested from this point of view, they are altogether on the upper margin of the growth of the bream in our waters (the Bratsk reservoir, the Eravnoe lake). As it was the case with roach also in these localities the failure in spawning has been very common and the age structure of the bream population is unstable. Abundance apparently influences production index values of the bream from the Pripjat river, where the 6–8th AG reach the highest increments (300–400 g) that essentially increase the production index. Low population size of these age groups can be judged from their representation in catches. A high production index of bream from the Bratsk reservoir was recorded in the period after the reservoir had been filled, and also the high values of production index of the bream from the lake of Žemžučnoe is equally connected with a low population size of this species here (it forms only 1 % of the total of all fish) Rudenko (1966). The only information of absolute abundance of bream comes from the lake of Tyuekemeer (Netherland, Goldspink, 1978) — 2130 ha, 426 pieces.ha The production

Table 4. The values of production index of chub in different localities

Locality (reference)[a]	P_I	Note	Locality (reference)[a]	P_I	Note
Kličava rs., 1, 2,	343 ±81	this paper, 53 ex ± ± 20 ha^{-1}	Slapy rs., 7	214	
			Váh r., 8	160	
Orava r., 3	170		Stour r., 9	527	
Orava rs., 3	508	after filling	Rokytná r., 10	188	
Orava rs., 4	607	two years later	Svratka r., 11	180	(160–180)
Želivka rs., 6	1045	after filling	Olza r., 7	81	

[a] References: 1, Pecl, 1969; 2, Hanel, 1980; 3, Balon, 1962; 4, Kirka, 1965; 5, Oliva, 1963; 6, Leontovyč, 1974; 7, Leontovyč, 1968, 8, Kirka, 1962; 9, Mann, 1967; 10, Libosvárský, Baru 1978; 11, Peňáz, 1968;

index of the bream in this lake is very close to that of the bream in the Orlík reservoir.

Chub *(Leuciscus cephalus)* occupies the 3rd–4th position with its biomass and production after roach, bream, ev. perch. Interesting values on growth are at disposal from the Orava and Želivka reservoirs, where the production index is known from the time before the reservoir has been filled (from the old river) Tab. 4. In both cases both pairs of values are very much alike and also the acceleration of growth, after the reservoirs has been filled, is the same. It is especially conspicuous with the chub from the Želivka reservoir, where the growth was evaluated immediately after the filling. Production index has increased five times in comparison with the values from the river. The growth of the chub population the Orava reservoir was evaluated roughly after the reservoir had existed 3–4 years, and accordingly production index increased only three times. Variability of the production index values from the Kličava reservoir is on the same level as it is with other species, and it forms 23.6 %

Table 5. The values of production index of rudd in different localities

Locality (reference)[a]	P_I	Note	Locality (reference)[a]	P_I	Note
Procházkova pool, Labe r. inund. area, 1	85		Poland lakes, 7	218	
			Lakes in GDR, 8	160	
			Denmark, 9	319	
Kličava rs. 2, 3	217 ±33	mean from 1964–1979 30 ex ± 12 . ha^{-1}	N. Dvina r., 10	52	14 spec. only
			Červenoe l., 11	260	BSSR
Záskalská rs. 4	236	mean 1974–1977	Drisa r., 12	150	BSSR
Slapy rs., 5	218	6 spec. only	Demenec l., 13	44	
Volga r., 6	582	estuary	455 ex . ha^{-1}		

[a] References: 1, Čihař, Frank, 1958; 2, Holčík, 1967a; 3, Novák, 1980; 4, Švátora, 1981; 5, Frank, 1959; 6, Trjapycina, 1975; 7. Zawisza, Zuromska, 1961; 8, Bauch, 1935; 9, Otterstrom, 1930, cited after 7; 10, Solovkina, 1969, 11, Galcova, 1954, cited after 6; 12, Penjaz, Ševcova, 1963, cited after 6; 13, Rudenko, 1971.

Table 6. The values of production index of perch in different localities

Locality (reference)*	P_1	Note
Klíčava rs., 1, 2, 3, 4	104 ± 20	mean from 1963 – 1979 242 ex. ± ± 111 . ha^{-1}
Záskalská rs. 4	99	mean from 1974 – 1979
Lipno rs , 3	55	mean from 1965 – 1968
Orlík rs., 3	121	
Slapy rs., 5	218	
Mšeno rs., 6	45	
Orava rs., 7	174	
Máchovo rs., 8	179	
Hamerský pond 4	125	
Horka rs., 4	155	
Velký Tisý pond, 4	204	
Vyžlovský pond, 4	167	
Glubokoe l., 9	135	
Demenec l., 10	64	1267 ex . ha^{-1}
Žemčužnoe l., 11	64	
Bratsk rs., 12	198–600	1 – 3 years after filling
Bratsk rs., 12	159	10 – 15 years after filling
Usa r., 13	200	tributary of the Pečora r.
lakes in the Vitim r. basin, 14	150–400	
Pripjat r. and lakes in its basin, 15	260–280	

*) References: 1, Holčík, 1969; 2, Pivnička, 1971; 3, 4, Švátora, 1974, 1981; 5, Frank, 1960; 6, Vostradovský, 1962; 7, Hnatevič, 1960; 8, Frank, 1958a; 9, Šamardina, 1968; 10, Rudenko, 1971; 11, Rudenko, 1966; 12, Mamontov, 1977; 13, Solovkina, 1962; 14, Kalašnikov, 1978; 15, Penjaz and oth., 1973.

of the average value. The growth of the chub in the Klíčava reservoir is by one third lower than that in the Orava reservoir, and twice as good as the growth of this species in the Slapy reservoir. The slow growth of the chub in the Slapy reservoir is especially noteworthy if we take into consideration that other species (roach, rudd, bream) grow here in a similar way as do the same species in the Klíčava reservoir, and some (perch, pike, carp) even better.

A very good growth of the chub in the Stour river (England) is very interesting, being above the level of the maximum growth of this species in the Klíčava reservoir, and equaling the growth of this species in the Orava reservoir closely after the filling. There are some evidences that the abundance of other species in the Stour river is low (Mann, 1976). The dependence of the growth of chub on temperature in relation to its own abudance was stated by Švátora and Pivnička, 1981.

Rudd (*Scardinius erythrophthalmus*) occupies the 4th–5th position with its biomass and production, after roach, bream, chub and or perch. Its growth has been regularly examined since 1964. From the data on the growth of rudd in other localities (Tab. 5) almost the same growth as from the Klíčava reservoir can be stated in the case of Slapy and Záskalská reservoirs, in the lakes in Poland or in the lake of Červonoe in the BSSR. The slowest growth of rudd in our country was recorded in the Procházkova pool in the Elbe river region, and a still worse one in the Northern Dvina river and in the lake of Demenec. The best growth, on the contrary, has been recorded from the Volga estuary. The difference between the lowest and the highest value is 540g; the minimum value thus represents one twelfth of the maximum growth. With this species, the temperature is most proably a very serious factor influencing the growth tempo. Rudd does not form a dominant population in most localities, and, mo-

Table 7. Back calculated length of pike from the Klíčava reservoir

AG	n	l_1	l_2	l_3	l_4	l_5	l_6	l_7	l_8
1	7	206							
2	7	201	332						
3	6	208	333	433			1967–1969		
4	4	180	334	436	544		$\log w = 3.161 \log l - 5.463$		
5									
6	3	174	305	427	534	600	642		
$\bar{x}$	35	194	326	445	533	623	642		
1	3	245							
2	6	169	286						
3	13	197	272	362			1975–1979		
4	7	172	272	414	493		$\log w = 3.036 \log l - 5.109$		
5	3	156	294	401	562	665			
6	1	165	276	384	459	540	650		
8	2	150	228	348	432	525	606	669	720
$\bar{x}$	35	168	271	382	487	577	628	669	720

reover, it should not get under the competitive pressure of other species, regarding the evident hebivory. The decline of production index values is well perceptible in comparable localities in the south-north direction.

Perch (*Perca fluviatilis*) occupies the third position after roach and bream in the Klíčava reservoir with its abundance, biomass, and production. The older age groups (4th and older) are considered predators (cf. Holčík, 1977) having some effect on the forage species. On the other hand, most perches are specialized on planctonic or benthic diet, so that they are dependent on their own abundance. The production index of this species was evaluated for the 2nd –6th AG, because older age groups occur rarely in the population. The variability of the production index in the Klíčava reservoir was on the same level as with other species, being on fifteen years' average on the level of 19 % Its value here is conformable to the production index in the Záskalská, Orlík and Hamr reservoirs. It is twice as good as the production index of perch in the Lipno and Mšeno reservoirs, and half of the same value in the Slapy and Orava reservoirs. The values in question from the latter reservoir were ascertained ehortly after the reservoir has been filled (Tab. 6).

The growth of perch (as was mentioned before) is considerably dependent on its own population size. The results from the Klíčava reservoir (Pivnička, Švátora, 1977) and other growth data, mentioned in literature, prove that. Thus in the lake of Demenec (60° N. L.) the growth corresponds above all with the abundance of perch in this lake. Also the growth prospects of perch in the Bratsk reservoir (Central Siberia) are worth mentioning. In the time after this reservoir had been filled production index reached 600 g. with quickly growing individuals, and after 15 years the general average declined to 159 g (quickly

Table 8. The values of production index of pike in different localities

Locality (reference)[a]	P_I	Note	Locality (reference)[a]	P_I	Note
canal Polárikovo N. Zámky, 1	500–700		Labe, Vltava, Berounka r., 9	4789	mean value
pools in the Labe r. inund. area, 2	6295		Stour r., 10	3144	England
Orava rs., 3	5210		Bratsk rs., 11	4000	14 years after filling
Slapy rs., 4	6587		Bratsk rs., 11	5800	3–6 years after filling
Lipno rs., 5	8044				
Irsko, 6	10871				
Záskalská rs., 7	4047		Glubokoe l., 12	1842	
Klíčava rs., 8	1935	from 1964	Demenec l., 13	1900	
Klíčava rs., this paper	3563	from 1967–1969	Oron l., Vitim r. basin, 14	2500	
Klíčava rs., this paper	4373	from 1975–1979	Bauntovsk's lakes lakes, 15	1800-3000	Vitim r. basin

[a] References: 1, Sedlár, 1971; 2, Poupě, 1974; 3, Balon, 1965; 4, Čihař, 1961; 5, Vostradovský 1977; 6, Toner, Lawler, 1969 cited after 2; 7, Švátora, 1981; 8, Holčík, 1968; 9, Tandon, Oliva 1978; 10, Mann, 1976; 11, Mamontov, 1977; 12, Šamardina, 1968; 13, Rudenko, 1971; 14, Kalašnikov, 1978; 15, Skrjabin, 1977.

growing perch disappeared from the catches). Thus in the case of low population density (like in the case of roach and bream) perch is capable, in a great part of its geographical distribution of essentially accelerating the growth rate.

Pike (Esox lucius) is, besides older perch and pikeperch, one of the predatory species that have a certain melioration effect (restricted above all by a low abundance of about several hundreds of individuals per the whole reservoir). Due to this and the fact that abundance and biomass of forage species has gradually increased, one can take into consideration that the growth of these species will gradually improve. As far as pike is concerned the first data on its growth in the Klíava reservoir come from the period 1963—1964, if we omit data on the growth of several pikes from 1957. From that period the growth of pike in 1964 was evaluated most completely (Holčík, 1968). The length growth from folloving periods is summarised in Tab. 7.

The production index for the period 1963–64 reached the value of 1935 g (Tab. 8). The corresponding values in the following periods vere 3563 g and 4373 g. As presumed the growth of pike in the reservoir has virtully improved. The problem is that it is necessary to take high variability of length and therefore also the weight growth into account. This variability can be estimated from the pike material from the Lipno reservoir (the data on the growth of more than 3000 pikes from the years 1960–67, Vostradovský, 1977). In this way it was ascertained that production index varies from the value of 6570 g (minimum) over 8044 g (average) to 9815 g (maximum), i. e., roughly within 20 % from average. From this standpoint it is then possible to evaluate a better growth of pike in the Klíčava reservoir in the years 1975–79 with regard to the years 1967–69 as being still within a possible variability, but as a clear improvement with regard to the year 1964.

For a general orientation in the growth of pike in various localities a survey of production indexes is sumarised in Tab. 8. Unles stated, the weight values have

Table 9. **Back calculated lengths of pikeperch from the Klíčava reservoir**

AG	n	l_1	l_2	l_3	l_4	l_5	l_6	l_7	l_8	l_9
1	11	143								
2	20	151	222							
3	10	148	216	293				1967–1969		
4	5	151	218	302	357					
5	3	138	240	337	398	436				
$\bar{x}$	49	146	224	311	378	436				
1	4	175								
2	3	157	234							
3	4	148	216	273				1975–1979		
4	1	135	207	269	320			$\log w = 2.515 \log l - 3.619$		
5	1	137	223	267	318	380				
6	1	130	226	288	350	385	425			
7	1	132	230	323	382	435	486	530		
8	1	121	202	282	368	456	541	614	660	
9	1	110	186	260	340	420	480	541	608	660
$\bar{x}$	17	138	210	280	346	415	483	562	829	660

been estimated by means of the length-weigh relation, mentioned by Vostradovský (1970). We do not know the reasons for slow growth of pike in the Klíčava reservoir. However, considering the upper limit of growth, we would reach the value of 5500 g which is already and, average of other reservoirs. The growth of the pike from the lake Glubokoe and Demenec is also conspicuous, as the first one corresponds with Klíčava very well (60 ha, 39 m max. depth). Moreover, the same abundance of forage fish can be assumed with both lakes (we even know it exactly as regards Lake Demenec). Representation of length groups of forage fish and also the lenght of vegetation period can play an important role with the pike. Also bad growth of the pike from the Stour rier in England (Mann, 1976) can be connected with the low abundance of forage fish here – cf. very good growth of the chub from this locality.

The minimum production index value was ascertained from the Polárikovo-Nové Zámky canal, the maximum one in Ireland, the minimum value being one fiftienth of the maximum.

Pikeperch *(Stizostedion lucioperca)*. In the past, as well as in the present, pikeperch has been more or less regularly stocked into a reservoir to keep down forage species. From the catches it can be concluded that the intensity of stocking has been lower in recent years. Up to 1980 we had no evidence on the spawning of pikeperch in the reservoir, though spontaneous spawning could be presumed. In fact only in 1980 and also in 1981 we collected some specimens of its fry. The length and weight growth were studied in two periods, namely in 1967–69 and 1975–79 (Tab. 9).

The growth of the pikeperch in the Klíčava reservoir when evaluated by production index was in the lower limit of the growth of this species in reser-

Table 10. The values of production index of pikeperch in different localities

Locality (reference)[a]	P_I	Note	Locality (reference)[a]	P_I	Note
Nováky rs., 1	3193		lakes in Poland, 3	2606	
Virt rs., 1	1400		lakes in		
canal Virt, 1	978		lakes in LithSSR, 4	2000	
Orava rs., 2	2597		Kama r., 5	2900	
Klíčava rs., this paper	1492	from 1967—1979	Kujbyšev rs., 6	1800	
			Ural r., 7	2141	

[a] References: 1, Sedlár, 1971a, 2, Bastl, 1965; 3, Nagiec, 1961; 4, Virbickas and oth., 1974, 5, Šmidtov, 1949, cited after 4; 6, Poddubnyj, 1959, cited after 6, 7, Petrova, 1980.

voirs (Tab. 10), like in the case of pike. Consequently, the growth of both species can hardly be considered low incidentally; it is rather necessary to take some common factors into account that play such a negative role with both species. It may be caused by the insufficiency of suitable food items (fish of suitable length groups), but the small number of fish used for the growth studies should be also taken into consideration. In the Orava reservoir and in Polish lakes the growth is doubled the best growth was found by Sedlár (1971a) in the Nováky reservoir.

DISCUSION

A particular growth study has always been confronted with the question of setting limits between a fast, slow, or average growth. In our opinion, the folowing data are necessary to be known to set the limits: a) variability of growth of the species from the extremely bad, over the average, up to the extreme favourable conditions (it can be ascertained by comparing a number of growth data); b) variability of growth in the conditions of one locality; c) comparative criterion (in this paper index of production was used).

Another evaluation of the growth variability was recommended by Szczerbowski (1977). As a mean growth he used the grand averages from a number of populations. The mean growth was then bordered by the fast and slow growth Both these values were estimated as the average from all values better or worse then the mean growth. By the same way the very fast and the very slow growth was obtained. All values were then smoothed by the von Bartallanffy curve. In this paper the mean growth and its ranges were not defined arithmetically but as the answer of fish to the given environmental conditions (from this reason our mean values of growth are not in the centre of the given ranges).

In the Klíčava reservoir the average growth of all cyprinids, corresponding with other localities inside and also outside Czechoslovakia to a considerable extend, has been observed. The growth of both predators (pike, pikeperch) was slower than that in other reservoirs, but a gradual slight increase has been observed in the last years As expected, the minimum growth of all cyprinids was ascertained in overpopulated localities, the maximum one in reservoirs in the period close after their filling. Some species (roach, bream, perch) proved

Table 11 Minimum, average, and maximum values of the production index of individual fish species and length (in mm) of 4th and 8th AG (2nd and 6th with perch) corresponds to the mean value of the production index.

Species	Minimum	Average	Maximum	4th (2nd) AG	8th (6th)
roach	50	200	700	185	230
chub	80	350	900	220	300
bream	120	500	1500	200	300
carp	1000	4000	12000	350	500
tench	140	750	2300	200	320
rudd	80	220	650	170	210
pike	1000	5000	12000	550	720
pikeperch	500	2000	6000	300	600
perch	50	100	250	115	175

to be able to reach the same maxima of the growth tempo in all localities inside of 48–58 parallels. Therefore, it seems that the geographical latitude is not a principal factor influencing their growth (except the periphery of their geographical distribution of course). The growth tempo of these species is influenced above all by their abundance, by the stability of age structure, or by the absence of fry. Especially the absence of fry and the small number of age groups were probably serious reasons for a good growth of the mentioned species in northern localities (failure in spawning was likely to be very common in these reservoirs). the fishes have been in fact in the situation of carp in a carp pond, where there is only one age group and no fry exist. Cartain independence of perch growth on geographical latitude in Sweden has also been claimed by Neuman (1976), of adult bream by Dgebuadze (1979). In the case of roach the similar values of maximal growth were estimated in the newly filled reservoirs in Czechoslovakia, in Sweden (Kempe, 1962) or in the Siberia (Bratsk reservoir), Mamontov (1977). The same situation can be also observed with bream and perch.

Chub should be recognized as a boundary species in the above mentioned groups influence of abundance and temperature on its growth is clearly visible. In a more abundant population the positive influence of temperature on growth has been fully masked by abundance (Švátora, Pivnička; 1981). With rudd it is above all temperature which influences its growth. In acordance with this the gradual increase of growth going from north to south can be observed.

When we compare the relation of the minimum, average, and maximum growth of the species, where all these values are at disposal (roach, chub, perch) or the relation between the minimum and the average growth (of all species), we can conclude that it approaches the rate of 1 : 4 : 3, or 1 : 12 (minimum : maximum value) Tab. 11. All examined species are thus able to increase their index of production to 12 times (in some cases even 15 times), if the conditions turn out to be optimum. Further growth studies will apparently not bring other values then the above limits (especially in the conditions of Central Europe). However, it is necessary to realize that maxima and minima are virtually observed values, and there is no doubt that they could still increase or decrease with further optimalization or deterioration of conditions (cf. Poljakov, 1975).

SUMMARY

1. A study of growth capacity i. e. the ability of population of individual species to react on the environment, and to change the size of increments conformably to its change, requires growth data from extremely bad up to extremely favourable conditions, the knowledge about the growth variability in one locality, and a comparative criterion.

2. As expected, the minimum growth tempo of all examined cyprinids was found in overpopulated localities, the maximum one in the newly built reservoirs.

3. Thanks to their growth capacity some species (roach, bream, perch) are able to reach maximum growth tempo in localities located between the 48–58° NL. Apparently, the growth tempo is influenced above all by the abundance of these species, by the stability of their age structure, and by the absence of fry. One the other hand, for other species(rudd, white bream) the temperature is a more decisive factor influencig the growth tempo.

4. The relation of minimum, average, and maximum growth tempo approaches the ratio of 1 : 4 : 3. All examined species are thus able to increase their growth tempo (measured by production index) 12 times, if the conditions turn out to be optimum.

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HELODRILUS OCULATUS (OLIGOCHAETA, LUMBRICIDAE), NEU FÜR DIE FAUNA DER TSCHECHOSLOWAKEI

Václav PIŽL

Eingegangen am 25. März 1982

Abstract The present paper contains the first record of *Helodrilus oculatus* Hoffmeister, 1845 (Oligochaeta, Lumbricidae) from Czechoslovakia

Bei faunistisch-ökologischen Untersuchungen des Naturschutzgebietes „Labské pískovce“ in Nordböhmen wurden im Material der Regenwürmer 4 Exemplare der Art *Helodrilus oculatus* festgestellt. Diese Lumbricidenart war bis jetzt nur aus Italien, der Schweiz, Frankreich (Černosvitov, 1935), Belgien, Österreich, England, Irland, Deutschland (Wilcke, 1968, Füller, 1976) und der Sowietunion (Perel, 1979) (im südeuropäischen Teil der UdSSR und Kaukasus) bekannt. Zajonc (1981) führt in seiner zusammenfassenden Arbeit diese Art aus unserem Gebiet nicht an. Unsere Funde kommen aus der Nähe der Stadt Děčín (3 Ex.) und aus dem Naturschutzgebiet Růžák (1 Ex.) an den Ufern des Baches Ludvíkovický potok und des Flusses Kamenice her und wurden im Herbst 1980 gesammelt. Die Standorte dieser Funde entsprechen ökologisch den bisherigen Literaturangaben; es handelt sich um lehmige Böden mit schwarzem Humushorizont.

Das Material wurde mittels 1 % Formaldehyd-Lösung aus dem Boden herausgetrieben.

Zusammen mit *Helodrilus oculatus* wurden folgende Lubricidenarten festgestellt:

	Děčín	Růžák
Allolobophora chlorotica (Sav.)	3 Ex	5 Ex
Dendrodrilus rubidus rubidus (Sav.)	4 Ex	
Dendrodrilus rubidus subrubicundus (Eis.)	1 Ex.	
Octolasium lacteum (Örley)	6 Ex.	3 Ex
Nicodrilus caliginosus caliginosus (Sav.)	9 Ex.	8 Ex
Nicodrilus caliginosus trapezoides (Dug.)	3 Ex	
Nicodrilus longus (Ude)	1 Ex.	
Nicodrilus roseus (Sav.)	2 Ex.	
Lumbricus castaneus (Sav.)	2 Ex	3 Ex
Lumbricus rubellus Hoffm.	1 Ex.	
Lumbricus terrestris L.	1 Ex.	
Eisenia foetida (Sav.)		1 Ex.
Eiseniella tetraedra (Sav.)	27 Ex.	19 Ex
Dendrobaena attemsi Mich.	1 Ex	
Dendrobaena octaedra (Sav.)	3 Ex.	
juv. Ex. der Gattungen *Allolobophora* und *Nicodrilus*	20 Ex	14 Ex.
juv. Ex der Gattung *Octolasium*	5 Ex	
juv. Ex der Gattung *Eiseniella*	21 Ex	23 Ex
juv. Ex. der Gattung *Lumbricus*		4 Ex
juv. Ex der Gattungen *Dendrodrilus* und *Dendrobaena*	12 Ex.	

Die Dominanz von *Helodrilus oculatus* erreichte 1,25 % in Děčín und 2,27 % in Ružak.

Die besprochene Art wurde von Hoffmeister (1845) als *Helodrilus oculatus* beschrieben. Inzwischen figuriert sie in der Literatur auch unter den Gattungen *Allolobophora* und *Eophila*, Perel (1976) hat sie aber anhand der Abwesenheit der Nephridienblasen wieder zur Gattung *Helodrilus* eingereiht.

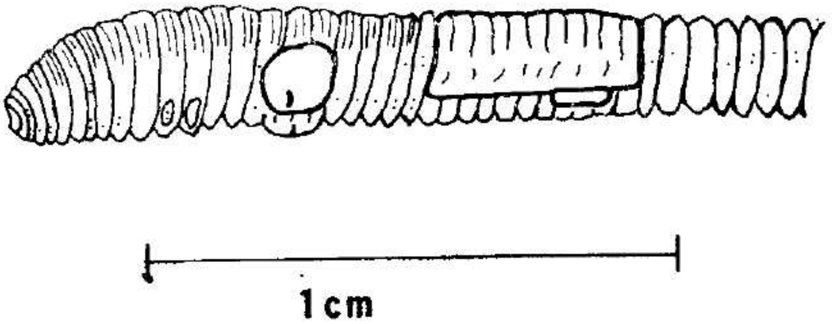

Abb 1 — *H. oculatus*, Vorderteil des Korpers (ventrolaterale Ansicht)

Die ausseren Merkmale des tschechoslowakischen Materials schwanken gleichfalls in den in der Literatur angeführten Variationsgrenzen: Lange: 35–80 mm; Dicke: 1,3–2,7 mm; Segmentzahl: 103–128: männliche Poren mit grossen erhabenen Drüsenhöfen, die sich vom 1.–16. Segment erstrecken; Clitellum: 21., 22 — 1 2 32., 32. Segm.; Pubertatswälle: 29 —30., 1 2 31. Segm.; epilobisches Prostomium; Borsten eng gepaart, a und b des 10. und 11. Segm. auf ovalen Papillen: erster Ruckenporus in der Intersegmentalfurche 4 5; Farbung im Leben fleischrot, pigmentlos. In der Anatomie der untersuchten Exemplare wurde auch kein Unterschied von den Literaturangaben festgestellt. Semensäcke (vesiculae seminales) 2 Paare im 11. und 12. Segm.; Samentaschen (receptaculi seminis) 2 oder 3 Paare im 10.–12. Segm.. Samentaschenporen in der Intersegmentalfurchen 9 10 oder 9/10–11/12 in der Borstenlinie cd. Dissepimente 5/6–8 9 stark verdickt.

Das Belegenmaterial ist in der Sammlung des Verfassers aufbewahrt.

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ERSTER FUND VON OCTOLASIUM MONTANUM (OLIGOCHAETA, LUMBRICIDAE) IN DER TSCHECHOSLOWAKEI

Václav PIŽL

Eingegangen am 10. April 1982

Abstract: The present paper contains the first record of ***Octolasium montanum*** (Wessely, 1905) (Oligochaeta, Lumbricidae) from Czechoslovakia.

Im Rahmen der ökologischen Untersuchungen der Obstanlagen bei Bavorov in Südböhmen, studierte ich die Familie Lumbricidae. In dem Primärmaterial wurden auch 3 adulte und 2 juvenile Exemplare der Art *Octolasium montanum* (Wessely, 1905) festgestellt.

Diese, von K. Wessely (1905) unter dem Namen *Allolobophora montana* beschriebene Art, wurde bisher nur aus Österreich (Wessely, 1905; Pop, 1947; Zicsi, 1965 a, 1965 b) und Ungarn (Zicsi, 1961, 1966; Wilcke, 1968) gemeldet. Unser Fund ist also das bis jetzt bekannte nördlichste Vorkommen dieser Art. Nach den Literaturangaben bevorzugt sie bindige Böden im Wald, Grünland und Acker. Sie dringt auch in tiefere Bodenschichten ein.

Zusammen mit *Octolasium montanum* wurden folgende Lumbricidenarten festgestellt: *Allolobopora caliginosa* Sav. 1 Ex., *Allolobophora caliginosa trapezoides* Dug. 1 Ex., *Allolobophora jenensis* Füll. 1 Ex., *Allolobophora rosea* Sav. 10 Ex., *Dendrobaena octaedra* Sav 1 Ex., *Dendrobaena platyura* Fitz. 9 Ex., *Lumbricus castaneus* Sav. 5 Ex., *Lumbricus rubellus* Hoffm. 2 Ex., *Lumbricus terrestris* L. 4. Ex., *Octolasium lacteum* Oerley 4 Ex., juv. Ex. der Gattung *Allolobophora* 64 Ex., juv. Ex. der Gattung *Dendrobaena* 17 Ex., juv. Ex. der Gattung *Lumbricus* 19 Ex., juv. Ex. der Gattung *Octolasium* 4 Ex.
Die Abundanz von *O. montanum* erreicht in der untersuchten Obstanlage 1,2 Ex./m^2, die Dominanz 2,1 %.

Die äusseren Merkmale der zwei untersuchten Exemplare entsprechen den Angaben in Zicsi (1965 b) und Wilcke (1968) (Abb. 1.): Länge fixiert: 82—113 mm; Ø: 5,7—7 mm; Segmentzahl: 124—181; Gewicht: 2,12—2,8 g; erster Rückenporus in der Intersegmentalfurche 12/13; Prostomium epilobisch (1/4—1/3), geschlossen; männliche Poren am 15. Segment von Drüsenhöfen umgeben, die auf die benachbarten Segmente nicht übergehen; die Clitellumlänge: 32.—36. Segment; Tubercula pubertatis erstrecken sich seitlich des Gürtels vom 1/2 32.—1/2 36. Segment; Borsten a b weit, c d eng gepaart, a b auf der linken Seite des 11. Segments Drüsenpapillen; Färbung grau. Das dritte Exemplar hatte im Unterschied von ihnen einen assymetrischen Gürtel (Abb. 1b). Clitellum dieses Exemplares reicht auf der linken Seite vom. 32. bis 36, auf der rechten Seite vom 33. bis 37. Segment. Auch die Pubertätswälle wurden assymetrisch verteilt (l.S. 1/2 32—1/2 36, r. S. 33—37). Borstenpapillen bei diesem Exemplar sind auf dem 10. Segment vorhanden. In der Anatomie aller drei Exemplare wurden keine Unterschiede von den Literaturangaben festgestellt: Samensäcke: 4 Paar im 9.–12 Segment; Samentaschen: 2 Paar im 10. und 11. Segment, die auf der Intersegmentalfurche 9/10 und 10/11 im Bereich der Borstenlinie c d ausmüden; Dissepimente 5/6–13/14 verdickt; ein Paar Kalkdrüsen im 10. Segment. Die Längsmusculatur ist nach Pop (1947) federförmig.

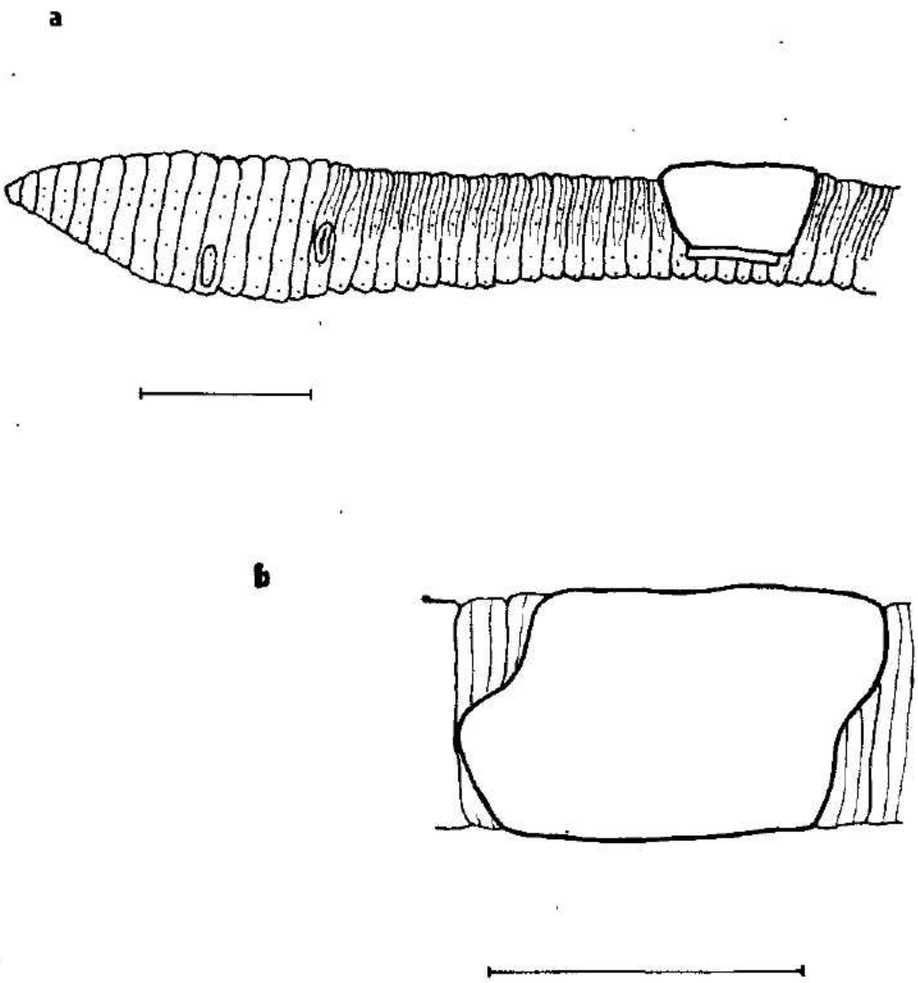

Abb. 1: *O. montanum*. a — Vorderteil des Körpers, b — assymetrisches Clitellum. Massstab = 1 cm.

Der Fund vom 13. X. 1981 in Bavorov ist der erste Nachweis dieser Art von dem Gebiet der Tschechoslowakei. Das Belegenmaterial ist in der Sammlung des Verfassers aufbewahrt.

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EINFLUSS DER LUFTBESPRITZUNG GEGEN DEN GRAUEN LÄRCHENWICKLER (ZEIRAPHERA DINIANA) AUF DIE ENTOMOFAUNA DES RHITHRONS IN KRKONOŠE (RIESENGEBIRGE)

Martin TONNER[1], Vladimír VÁVRA[2], Oldřich SYROVÁTKA[1] und Tomáš SOLDÁN[1]

Eingegangen am 4. Februar 1982

Abstract: The immediate and long-term effects of aerial spraying (Actelic, Ambush) against *Zeiraphera diniana* (Lepidoptera, Tortricidae) on rhithron steam fauna in Krkonoše (Giant Mountains) were investigated In total 37 species of insects were ascertained in determined samples, Plecoptera and Trichoptera larvae being dominating Direct effects of insecticides are manifested by enormous increase of drifting specimens (at least 100 times) which is caused mostly by behavioral changes of affected larvae or adults (stonefly larvae move to exposed side of stones, caddisfly larvae leave their cases) Drift dial periodicity is completely eliminated. The effects of spraying begin to disappear after 1—2 days. As other authors investigating effects of pesticides in streams, we did not observe total reduction of bottom fauna. After one year nearly original composition and abundance of stream insect fauna were found

Die, zur Zeit in Mitteleuropa verlaufende fünfte Massenvermehrung des Grauen Lärchenwicklers wird vom Gesichtspunkt der Forstwirtschaft zu einem ernsthaften Problem, besonders in Jizerské hory (Isergebirge) und Krkonoše (Riesengebirge). In diesen Gebieten handelt es sich vor allem um die Schäden in den Fichtenbeständen. Die Einzelheiten über die Massenvermehrung, die Flugaktivität und andere Aspekte des Vorkommens dieser Art bringen z. B. Skuhravý et al. (1979, 1980).

Es wurde beschlossen einige Bestande mit den Insektiziden zu behandeln. Im Jahre 1981 wurde die chemische Behandlung Ende Mai und Anfang Juni von den Flugzeugen durchgeführt (Abb 1). Die wirksamen Spritzmittel waren Insektizide Actellic (Pirimiphosmethyl) 1 % Lösung und Ambush (Decametrin), 150 g auf 100 l der Actellic — Lösung, also eine Kombination des Organophosphats und des Pyrethroids. Obwohl ahnliche Eingriffe schon in vielen anderen Gebieten verwirklicht wurden, ist der Einfluss der Forstbespritzungen nur in Kanada systematisch untersucht worden (z. B. Ide, 1961; Banks, 1973; Eidt, 1975; Kingsbury & Mc Leod, 1979; Kingsbury & Kreutzweiser, 1980 u. a.). In der vorliegenden Arbeit wird sowohl über den unmittelbaren ,als auch langzeitigen Effekt der chemischen Bespritzung auf die Entomofauna ausgewählter Bergströme im behandelten Gebiet berichtet.

MATERIAL UND METHODE

Insgesamt 11 ausgewählte Lokalitäten im Úpa — Stromgebiet (Elbe — Gewässersystem) wurden untersucht. Drei Lokalitäten lagen in dem Bergtal Zelený důl (Abb 3), und zwar Bach Jelení potok (1100 m), Bach Liščí potok (1000 m) und Bach Zelený potok (950 m) Die Bache Jeleni potok und Lišči potok sind Zustrome des Baches Zeleny potok Weitere Lokalitaten waren Bach Černohorsky potok in Janske Lazne (830 m) und Úpa, Horni Maršov (580 m, Abb 4) An der Lokalitat Černohorsky potok wurden die Proben 1 Tag nach der Behandlung des Gebietes und die Driftproben in der Zeitspanne von 36—48 Stunden nach der Behandlung, entnommen An den Lokalitat Úpa, Horni Maršov wurde nicht gespritzt Hier wurde der Effekt der Bespritzung im Gebiet der Úpa — Zustrome untersucht Ausserdem hat V Vavra in den Jahren 1981 und 1982 die Driftaktivitat an weiteren 6 Lokalitaten vor und nach der Bespritzung erforscht, wobei auch quantitative Feststellungen durchgefuhrt wurden Alle Lokalitaten befinden sich im Rhithronbereich Die Wassertemperatur (gemessen an den ersten 5 Lokalitaten) schwank von 9,5 bis 12,0 °C), pH Werte von 4,5 bis 5,1 (Úpa 6,5) Nach der Bespritzung wurden die pH Werte 3,0—5,7 gemessen Wahrscheinlich handelt es sich aber um keine nachweisbare Wirkung der Bespritzung auf die Reaktion des Wassers Wahrend der Untersuchungen im Jahre 1981 war ein bestandiges sonniges Wetter, grossere Schwankungen des Wasserspiegels wurden nicht notiert

Die Proben an den Lokalitaten 1—5 wurden af zwei Weisen entnommen, einerseits unter Anwendung der gewohnlichen Sammlungsweise der bentischen Organismen (Sammeln mit dem Sieb und individuelles Sammeln der Larven vom den Steinen), welche gewissermassen quantifiziert wurde, so dass 2 Mitarbeiter 1-2 Studen gesammelt haben, wobei allen Mikrohabitaten gleichmassige Aufmerksamkeit gewidmet wurde und anderseits in das *Driftnetz* Das *Driftnetz* bildet ein *Rahmen* mit *1 m* langen Seiten, der mit einem Netzstoff bezogen wird (Maschenweite 1,5 mm) Das Netz wurde immer 10—15 cm eingetaucht, so dass auch die Oberflachendricht gesammelt wurde Das Netz wurde an den Lokalitaten uber Nacht plaziert (20 00—08 00 Uhr, Bach Černohorsky potok, Úpa) oder tagsuber (Zeleny důl) und zwar so, dass die Driftorganismen vom ungefahr 1 2—1/3 des Stromprofils gefangen wurden Im Hinblick darauf, dass besonders der Gesamteffekt studiert wurde, wurden die Proben nur einmal entnomen Die Mortalitat der Larven wurde nach dem Mass der Thoraxmuskulaturlahmung bestimmt Als tot wurden die stark gelahmten, unbemerkbar auf die Beruhrung reagierenden und nicht reagierenden Larven bezeichnet Das Material wurde im $70^0{}_0$ Äthylakohol fixiert Terrestrische Organismen in der Drift wurden nicht ausgewertet An den Lokalitaten 6—11 wurde mittels eines Netzes von 600 cm’ Flache gesammelt, wobei das ganze Vertikalprofil des Stromes erfasst wurde Fur die quantitativen Probenentnahmen wurde eine Modifikation des Netzes nach Surber (1936) von 0,1 m^2 Flache verwendet Die angegebenen Werte sind ein Durchschnitt von immer zwei Proben an derselben Lokalitat

ERGEBNISSE

Insgesamt wurden an den ersten 5 erforschen Lokalitaten 37 Arten der Wasserinsekten, die in 5 Ordnungen gehoren, festgestellt Ephemeroptera (2 Arten), Plecoptera (9 Arten), Trichoptera (18 Arten), Coleoptera (2 Arten), Diptera (6 Arten) Mit Hilfe des Siebes und des Driftnetzes wurde ein Material von 2529 Individuen, meistens Larvalstadien der hoher erwahnten Gruppen angesammelt Die Imagines wurden nur bei den Gattungen *Agabus* und *Coelambus* (Coleoptera) gesammelt Individuell und in den Sieb haben wir 32 von der Gesamtzahl 37 nachgewiesenen Arten gefangen, wovon 11 nur in diesen Proben festgestellt wurden und in der Drift fehlten Nur in der Drift fand man 5 Arten Naheres uber die Angaben zum Vorkommen der einzelnen Arten siehe Tabellen 1—5

Vor der Bespritzung wahrend des Tages hat es praktisch keine Drift gegeben. Nach 1—3 Stunden nach der Plazierung des Netzes an der Lokalitat wurden keine Larven der festgestellten Arten gefangen Dem entgegen hat die Drift nach der Bespritzung heftig an der Intensitat zugenommen, z B bei den Steinfliegen (Plecoptera) bei den haufigsten Arten bis auf mehrere hundert Stuck wahrend 2—6 Stunden, siehe die Tabellen 1—3 Die Steinfliegen scheinen die empfindlichste Gruppe von den untersuchten Wasserinsekten zu sein, was

Tabelle 1. Vorkommen der Organismen an der Lokalitat Bach Jeleni

	Vor der Bespritzung			Nach der Bespritzung					
				Drift					
	Sammeln	Drift	Sammeln	2 Stunden		4 Stunden		6 Stunden	
				lebend	tot	lebend	tot	lebend	tot
PLECOPTERA									
Protonemura auberti	14	—	18	55	102	158	122	61	96
Nemurella picteti	1	—	3	5		3	1		1
Brachyptera seticornis	4	—	25	34	41	82	41	17	22
Brachyptera sp	—	—	2	3	1	5	4	1	2
Leuctra nigra	1	—	—	—	3	1	6	—	1
TRICHOPTERA									
Potamophylax luctuosus	2	—	1	—	—	—	—	—	—
Potamophylax latipennis	—	—	3	—	—	—	—	—	—
Rhyacophila obliterata	4	—	—	—	—	—	—	—	—
Rhyacophila fasciata	—	—	—	—	—	—	—	—	—
Chaetopteryx villosa	3	—	—	—	—	—	—	—	1
Chaetopteryx sp	2	—	1	—	—	—	—	—	—
Drusus annulatus	1	—	—	—	—	—	—	—	4
Drusus biguttatus	—	—	—	—	—	—	—	—	1
Allogamus auricollis	4	—	2	—	1	—	—	—	—
Annitella obscurata	—	—	—	—	—	—	—	1	—
Plectrocnemia conspersa	—	—	—	—	—	—	—	—	1
COLEOPTERA									
Agabus sp	—	—	—	—	—	3,3I	2I	2,2I	3,1I
Coelambus sp	—	—	—	—	—	2I	2I	2I	1I
DIPTERA									
Dicranota sp	2	—	—	—	—	—	—	—	2
Prosimulium latimucro	5	—	4	—	—	—	—	—	—

I — Imagines

auch den Angaben in der Literatur entspricht An Hand unserer Ergebnisse ist es unmoglich die Organismen der Empfindlichkeit zu den Insektiziden nach, einzuordnen. Man kann nur feststellen, das die ubrigen Ordnungen (Trichoptera, Ephemeroptera, Coleoptera und Diptera) im Gegenteil zu den Steinfliegen eine zu den genannten Praparaten weniger empfindliche Gruppe bilden

Die Auswirkung der benutzten Insektizide hat bedeutend auch das Verhalten der betroffenen Tiere beeinflusst Die kontaminierten Steinfliegenlarven kriechen an die exponierte Seite der Steine und werden fortschreitend paralysiert In dem Driftnetz haben die vergifteten Larven den vorderen Korperteil nach oben gehoben und ubten unkoordinierte Bewegungen aus Spater haben sie die Beweglichkeit verloren und sind untergegangen Die Kocherfliegenlarven *(Chaetopteryx* sp*)* haben ihre Kocher verlassen und sind in der Drift erschienen Es ist merkwurdig, dass die flugfahigen Imagines der Kafer *(Agabus* sp, *Coelambus* sp) nach der Bespritzung ihre Verstecke verlassen haben (mit den ublichen Methoden wurden sie nicht ermittelt) und auf dem Wasserspiegel geschwommen sind und fortschreitend der Vergiftung unterlegen haben, ohne zu versuchen das betroffene Gebiet zu verlassen

Tabelle 2. Vorkommen der Organismen an der Lokalität Bach Lišči.

	Vor der Bespritzung		Nach der Bespritzung		
	Sammeln	Drift	Sammeln	Drift	
				lebend	tot
PLECOPTERA					
Protonemura auberti	8	—	5	206	413
Protonemura sp.	2	—	—	—	—
Nemurella picteti	—	—	1	23	22
Brachyptera seticornis	2	—	—	—	3
Brachyptera sp.	—	—	1	—	—
Leuctra nigra	1	—	2	27	39
Leuctra handlirschi	—	—	—	—	33
Leuctra sp.	2	—	—	—	2
TRICHOPTERA					
Rhyacophila obliterata	—	—	—	—	1 L
Rhyacophila polonica	—	—	—	—	2 L
Chaetopterygopsis maclachlani	—	—	1 L	—	3 L
Chaetopteryx sp.	—	—	—	—	1 L
Halesus sp.	1 L	—	—	—	—
Micropterna sp.	1 L	—	1 L	—	1 L
COLEOPTERA					
Agabus sp.	1 L	—	—	5	5 L
DIPTERA					
Pedicia sp.	—	—	—	1 L	—
Prosimulium latimucro	—	—	—	—	1 L

In den Proben an den weiteren 6 Lokalitäten kamen in grösseren Mengen auch nur Steinfliegen und Köcherfliegen, an einem Bach (Krakonošova strouha bei Špindlerův Mlyn) auch die Eintagsfliegen vor. Die Vertreter der Ordnungen Diptera, Coleoptera u. a. spielten vom Gesichtspunkt der quantitativen Untersuchung eine ziemlich kleine Rolle. Alle erforschten Lokalitäten waren im Fichtenwald (700–900 m).

Die Drift vor der Bespritzung erreichte an allen Lokalitäten zwar sehr kleine Werte, doch immer war sie deutlich feststellbar. In allen Fällen (in der Vormittagsstunden beobachtet) schwanken die Werte der Drift um 5–12 Stück pro Stunde bei den Steinfliegen und um 1–5 Stück pro Stunde bei den Köcherfliegen.

Nach der Bespritzung kam es zu einem enormen Driftzuwachs, bei den Steinfliegen 20–50 mal, bei den Köcherfliegen 20–150 mal im Vergleich zu den Normalwerten vor der Bespritzung. Die Drift erreichte die Höchstwerte in der ersten Stunde nach der Bespritzung und nach weiteren 5—6 Stunden wurden wieder fast die Normalwerte erreicht. Die driftierenden Larven häuften sich in den Tümpeln noch einige Hundert Meter unter der Grenze der vergifteten Stromabschnitte an, und bildeten sogar mehrere Zentimeter dicke Schichten auf dem Grund.

Tabelle 3. **Vorkommen** der Organismen an der Lokalität Bach Zelený.

	Vor der Bespritzung		Nach der Bespritzung		
	Sammeln	Drift	Sammeln	Drift	
				lebend	tot
PLECOPTERA					
Protonemura auberti	23	—	30	88	104
Nemurella picteti	1	—	—	—	3
Brachyptera seticornis	3	—	1	9	12
Brachyptera sp	7	—	4	11	8
Leuctra nigra	3	—	1	—	7
Leuctra handlirschi	5	—	—	—	5
TRICHOPTERA					
Rhyacophila fasciata	1	—	1	—	—
Plectrocnemia conspersa	1	—	—	—	—
Chaetopteryx villosa	7	—	2		1
Drusus biguttatus	1	—	—		—
Micropterna sp.	1	—	—	—	—
COLEOPTERA					
Agabus sp.	3 L	—	1	—	—
DIPTERA					
Pseudodiamesa branickii	2	—	—	—	—
Pentaneurini (Chironomidae)	1	—	—	—	—

Die Quantitativentnahmen wurden an drei Lokalitäten im Jahre 1981 durchgeführt, wovon nur eine (namenloser Bach, Berg Černá Hora, 800 m) bespritzt wurde Diese Lokalität wurde auch schon im Juni 1980 mit Insektiziden behandelt. Die Abundanz der Steinfliegen und der Köcherfliegenlarven hat sich ein halbes Jahr nach der Bespritzung bedeutend erhöht, aber die Normalwerte wurden noch nicht erreicht. Im Dezember sollte die Abundanz sogar höher als im Mai sein (Helan et al.. 1973), siehe Tab. 6. Ähnlicher Weise an der Lokalitat Bach Medvědí, welche auch in beiden Jahren bespritzt wurde, fand man pro 1 m^2 125 Steinfliegen und 185 Köcherfliegenlarven und 50 Larven der Diptera (*Chironomidae, Simuliidae, Dicranota sp.*) also im Verleich zu den Literaturangaben einigermassen niedrigere Mengen der Insektenlarven besonders bei der Diptera. Niemals kam es zu einer Totalreduktion der aquatischen Insektenfauna. Die Tabelle 7 zeigt die Ergebnisse der quantitativen Entnahmen von einem direkt nicht bespritzten Stromabschnitt des namenlosen Baches (Bergtal Černý důl, 750 m). Alle Individuen waren lebend, obwohl in den nahe liegenden Tumpeln Tausende von vergifteten Larven lagen. Die Mortalität der angehauften Larven 24 Stunden nach der Bespritzung wurde mit Hilfe der Reaktion der Larven im 4 % Formol ermittelt. Von der Tabelle 8 ergibt sich, dass 20—40 % der betroffenen Larven die Bespritzung überlebt haben. Noch mehrere Tage nach dem Eingriff bei weiteren Kontrollen lebten noch fast alle von diesen angehauften Larven in den Tümpeln und begannen fortschreitend wieder die vergifteten Stromabschnitte zu besiedeln.

Tabelle 4. Vorkommen der Organismen an der Lokalität Bach Černohorský.

	Vor der Bespritzung		Nach der Bespritzung		
	Sammeln	Drift	Sammeln	Drift	
				lebend	tot
PLECOPTERA					
Protonemura auberti	20	—	22	81	72
Nemurella picteti	1	—	—	—	1
Brachyptera seticornis	4	—	1	29	35
Brachyptera sp.	1	—	—	1	5
Leuctra nigra	5	—	3	—	1
TRICHOPTERA					
Potamophylax latipennis	—	—	—	1	—
Rhyacophila obliterata	—	—	1	4	—
Chaetopteryx villosa	1	—	2	9	—
Drusus biguttatus	—	—	1	—	1
Drusus discolor	1	—	—	1	—
Drusus sp.	1	—	—	—	—
Halesus sp.	—	—	—	1	—
Allogamus auricollis	2	—	—	2	—
DIPTERA					
Pedicia sp.	—	—	—	—	1

DISKUSSION UND SCHLUSSFOLGERUNGEN

Was die Entomofauna des Rhithrons im Riesengebirge betrifft, sind die Auswirkungen der Luftbespritzung gegen den Grauen Lärchenwickler doppelter Natur. Der direkte Effekt macht sich durch unmittelbare Mortalität sowohl der Larven. als auch der Imagines sichtbar, während indirekte Effekte (durch die Drift verursachte Habitatwechsel) können vom Gesichtspunkt der Wirkung des Insektizides reversibel sein.

Die Toxizität der Karbamate und der Organophosphate fur die Wasserorganismen ist verhältnissmässig weining bekant, man erwarb einige Angaben fur Carbaryl (Burdick et al., 1960; Pimentel, 1971; Hulbert, 1978) und für Fenitrothion (z. B. Eidt, 1975), sonst wurde die Aufmerksamkeit besonders den chlorierten Präparaten geschenkt, die aber bei den unterschiedlichen Gruppen sehr unterschiedliche Auswirkung aufweisen (Muirehead-Thompson, 1973). Mehr wurden die Residua der Karbamate und Organophosphate untersucht. Die Werte nach der Luftbespritzung liegen zwischen 0,5–6,5 ppb (Fenitrothion) und 0,01–0,08 mg 1 (Carbaryl) Aly & El Dib, 1972; Langer & Taylor, 1974; Peterson & Zitko, 1974; Eidt, 1975; Courtemanch & Gibbs, 1980). In Anbetracht dessen, dass die Residua in Krkonoše nicht untersucht wurden, beschränken wir weitere Diskussion an die indirekte Auswirkungen, wobei die Mortalitat ermittelt wurde. Diese Fragen sind für weitere Untersuchungen vorgesehen Es ist fraglich, ob das Feststellen der Residua von so grosser Bedeutung ist, weil die aktuelle Konzentration der Wirkstoffe im Wasser auch bei beständigem Wetter extrem schwankt (vergl. Eidt, 1975). Ide (1960) hat eine vollständige Erneuerung der

Tabelle 5. Vorkommen der Organismen an der Lokalität Úpa.

	Sammeln	Ganze Nacht Drift lebend	tot
EPHEMEROPTERA			
Ecdyonurus lateralis	2	—	—
Rhithrogena semicolorata	10	—	—
PLECOPTERA			
Protonemura nimborum	—	1	—
Leuctra nigra	15	—	—
TRICHOPTERA			
Rhyacophila obliterata	1	—	—
Rhyacophila vulgaris	3	—	—
Rhyacophila fasciata	1	—	—
Rhyacophila polonica	1	—	—
Drusus sp.	1	—	—
Allogamus auricollis	10	1	—
DIPTERA			
Diamesa bohemanii	—	5	—

Fauna und die Rückkehr zu einem fast ursprünglichen Zustand nach einer Vergiftung der Ströme mit DDT erst nach 6 Jahren beobachtet. Sowohl die extrem steigende Anzahl der Organismen in der Drift in Krkonoše (Tab. 1.—4.), als auch die Zeitverteilung und das Abklingen der Driftaktivität ist mit anderen Autoren gut vergleichbar. Courtemanch & Gibbs (1980) z. B. haben beobachtet 1—2 Tage nach der Bespritzung 170 mal grössere Anzahl der Organismen in der Drift nach der Behandlung mit Carbaryl gegen die Wickler in Kanada, Eidt (1975) stellte einen Zuwachs von 13 028 auf 95 660 Individuen nach der Bespritzung mit Fenitrothion während 24 Stunden fest. Ähnliche Angaben bekamen Coutant (1964), Langer & Taylor (1974), Peterson & Zitko (1974), Sarrazin (1975), Kingsbury (1976), Kingsbury & McLeod (1979), Kingsbury & Kreutzweiser (1980) u. a., und zwar auch bei einer experimentellen Vergiftung des Stromes. In unserem Falle ist die Driftaktivität um so grösser, weil es vor der Bespritzung fast keine Drift gab, was wahrscheinlich durch einige Besonderheiten der Insektenfauna in Krkonoše verursacht wird (siehe weiter).

Es ist merkwürdig, dass die Drift die Nullwerte auch in den Nachtstunden aufwies (Lokalität 4), was den früher festgestellten Angaben über die Tages — und Jahresperiodik der Drift widerspricht (Waters, 1962; Müller, 1966; Waters, 1972; Clifford, 1972). Der kurzfristigen Beobachtung wegen. war es nicht möglich nicht einmal den Einfluss der erhöhten Abschwemmung an die Drift zu studieren; die der Literatur nach, etwas ausdrucksvoller sei, aber mit dem Effekt der Bespritzung nicht verleichbar ist (Eidt, 1975).

Der Anfangsanstieg der Drift klingt etwa nach zwei Tagen (Bach Černohorský potok) ab und man kann voraussetzen, dass nach weiteren 3—5 Tagen

Tabele 6. Die Anzahl der Individuen der dominanten Insektengruppen (n) in den quantitativen Proben vom namenlosen Bach (Berg Černá Hora, 800 m)

Datum 1981	Plecoptera (n/m²)	Trichoptera (n/m²)
29. 5. 2 Tage vor der Bespritzung	890	114
31. 5. 3 Stunden nach der Bespritzung	20	10
6. 6.	10	15
12. 6.	130	15
19. 12.	280	65

die Drift wieder ihre sehr niedrige Normalwerte erreicht. An einigen Lokalitaten wurde sogar schon 5–6 Studen nach der Bespritzung der Normalzustand der Driftaktivität erreicht.

An Hand der Hypothese von Waters (1972), Edit (1975) vermutet sogar bei langfristigen Beobachtungen des Luftbespritzungsseffektes des Fenitrothion, dass die Drift an den beeinflussten Lokalitäten die gleiche Periodik wie die Normaldrift aufweisst. Was die Vertikalverteilung der Drift betrifft, kann man voraussetzen, wie es sich von den an der Lokalität Úpa erworbenen Resultaten, wo die Drift auch nach der Bespritzung an den Normalwerten bleibt, ergibt (Tab. 5), dass die erhöhte Driftaktivitat sehr schnell abklingt. Infolge der Verdunnung kann man also offensichtlich der Effekt einer Lokalbespritzung auszuschliesen, mindestens in den Stromen der 1. und 2. Ordnung.

Die Ursachen der erhöhten Drift sind auf die direkte Toxizität der Präparte fur die Waserinsekten zurückzuführen. Sie macht sich einerseits durch die direkte Mortalität, anderseits durch die Verhaltensveranderungen (die Abschwemmung der bentischen Organismen zu Folge haben) bemerkbar, es steigt also die Anzahl der in dem Strom schwimmenden Insekten. In unserem Falle war die Mortalitat sehr verschieden, je nach dem Taxon 50–80 %. Eidt (1975) stellte die Mortalitat 30–90 % in der Drift wahrend 24 Stunden fest. Peterson & Zitko (1974) geben bei den Residuen 4.84 ppb von Fenitrothion die Gesamtmortalität 10 % an. Bei der Gesamtmortalitat unter 90 % (bei einmaliger Bespritzung) ist die Gesamtpopulation derjenigen Art nicht wesentlich beeinflusst, es besteht kein bemerkbarer Effekt an die Transformation und Oviposition bei den Steinfliegen.

Die sekundären Auswirkungen der erhöhten Drift, d. h. die Abschwemmung der Larven in ungeeignete Habitate hat auf die Population der einzelnen Arten keinen entscheidenden Einfluss, da vom ökologischen Gesichtspunkt aus, es sich bei einmaliger Bespritzung um sogenannte „katastropische Drift“ handelt,

Tabelle 7. Abundanz der dominierenden Insektenordnungen 400 m unter dem bespritzten Stromabschnitt (namenloser Bach in dem Bergtal Černý Dul, 750 m)

Datum 1981	Plecoptera	Trichoptera	Chironomidae
29. 5. 1 Tag vor der Bespritzung	270	70	205
31. 5. 1 Tag nach der Bespritzung	220	35	215

Tabelle 8. Mortalität der durch die Drift in den Tumpeln angehauften Insektenlarven, 24 Stunden nach der Bespritzung

Ordnung	Anzahl der Larven	Mortalitat (%)
Plecoptera	492	80 – 88
Trichoptera	111	58 – 75
Chironomidae	63	71

die z. B. bei Überschwemmungen (vergl. z. B. Andersson & Lehmkuhl, 1968 u. a.) oder beim Fischfang mit elektrischem Strom (Bisson, 1976; Fowles, 1975) geläufig, und im langfristigen Aspekt nicht zu bedeutend ist.

Was die einzelnen Insektengruppen in der Drift betrifft, weist die Fauna in Krkonoše einige Besonderheiten auf. Vor allem handelt es sich um eine mit der Acidifizierung beeinflusste Fauna, wo fast ganz die Eintagsfliegen (Ephemeroptera) fehlen (vergl. Winkler, 1979) wo die Steinfliegen (Plecoptera) dominieren, bei welchen aber auch manche Familien z. B. Perlidae eliminiert sind. Die Steinfliegen wiesen auch die höchste Mortalität auf, und bei einigen war sogar die Mehrzahl der toten Individuen (z. B. *Protonemura auberti*). Trotzdem kann man nicht behaupten, dass irgend eine Art selektiv ganz ausgerottet wurde (vergl. Eidt, 1975). Eine quantitative Veränderung der Bodenfauna nach der Bespritzung kann man keinesfalls ausschliessen, mann kann vielleicht auch eine gewissermassen verschiedene Artenzusammensetzung (vergl. z. B. Hopkins, 1966) voraussetzen.

Auch wenn es unmöglich ist, die Empfindlichkeit zu den Insektiziden nach, eine Organismenskala zusammenzusetzen, ist es offensichtlich, dass die Steinfliegen die sensiebelste Gruppe vorstellen. Zu gleichen Schlussvolgerungen kamen auch Peterson & Zitko, (1974), Eidt (1975), Hopkins (1966) und Courtemanch & Gibbs (1980). Die letzgenannten Autoren haben sogar eine bemerkbare Beeinflussung der Steinfliegenlarven noch nach 60 Tagen nach der Bespritzung beobachtet. Die übrigen Insektenordnungen (Trichoptera, Ephemeroptera und Coleoptera) weisen etwa die gleiche Empfindlichkeit auf. Es ist interessant, dass die Imagines der Kafer (Dytiscidae) wurden überhaupt nicht mittels klassischer Methoden gefunden, und erst nach Bespritzung in der Drift erschienen. Ähnlich ist es mit vielen Trichopteren — Arten (Tab 1. — 4.). Eidt (1975) und Courtemanch & Gibbs (1980), wiesen nach, dass die niedrigen Konzentrationen der Organophosphate und Karbamate auf die in den Bodeninterstizien lebenden Organismen keinen Einfluss haben, weil dort die wirkungsvollen Konzentrationen nicht gelingen. Ebenfalls in unserem Falle haben wir mit Ausnahme einiger parasitischen Mermithiden, die offensichlich ihre Wirte verliessen, keine Oligochaeten und andere Wurmer uberhaupt gefunden. Auch Diptera (besonders Chironomidae) escheinen in der Drift nur sehr selten. Diese Larven weisen meistens auch keine Tagesperiodik der Drift auf (Waters, 1972 u. a.) und wurden von den Insektiziden offenbar nicht beeinflusst. Dagegen bei den Larven der Familie Simuliidae (exponiert lebende Formen) zeigte sich eine grosse Mortalität.

Zum Schluss kann man sagen, dass eine einmalige Luftbespritzung (Actellic, Ambush) (auch trotz der Toxizitat der Präparate für eine ganze Reihe von Wasserinsekten) fur die Entomofauna des Rhithorns in Krkonoše keine katastrophalen Folgen hat. Da in den meisten Strömen infloge der hohen Acidität des Wassers keine Fische mehr leben, hat die Reduktion des Benthos vom *Gesichtspunkt der Fischnahrung keine Bedeutung. Man kann aber keinesfalls* ausschliessen, dass eine langfristige und besonders mehrmalige Bespritzung (mehrmals als 1 mal jährlich) sich als sehr negativ zeigen würde.

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THE RHAGIDIIDAE (ACARINA: PROSTIGMATA) FROM THE CENTRAL CAUCASUS, SIBERIA, AND SOME OTHER PARTS OF THE USSR

Miloslav ZACHARDA

Received March 16, 1982

Abstract: The Rhagidiidae from the Central Caucasus, Siberia, Kamchatka and Central Asia are reported. *Foveacheles caucasica* sp. n., *F. cegetensis* sp. n. are described as the new species. *Poecilophysis pseudoreflexa* Zacharda, *P. saxonica* (Willmann), *P. pratensis* (C. L. Koch), *Robustocheles mucronata* (Willmann), *Rhagidia punkva* Zach., *Evadorhagidia bezdezensis* Zach., *Cocorhagidia pittardi* Strandtmann, *C. clavifrons* (Canestrini), *Thoria uniseta* (Sig Thor), *T. brevisensilla* Zach., *Foveacheles brevichelae* Zach., are reported from various parts of the USSR. A list of the Rhagidiidae found in the USSR is presented.

INTRODUCTION

Soil mites of the family Rhagidiidae are well known to Soviet acarologists from various parts of the USSR as a frequently occurring component of the soil fauna. Unfortunately, nobody, except for Sig Thor (1909) and MacLean, etc., (1978), has studied these mites to the species in the area of the USSR up to this time. At present a revision of the Rhagidiidae (Zacharda, 1980) enables their reliable identification. Therefore many new taxonomic as well as biogeographic data on the Rhagidiidae from the USSR can be expected.

In 1974 and 1976 I collected the rhagidiids in the region of the Elbrus volcano, the Central Caucasus. The mites were collected by using a small aspirator containing ethyl-alcohol, or extracted from litter and soil samples in Tullgren apparatus. In 1980, during my stay in the Institute of Evolutionary Morphology and Ecology of A. N. Severcov, Soviet Academy of Sciences, Moscow, Dr. D. A. Krivoluckij kindly provided me with some material of the Rhagidiidae from various parts of the USSR. Also Dr. N. G. Samedov, Zoological Institute, Azerbajdzhan Academy of Sciences, Baku, extended me some material from Azerbajdzhan.

Note: The figures presented in this paper were drawn according to the original specimes collected in the USSR.

The type material of the new species is deposited in the collection of the Laboratory of Soil Biology, Institute of Landscape Ecology, ČSAV, Na sádkách 702, 370 05 České Budějovice, Czechoslovakia.

SYSTEMATIC PART

Genus *Foveacheles* Zacharda, 1980

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

1. *Foveacheles (Foveacheles) caucasica sp. n.*

(Fig. 1)

Diagnosis: Proximal cheliceral seta distinctly distal to joint of digitus mobilis. Rhagidial organs I and II consist of 4 separated rhagidial setae, stellate seta between 1st and 2 nd proximal rhagidial seta. Length of body 1300—1750 μm.

Description: 7 ♀ examined. Body length 1444 (1300—1750) μm, ratio of leg I length to body length: 1.06 (0.86—1.14).

Dorsum (measurements in μm): iv-83 (79—97), ev-94 (88—97), filiform trichobothrium 145 (140—149), sc-176, ih-88 (79—105), eh-193, d_1-88, d_2-97, il-145, el-88, is-torn off, es-79.

Venter: Epimeral formula 3-1-6-3, trochanteral formula 1-1-2-2. 5 pairs of progenital and 5 pairs of paragenital setae. Length of progenital lips 182 (158—220) μm.

Gnathosoma: Hypostome longitudinally oval, slender, ratio of length to breadth: 1.18 (1.16—1.23). Chelicerae with large, slender shears, both cheliceral setae distal to joint of digitus mobilis. Apex of fixed digit 4-cusped, inner margin of digitus mobilis finely serrate in middle part. Length of chelicera 363 (334—378) μm, breadth 154 (132—167) μm, length of digitus mobilis 145 (132—158) μm, length of proximal and distal cheliceral setae 37 (35—44) and 54 (53—61) μm, respectively. Distance between bases of cheliceral setae 45 (35—53) μm. Ratio of chelicera length to breadth: 2.35 (2.21—2.53), length of digitus mobilis to chelicera length: 0.40 (0.38—0.42), length of digitus mobilis to breadth of chelicera: 0.94 (0.88—1.0).

Terminal palpal segment oval, with 10 ciliated setae and 1 spiniform solenidion. Ratio of length to breadth: 2.46 (2.33—2.60).

Tarsus I long, slender, gently rounded forward. Ratio of length to breadth: 5. 25 (4.70—6.0). Slender empodium overlapping tips of claws with distinct basal clawlets.

Rhagidial organ I consists of 4 oblique, separated rhagidial setae, stellate seta between 1st and 2nd proximal rhagidial setae. Rhagidial organ II consists of 4 oblique, separated rhagidial setae, spiniform seta between 1st and 2nd proximal rhagidial setae.

Solenidia: Tibia I with 1 laterodorsal, medioproximal solenidion and dorsodistal rhagidial seta resembling lanceolate seta in slant depression. Genu I with 1 medioventral solenidion. Tibia II with dorsolateral, proximal solenidion and narrow dorsodistal lanceolate seta in depression with small terminal opening. Genu II with 1 ventral, mediodistal solenidion. Tibia III with 2 laterodorsal, tandem solenidia. Genu III with 1 lateroventral, medial solenidion. Tibia IV with 1 very small, lateroventral, medial solenidion. Other solenidia not observed.

Males: 3 specimes examined. No principal morphological differences were observed.

Material examined: 1 ♀, holotype, the Central Caucasus, Kabardino-Balkarskaja SSR, Poljana Azau, 2km W of Terskol, N-slope of Ceget Mt., about 2600 m, birch and rhododendron litter, 28. 6. 1976, leg. M. Zacharda, coll. LSB ILE ČSAV;

5 ♀, 3 ♂, paratypes, otherwise the same data as in the holotype, 8 ♀ paratypes 6 7 1974, otherwise the same data as in the holotype

Differential diagnosis The morphology of the cheliceral shears and the more distal location of the cheliceral setae explicitly separate *F* (*F*)

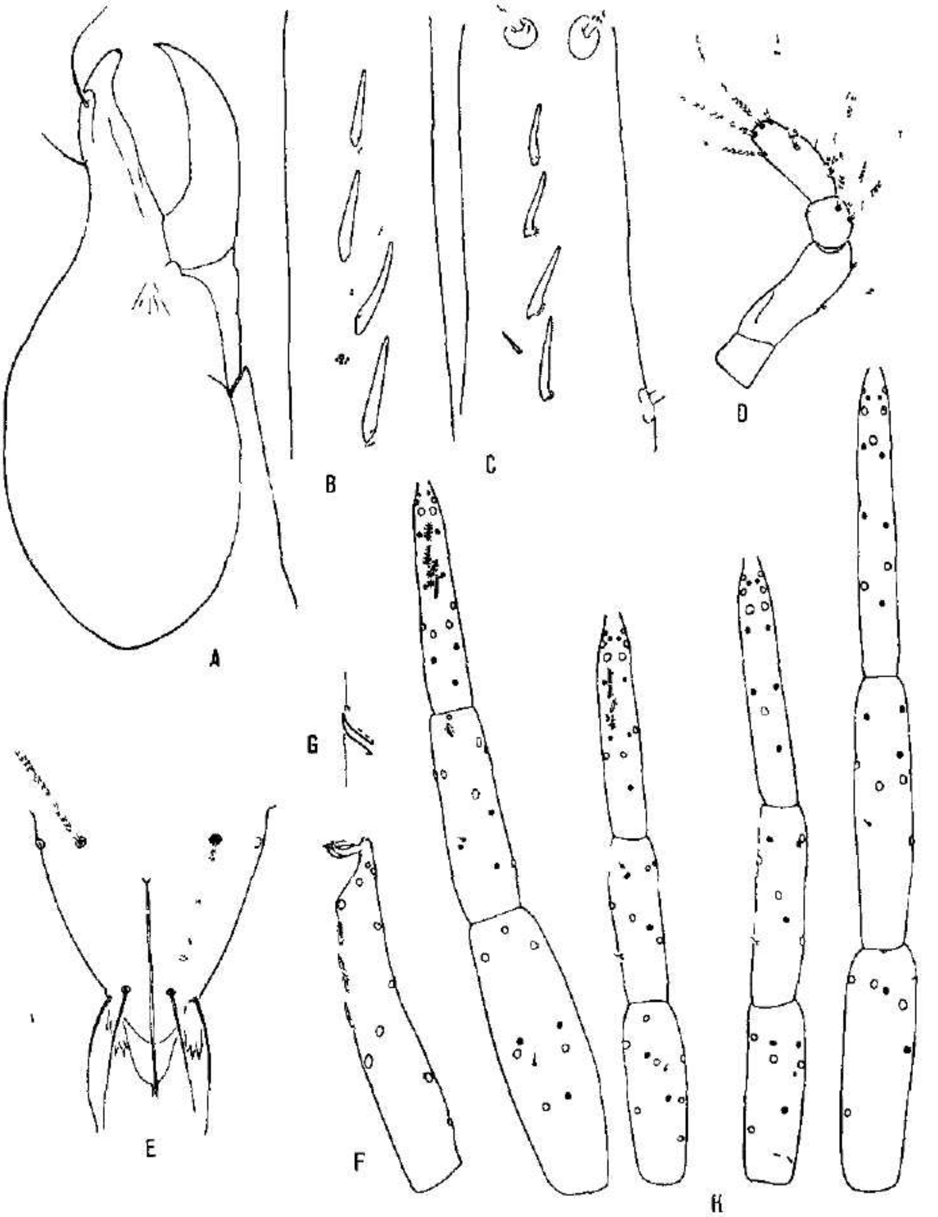

Fig 1 *Foveacheles caucasica* A — chelicera, B — rhagidial organ I, C — rhagidial organ II, D — pedipalpus, E — hypostome, F tarsus I in profile, G — rhagidial seta on tibia I, H — solenidia and chaetotaxy location on legs I–IV

caucasica from the other representatives of the subgenus *Foveacheles* On the other hand, however, this species is very close to the sympatric *F (F) cegetensis* (see below) from which it differs in the body size and the morphology of the cheliceral shears

The species is named for the Caucasus

2 *Foveacheles (Foveacheles) cegetensis* sp n
(Fig 2—3)

Diagnosis Proximal cheliceral seta inserted just before joint of digitus mobilis and almost reaching basis of distal cheliceral seta Rhagidial organ I and II consists of 4 separated rhagidial setae Stellate seta between 1st and 2nd proximal rhagidial setae Length of body 970—1150 μm

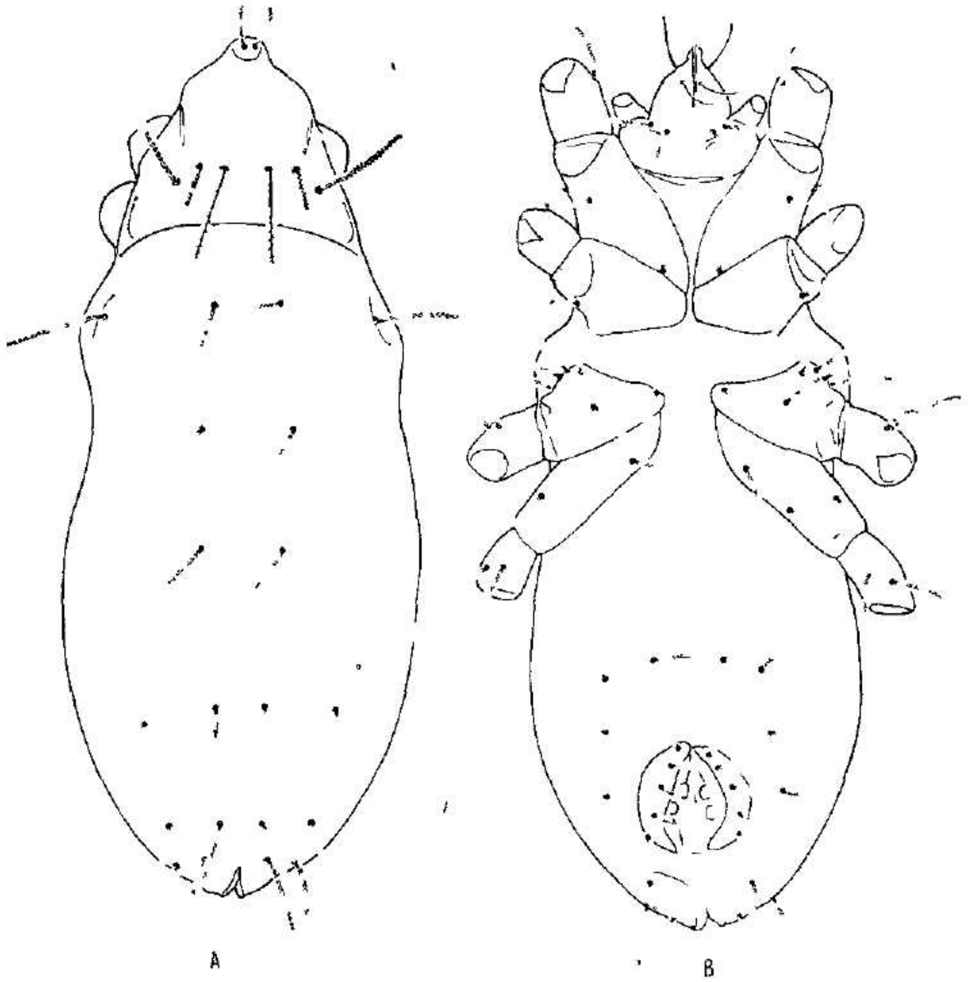

Fig 2 *Foveacheles cegetensis* A — dorsum, B — venter

Description: 6♀ examined. Length of body 1076 (978—1141) μm, ratio of length of leg I to body length: 0.90 (0.85—1.0).

Dorsum (measurements in μm): iv-48-60, ev-53-66, filiform trichobothrium 97-123, sc-123-140, ih-44-79, eh-105-158, $d_{1,2}$-44-60, il-61-97, el-44-70, is-88-97, es-53-79.

Venter: Epimeral formula 3-1-6-3, trochanteral formula 1-1-2-2. 5 pairs of progenital and 5 pairs of paragenital setae. Length of progenital lips 105—176 μm.

Gnathosoma: Hypostome broadly oval, ratio of length to breadth: 1.09. Internal malae spiniform, external ones membranous. Large serrate rutellae. Chelicerae with robust shears, proximal cheliceral seta inserted just before joint of digitus mobilis. Inner margin of digitus mobilis finely serrate. Length of chelicera 251 (199—273) μm, breadth 107 (87—122) μm, length of digitus mobilis 89 (77—98) μm, length of proximal and distal cheliceral setae 28 (21—33)

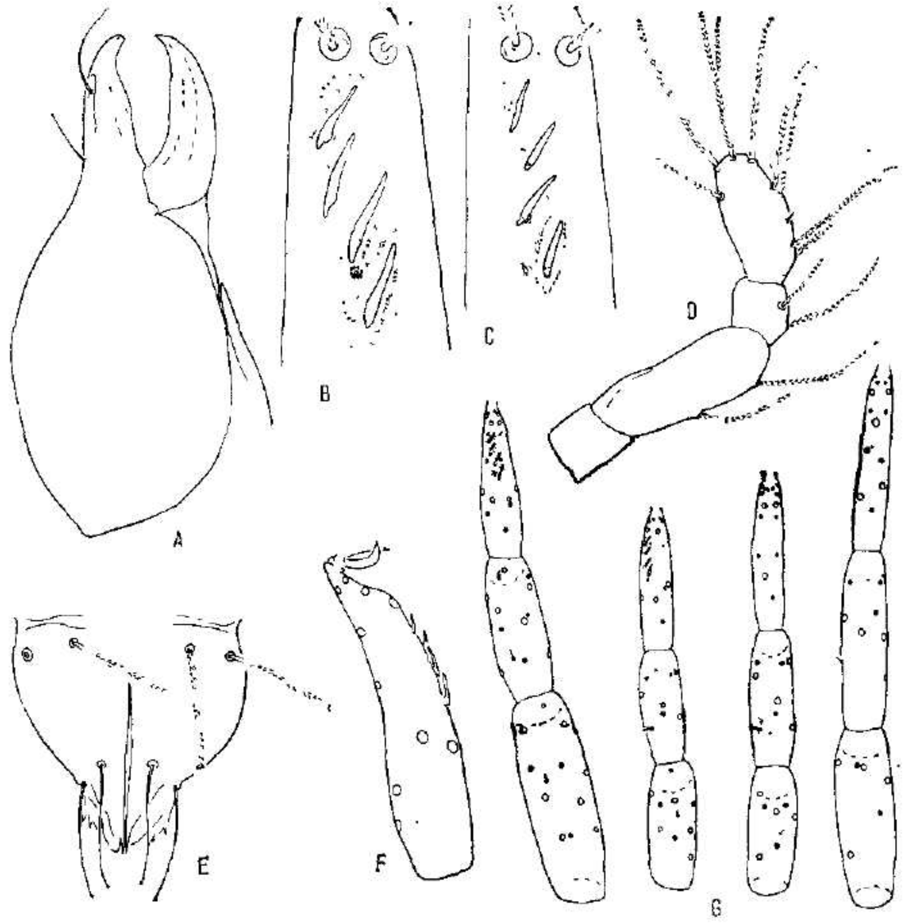

Fig. 3: *Foveacheles cegetensis:* A — chelicera, B — rhagidial organ I, C — rhagidial organ II, D — pedipalpus, E — hypostome, F tarsus I in profile, G — solenidia and chaetotaxy location on legs I—IV.

and 38 (28–45) μm, respectively. Distance between bases of cheliceral setae 36 (31–42) μm. Ratio of chelicera length to breadth: 2.34 (2.14–2.44), length of digitus mobilis to chelicera length: 0.35 (0.34–0.38), length of digitus mobilis to breadth of chelicera: 0.83 (0.77–0.88).

Terminal palpal segment oval with 10 ciliated setae and 1 spiniform solenidion. Ratio of length to breadth: 2.0–2.50.

Tarsus I gently rounded forward, ratio of length to breadth: 3.66–4.40. Slender empodium overplapping tips of claws with small, blunt, basal clawlets.

Rhagidial organ I consists of 4 separated, oblique rhagidial setae, stellate seta between 1st and 2nd proximal rhagidial setae. Rhagidial organ II consists of 4 small separated, oblique rhagidial setae, spiniform seta beside 1st proximal rhagidial seta.

Solenidia: Tibia I with 1 laterodorsal, proximal solenidion and dorsodistal rhagidial seta in slant depression resembling lanceolate seta on tibia II. Genu I with I distimedial, ventral solenidion. Tibia II with 1 lateroproximal solenidion and dorsodistal lanceolate seta in deep depression with small terminal opening. Genu II with 1 ventral, mediodistal solenidion. Tibia III with 2 laterodorsal, medioproximal tandem solenidia, genu III with 1 lateroventral, medial solenidion. Tibia IV with 1 lateroproximal solenidion.

Material examined: 1 ♀, holotype, the Central Caucasus, Kabardino-Balkarskaja SSR, Poljana Azau, 2 km W. of Terskol, N-slope of Cegent Mt., about 2600—2800 m, birch and rhododendron litter, 28. 6. 1976, M. Zacharda leg., coll LSB ILE ČSAV; 5 ♀, paratypes, otherwise the same data as in the holotype.

Differential diagnosis: F. (F.) cegetensis is undoubtedly very close to the sympatric *F. caucasica,* but it differs with the morphology of the location of the cheliceral setae. Its body length is distinctly smaller. *F. cegetensis* differs from *F. osloensis* (Sig Thor) (cf. Zacharda, 1980 : 662.) with the morphology of the cheliceral shears, the mutual position of the cheliceral seate and the shorter rhagidial seate. *F. cegetensis* also very resembles *F. brevichelae* Zacharda, 1980 (see also below), but it differs with the morphology of the rhagidial setae which are slender in *F. cegetensis.* Also the shape of the cheliceral shears and chaetotaxy length and location are different.

The species is named for the Ceget-mountain, the Central Caucasus.

3. *Foveacheles (Foveacheles) brevichelae* Zacharda, 1980

(Fig. 4-A-F)

F. brevichelae Zacharda, 1980, Acta Univ Carol Biol (1978), 5–6: 666–670.

Some morphological data on the material examined: 1 ♀, body length 695 μm, ratio of leg I length to body length: 0.88. Length of chelicera 168 μm, breadth 77 μm, length of digitus mobilis 56 μm, length of proximal and distal cheliceral setae 19 and 24 μm, respectively. Distance between bases of cheliceral setae 21 μm. Ratio of chelicera length to breadth: 2.18, length of digitus mobilis to chelicera length: 0.33, length of digitus mobilis to breadth of chelicera: 0.72.

Rhagidial organs, solenidia, ventral and palpal chaetotaxy and other diagnostic characters as in the original description.

Material examined 1 ♀, the Central Caucasus, Kabardino-Balkarskaja SSR, Poljana Azau, 2 km W of Terskol, S – slope of Elbrus, about 3000 m, grass rhizosphere on alpine meadow, 5. 7. 1976, M. Zacharda leg. et coll.

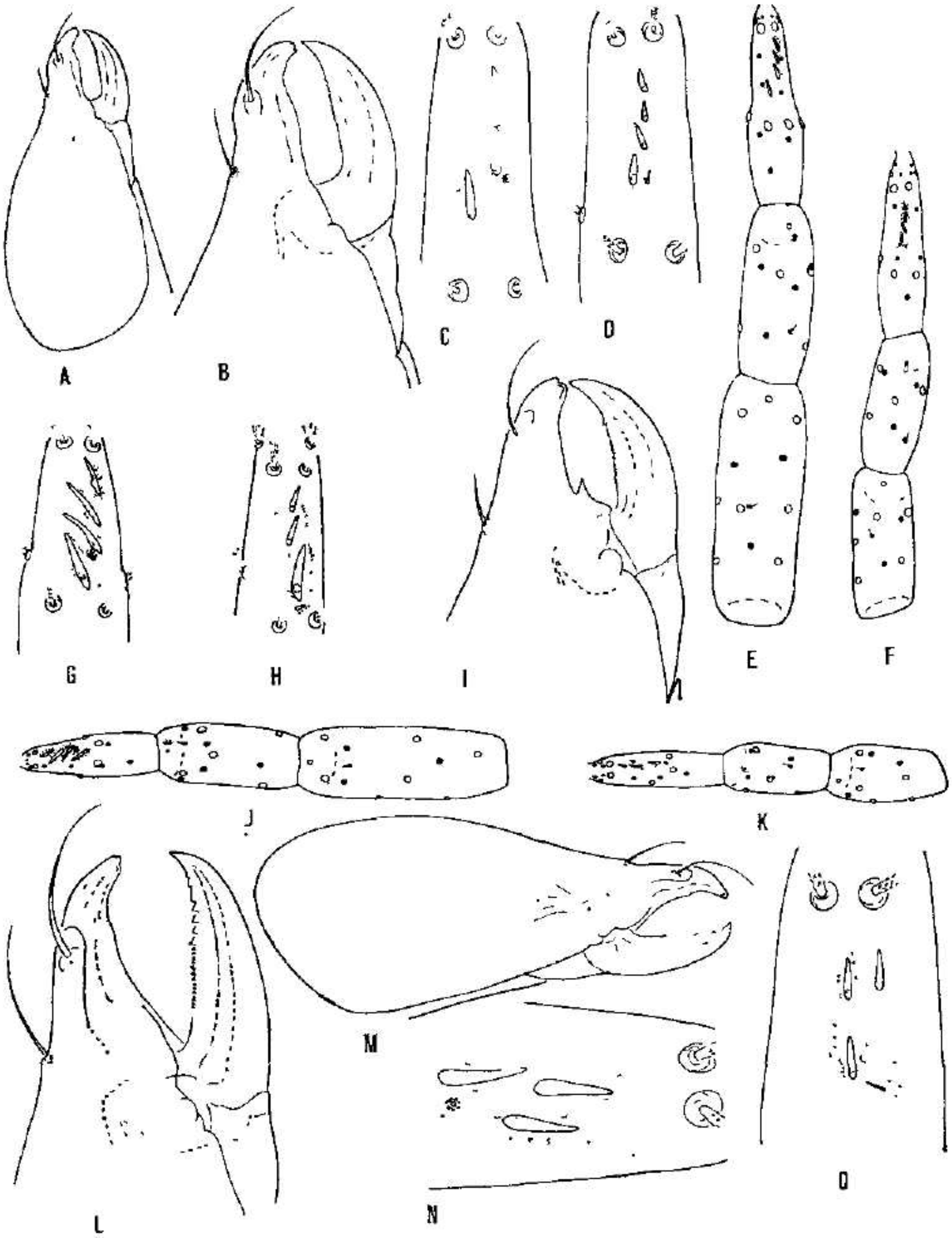

Fig. 4: *Foveacheles brevichelae* (A–F): A – chelicera, B – cheliceral shears, C – rhagidial organ I, D – rhagidial organ II, E, F – solenidia and chaetotaxy location on legs I, II, respectively; *Robustocheles mucronata* (G–K): G – rhagidial organ I, H – rhagidial organ II, I – cheliceral shears, J, K – solenidia and chaetotaxy location on legs I, II, resp.; *Evadorhagidia bezdezensis* (L–O): L – cheliceral shears, M – chelicera, N – rhagidial organ I, O – rhagidial organ II

Genus *Poecilophysis* Cambridge, 1876

Poecilophysis: Zacharda, 1980, Acta Univ. Carol. Biol. (1978), 5—6. 559—601.

1. *Poecilophysis (Procerocheles) pseudoreflexa* Zacharda, 1980

(Fig. 5—C—F)

Procerocheles Zacharda, 1980, ibid.: 609
P. (P.) pseudoreflexa Zacharda, 1980, ibid.: 614—617

Some morphological data on the material examined: 2 ♀, length of body 792, 909 µm, ratio of leg I length to body length: 0.97, 1.10. Length of chelicera 202, 246 µm, breadth 97, 114 µm, length of digitus mobilis 88, 105 ♀m, length of proximal and distal cheliceral setae 13, 18 and 44, 60 µm, respectively. Distance between bases of cheliceral setae 18, 22 µ. Ratio of chelicera length to breadth: 2.08, 2.15, length of digitus mobilis to chelicera length: 0.42, 0.43, length of digitus mobilis to breadth of chelicera: 0.90, 0.92. Ratio of tarsus I length to breadth: 4.0, 5.25. Ratio of terminal palpal segment length to breadth: 2.28, 2.50. Epimeral formula 3-1-5-3. Solenidia and rhagidial organs as in the original description.

Material examined: 1 ♀, the Central Causus, Kabardino-Balkarskaja SSR, Poljana Azau, 2 km W of Terskol, S — slope of Elbrus, about 2600 m, grass rhizosphere, 10. 7. 1974, M. Zacharda leg. et coll.; 2 ♀, in moss on the bank of the Baksan

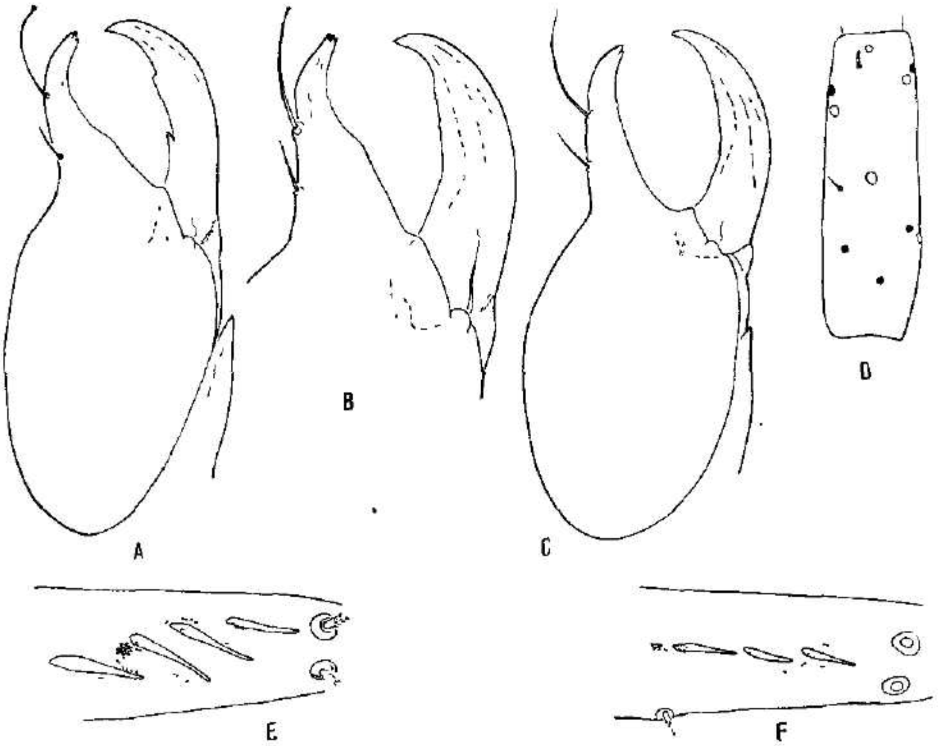

Fig. 5: *Poecilophysis pratensis:* A — chelicera; *Poecilophysis saxonica:* B — cheliceral shears; *Poecilophysis pseudoreflexa:* C — chelicera, D — cheatotaxy and solenidion location on tibia I, E — rhagidial organ I, F — rhagidial organ II.

river, 30 6 1974, otherwise the same data, 1 ♀, Terskol, 9 7 1974, otherwise the same data, 2 ♀, the Tjan-Šan Mtns, Kirgiskaja SSR, fir litter, 23 5 1968, P Vtorov **leg**, coll M Zacharda

2 *Poecilophysis (Soprocheles) saxonica* (Willmann 1934)

(Fig 5—B)

Rhagidia saxonica Willmann 1934, Zool Anz 107 306—307
Soprocheles Zacharda 1980, Acta Univ Carol Biol (1978) 5—6 634
Poecilophysis (S) saxonica Zacharda 1980, ibid 635—639

Some morphological data on the material examined 1 ♀, body length 686 μm, ratio of leg I length to body length 0 69 Length of chelicera 178 μm, breadth 77 um, length of digitus mobilis 73 μm, length of proximal and distal cheliceral setae 16 and 28 μm, respectively, distance between their bases 16 μm Ratio of chelicera length to breadth 2 31, lengt of digitus mobilis to breadth of chelicera 0 95 length of digitus mobilis to length of chelicera 0 41 Empodium I very short! Rhagidial organs, solenidia as in the redescription (cf Zacharda 1980 635)

Material examined 1 ♀ the Central Caucasus Kabardino-Balkarskaja SSR Poljana Azau, 2 km W of Terskol S — slope of Elbrus about 3200 m, in moss and lichens, 6 7 1974, M Zacharda leg et coll 1 ♀, 1 tritonymph N — slope of Ceget Mt, about 3000 m, alpine meadow rhizosphere otherwise the same data as in the foregoing item 1 ♀, 1 tritonymph Adyr-su valley Schelda glacier in moss 2 7 1974 otherwise the same data 2 ♀, 1 tritonymph, the Tjan-Šan Mtns, Kirgiskaja SSR, Čom-Kyzyl-Su, 2200 m, 20 5 1968, P Atov leg, coll M Zacharda, 1 ♀, 1 tritonymph, Central Siberia, Jakutskaja SSR 30 km N of Jakutsk, the vicinity of the Lena river birch forest litter, permafrost, VI, 1967, D A Krivoluckij leg coll M Zacharda,

3 *Poecilophysis (Dentocheles) pratensis* (C L Koch, 1835)

(Fig 5—A)

Scyphius pratensis C L Koch 1835 Deutschlands Crustaceen, Myriapoden und Arachniden Fasc 1,14 Regensburg
Dentocheles Zacharda 1980 Acta Univ Carol Biol (1978) 5—6 621
Poecilophysis (D) pratensis Zacharda, 1980, ibid 621—626

In comparison with the redescription of this species (Zacharda, 1980) no principal differences were found

Material examined 2 ♀, 1 tritonymph, the Central Caucasus, Kabardino-Balkarskaja SSR, Poljana Azau, 2 km W of Terskol N-slope of Ceget-Mt, about 2500 m birch and rhododendron litter 7 7 1974 M Zacharda leg et coll 6 ♀, Apšeron, Azerbajdžanskaja SSR, Džiranbatanskij lesnoj massiv, oak forest litter, 20 5 1980 M Zacharda leg et coll 1 ♀ Azerbajdzanskaja SSR Girkanskij les Aleksejevka, II 1977, V Lobačeva leg, coll M Zacharda 1 ♀, 1 deutonymph, Kamchatka, 18 km N of Županovo, gorjačije ključi, grass rhizosphere 25 7 1970, A D. Nikitina leg, coll M Zacharda

Genus *Rhagidia* Thorell 1872

Rhagidia Zacharda, 1980, Acta Univ Carol Biol (1978), 5—6 556—557

1 *Rhagidia (Noerneria) punkva* Zacharda, 1980

(Fig 6—F—J)

Noerneria Zacharda, 1980, Acta Univ Carol Biol (1978), 5—6 565.
Rhagidia (N) punkva Zacharda, 1980, ibid 575—577

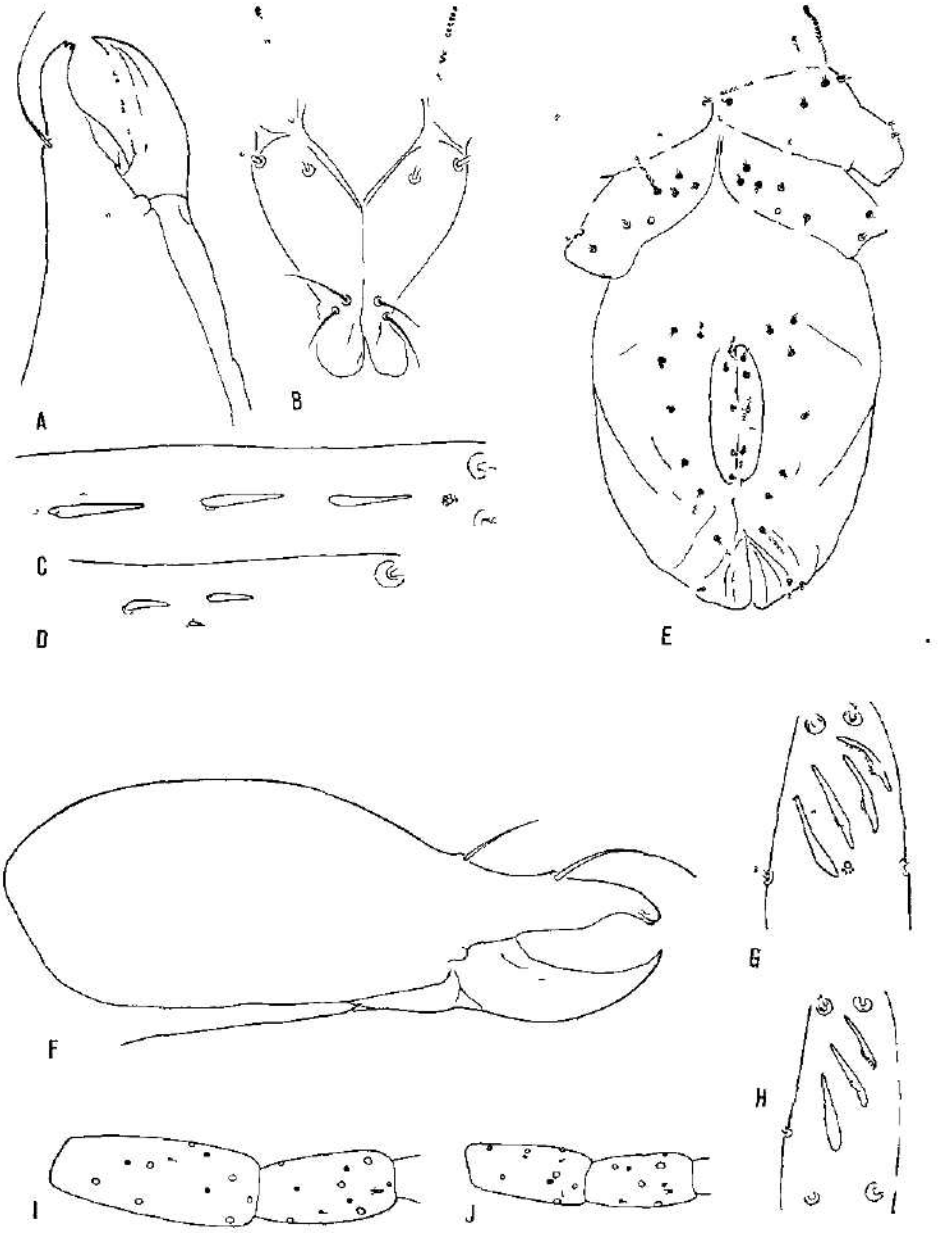

Fig 6 ***Thoria uniseta*** *A — cheliceral shears,* B — hypostome, C — rhagidial organ I D — rhagidial organ II, E — ventral chaetotaxy, ***Rhagidia punkva*** F — chelicera, G — rhagidial organ I, H — rhagidial organ II, I, J — solenidia and chaetotaxy location on tibiae and genua I and II, respectively

Some morphological data on the specimen examined: 1 ♀, length of body 686 μm, ratio of leg I length to body length: 0.75. Length of chelicera 160 μm, breadth 59 μm, length of digitus mobilis 52 μm, length of proximal and distal cheliceral setae 17 and 31 μm, respectively. Distance between bases of cheliceral setae 24 μm. Ratio chelicera length to breadth: 2.72, lengt of digitus mobilis to chelicera length: 0.32, length of digitus mobilis to breadth of chelicera: 0.88. Ratio of tarsus I length to breadth: 3.0, the same for terminal palpal segment: 2.33. Epimeral formula 3-1-5-3. Rhagidial organs, solenidia, chaetotaxy as in the original description.

Material examined: 1 ♀, Central Siberia, Jakutskaja SSR, 30 km N of Jakutsk, the vicinity of the Lena river, in larch litter with moss, VI., 1967, D. A. Krivoluckij leg., coll. M. Zacharda.
Note: This is the second finding of this species reported.

Genus *Robustocheles* Zacharda, 1980

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

1. *Robustocheles (Robustocheles) mucronata* (Willmann, 1936)

(Fig. 4—G—K)

Rhagidia mucronata Willmann, 1963, Zool. Anz. 116: 297.
Robustocheles (R.) mucronata: Zacharda, 1980, Acta Univ. Carol. Biol. (1978), 5—6: 532—536.

In comparison with the redescription of this species no principal differences were observed.

Material examined: 2 ♀, the Central Caucasus, Kabardino-Balkarskaja SSR, Poljana Azau, 2 km W of Terskol, N-slope of Elbrus, about 3000 m, alpine meadow rhizosphere, 5. 7. 1976, M. Zacharda leg. et coll.; 3 ♀, E-slope of Ceget, about 2900 m, 7. 7. 1974, otherwise the same data; 2 ♀, Adyr-su valley, the Šchelda glacier, in moss, otherwise the same data; 6 ♀, the Skalistyj chrebet Mtns., about 10 km N of Tyrnyauz, wet grass rhisosphere on limestone rock, 10. 7. 1974, otherwise the same data; 8 ♀, Kamchatka, 18 km from Županovo, gorjačie ključi, in moss and grass rhizosphere, 25. 7. 1970, A. D. Nikitina leg., coll. M. Zacharda; 3 ♀, 1 tritonymph, the Tjan-Šan Mtns., Kirgiskaja SSR, Kungej Ala-tau, the vicinity of Čoi-Kemin river, fir forest litter, 4. 9. 1968, P. Vtorov leg., coll. M. Zacharda; 1 deutonymph, Central Siberia, Jakutskaja SSR, 30 km N of Jakutsk, in the vicinity of the Lena river, permafrost, steppe, grass rhizosphere, VI., 1967, D. A. Krivoluckij leg., coll. M. Zacharda.

Genus *Evadorhagidia* Zacharda, 1980

Evadorhagidia Zacharda, 1980, Acta Univ. Carol. Biol. (1978), 5—6: 725—726.

1. *Evadorhagidia bezdezensis* Zacharda, 1980

(Fig. 4 — L—0)

Evadorhagidia bezdezensis Zacharda, 1980, Acta Univ. Carol. Biol. (1978), 5—6: 734—737.

Some morphological data on the specimens examined: 1 ♀, length of body 1280 μm, ratio of leg I length to body length: 0.80. Epimeral formula 3-1-4-4. Length of chelicera 240 μm, breadth 93 μm, length of proximal and distal cheliceral setae 35 and 38 μm, respectively. Distance between bases of cheliceral setae 24 μm. Ratio of chelicera length to breadth: 2.60, length of digitus mobilis to chelicera length: 0.32, length of digitus mobilis to breadth of chelicera: 0.84. Ratio of tarsus I length to breadth: 4.0, the same for terminal palpal segment: 2.75. Rhagidial organs and solenidia on legs as in the original description.

Material examined: 1 ♀, Central Siberia, Jakutskaja SSR, 30 km N of Jakutsk, in the vicinity of the Lena river, permafrost, larch litter, VI., 1967, D. A. *Krivoluckij leg., coll. M. Zacharda.*

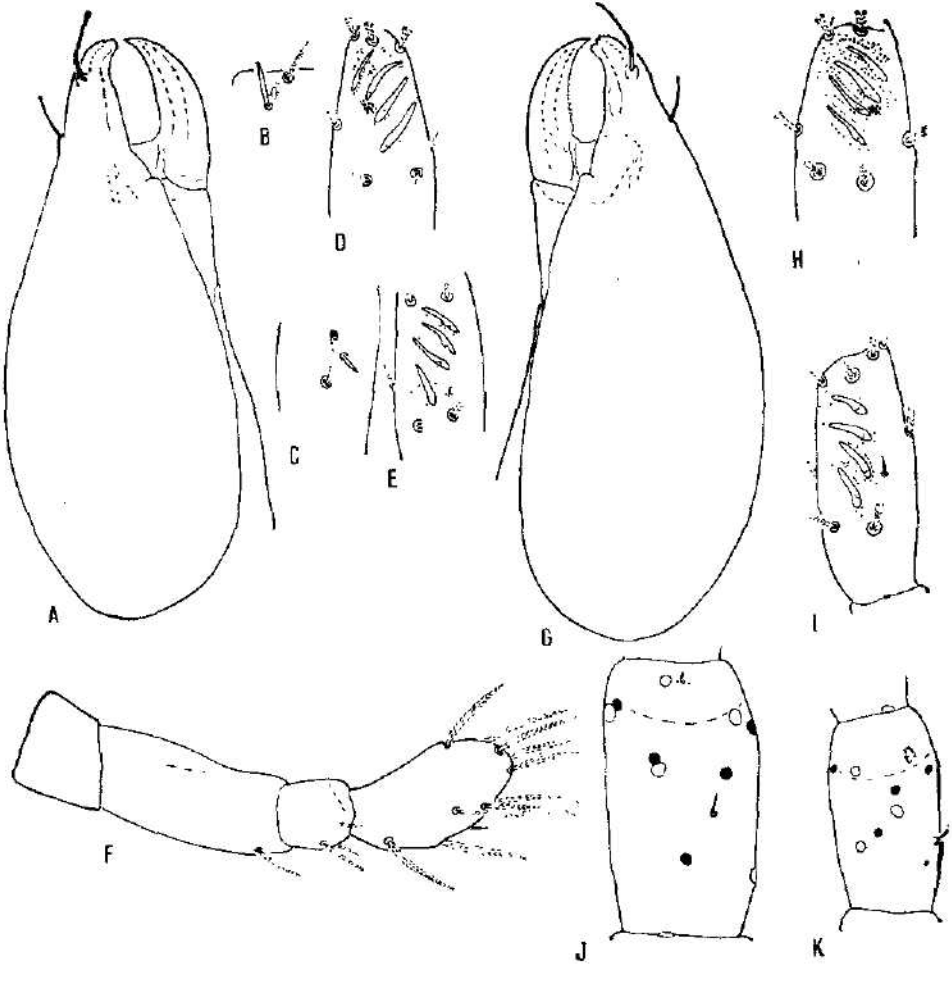

Fig. 7: *Coccorhagidia clavifrons:* A — chelicera, B — solenidion on tibia I, C — solenidion on tibia II, D — rhagidial organ I, E — rhagidial organ II; *Coccorhagidia pittardi:* F — pedipalpus, G — chelicera, H — rhagidial organ I, I — rhagidial organ II, J — solenidion on tibia I, K — solenidion on tibia II.

Genus *Coccorhagidia* Sig Thor, 1934

Coccorhagidia Sig Thor, 1934, Zool Anz 105: 318.
Coccorhagidia: Zacharda, 1980, Acta Univ. Carol Biol. (1978), 5–6: 704.

1. *Coccorhagidia clavifrons* (Canestrini, 1886)
(Fig. 7–A–E)

Norneria clavifrons Canestrini, 1886, Atti Ist. veneto Sci, Ser. 6,4: 710.
Coccorhagidia clavifrons: Zacharda, 1980, Acta Univ. Carol. Biol. (1978), 5–6: 704–708.

In comparison with the redescription of this species (Zacharda, 1980) no principal morphological differences were found.

Material examined: 5 ♀, the Central Caucasus, Kabardino-Balkarskaja SSR, Poljana Azau, 2 km W of Terskol, S-slope of Elbrus, about 3000 m, alpine meadow rhizosphere, 5. 7 1976, M. Zacharda leg. et coll

2. *Coccorhagidia pittardi* Strandtmann, 1971
(Fig. 7–F–K)

Coccorhagidia pittardi Strandtmann, 1971, Pacif. Insects, 13 (1): 98—101.
C. pittardi: Zacharda, 1980, Acta Univ. Carol. Biol. (1978), 5–6: 708–711.

In comparison with the original description and redescription of this species no principal morphological differences were found.

Material examined: 2 ♀, the Central Caucasus, Kabardino-Balkarskaja SSR, Poljana Azau, 2 km W of Terskol, S – slope of Elbrus, just under snow zone, in moss and lichen, about 3600m, 6. 7. 1974, M. Zacharda leg. et coll.; 2 ♀, in lava scree, about 2700 m, otherwise the same data, 2 ♀, Central Siberia, Jakutskaja SSR, 30 km N of Jakutsk, in the vicinity of the Lena river, permafrost, steppe, grass rhizosphere, VI, 1967, D A. Krivolucky leg., coll. M. Zacharda

Genus *Thoria* Zacharda, 1980

Thoria Zacharda, 1980, Acta Univ. Carol Biol. (1978), 5–6: 747–748.

1. *Thoria uniseta* (Sig Thor, 1909)
(Fig. 6–A–E)

Rhagidia uniseta Sig Thor, 1909, Mém. Acad. St. Pétersb, Sér. 8, 18, 14: 10–11.
Thoria uniseta: Zacharda, 1980, Acta Univ Carol. Biol (1978), 5—6: 752—759.

Some morphological data on the specimens examined: 3 ♀, length of body 932–978 μm, ratio of leg I length to body length: 1.70. Epimeral formula 3-1-4-8, exceptionally 3-1-4-10/9. 5 pairs of progenital, or 4/5 progenitals, 6 pairs, or 6/5, of paragenital setae. Terminal palpal segment with 12 ciliated setae and 1 spiniform solenidion. Length of chelicera 199, 196, 210 μm, breadth 59, 59, 66 μm, length of digitus mobilis 52 μm, length of 1 cheliceral seta 35 μm. Ratio of chelicera length to breadth: 3.37, 3.32, 3.15, length of digitus mobilis to chelicera length: 0.26, 0.26, 0.24, length of digitus mobilis to breadth of chelicera: 0.88, 0.88, 0.87. Ratio of tarsus I length to breadth: 6:33, the same for terminal palpal segment: 4.0–5.0. Rhagidial organs as in the redescription, spiniform seta of rhagidial organ II between 2 rhagidial setae. Solenidia very small, vestigial. Tibia I with 1 laterodorsal, proximal solenidion, tibia II with 1 laterodorsal, proximal solenidion Tibia III with 2 laterodorsal, proximal, tandem solenidia. Other solenidia not observed.

Material examined· 5 ♀, the Central Caucasus, Karbadino-Balkarskaja SSR Poljana Azau, 2 km W of Terskol, N – slope of Ceget Mt., about 2600 m, moss under rhododendron shrubs, 30. 6. 1974, M. Zacharda leg et coll.; 1 tritonymph, Central Siberia, Jakutskaja SSR, 30 km N of Jakutsk, in the vicinity of the Lena river, permafrost, birch forest litter, VI., 1967, D. A. Krivoluckij leg, coll. M. Zacharda.

Discussion: The specimens of *T. uniseta* presented in this paper seem to be very close to „specimen B" as it was described and discussed in Za-

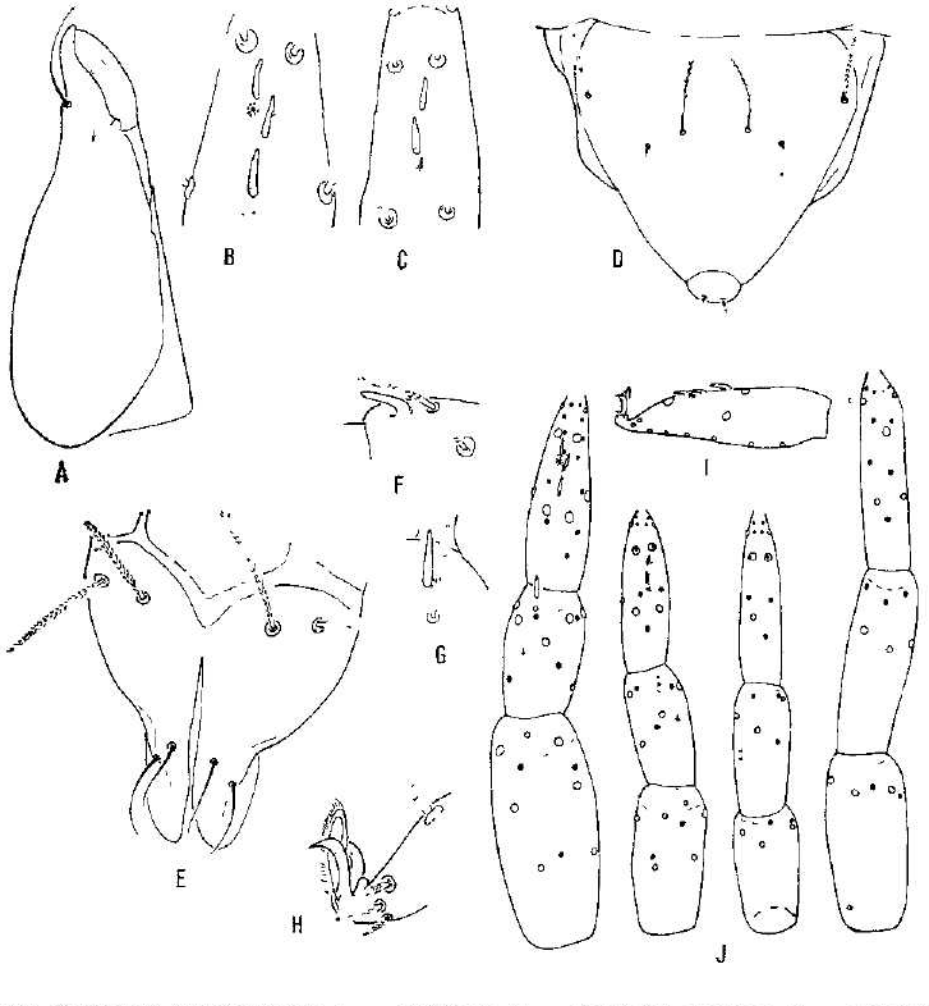

Fig 8: ***Thoria brevisensilla:*** A – chelicera, B – rhagidial organ I, C – rhagidial organ II D – prodorsal chaetotaxy, E – hypostome, F, G – rhagidial seta on tibia I, H – claws and enlarged empodium on tarsus I, I – tarsus I in profile, J – solenidia and chaetotaxy location on legs I—IV.

charda, 1980. The variability of the ventral chaetotaxy suggests that the variable ventral polytrichous chaetotaxy in *T. uniseta* should be taken into consideration. Hence the specimens "A and B" (cf. Zacharda, 1980: 752—757.) are probably only the morphological forms of the one species.

2. *Thoria brevisensilla* Zacharda, 1980

(Fig. 8)

Thoria brevisensilla Zacharda, 1980, Acta Univ. Carol. Biol. (1978), 5—6: 748—752.

In comparison with the original description no principal morphological differences were observed.

Material examined: 1 ♀, the Central Caucasus, Kabardino-Balkarskaja SSR, Poljana Azau, 2 km W of Terskol, N — slope of Ceget Mt., about 3000 m, Alpine meadow rhizosphere, 6. 7. 1976, M. Zacharda leg. et coll.; 2 ♀, S-slope of Elbrus, about 2600 m, otherwise the same data; 1 tritonymph, the Tjan-Šan Mtns., Kirgiskaja SSR, Čom-Kyzyl-Su, 2200 m, 20. 5. 1968, P. Atov leg., coll. M. Zacharda; 20, Central Siberia, Jakutskaja SSR, 30 km N of Jakutsk, in the vicinity of the Lena river, permafrost, steppe, VI. 1967, D. A. Krivoluckij leg., coll. M. Zacharda.

A LIST OF THE RHAGIDIIDAE FOUND IN THE USSR

The Central Caucasus, Kabardino-Balkarskaja SSR, Poljana Azàu and its vicinity, about 2 km W of Terskol, slopes of the Baksan Canyon, about 2400—3600 m:

Coccorhagidia clavifrons (Canestrini), ***Coccorhagidia pittardi*** Strandtmann, ***Foveacheles caucasica*** sp. n., ***Foveacheles cegetensis*** sp. n., ***Foveacheles brevichelae*** Zacharda, *Poecilophysis pratensis* (C. L. Koch), ***Poecilophysis saxonica*** (Willmann), *Poecilophysis pseudoreflexa* Zacharda, *Robustocheles mucronata* (Willmann), ***Thoria uniseta*** (Sig Thor), ***Thoria brevisensilla*** Zacharda.

Central Siberia, Jakutskaja SSR, 30 km N of Jakutsk, the vicinity of the Lena river, permafrost:

Coccorhagidia pittardi Strandtmann, ***Evadorhagidia bezdezensis*** Zacharda, ***Poecilophysis saxonica*** (Willmann), ***Rhagidia punkva*** Zacharda, ***Robustocheles mucronata*** (Willmann), *Thoria uniseta* (Sig Thor), *Thoria brevisensilla* Zacharda.

East Siberia, Northern Chukotka, Chaun Bay (data taken from McLean, etc., 1978):

Arctorhagidia sateri (Strandtmann), ***Eskimaia capitata*** (Strandtmann), ***Shibaia longisensilla*** (Shiba), *Thoria uniseta* (Sig Thor) cf. ***T. brevisensilla*** Zacharda (!)

The Tjan — Šan Mtns., Kirgiskaja SSR:

Poecilophysis pseudoreflexa Zacharda, *Poecilophysis saxonica* (Willmann), *Robustocheles mucronata* (Willmann), ***Thoria brevisensilla*** Zacharda

Apsheron, Azerbajdzhanskaja SSR:

Poecilophysis pratensis (C. L. Koch)

Kamchatka peninsula, RSFSR:

Poecilophysis pratensis (C. L. Koch), ***Robustocheles mucronata*** (Willmann).

North Siberia:

Rhagidia gelida Thorell (cf. Zacharda, 1980: 560.), ? ***Poecilophysis spelaea*** (Wankel) (cf. Zacharda, 1980: 620–621.).

CONCLUSION

The examination of the Rhagidiidae from various parts of the USSR presented in this paper contributes to our knowledge of the biogeography of these soil mites. Many species mentioned here, e. g. *Foveacheles brevichelae, Poecilophysis pratensis, P. saxonica, Robustocheles mucronata, Coccorhagidia clavifrons, C. pittardi, Thoria brevisensilla*, are the genuine holarctic species. The discovery of *Evadorhagidia bezdezensis* and *Rhagidia punkva* corroborates the existence and taxonomic status of these species which have been known only from Czechoslovakia up to this time.

Of course, it is expected that the rhagidiids listed in this paper represent only a small fragment of the Rhagidiidae in the USSR. This view is supported by findings of nymphs of many other species which were found in the studied material and which could not be identified reliably.

Acknowledgement

I wish to thank Dr. M. Kunst, CSc., and Dr. J. Buchar, CSc., Department of Systematic Zoology, Charles University, Prague, who kindly enabled me my working stay in the mountains of the Central Caucasus in 1974 and 1976.

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Zacharda, M, 1980: Soil mites of the family Rhagidiidae (Actinedida: Eupodoidea). Morphology, systematics, ecology. *Acta Univ. Carol. Biol.*, (1978), 5–6: 489–785.

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Tembrock, G.: *Spezielle Verhaltensbiologie der Tiere. Band I: Funktionskreise. Wirbellose* (528 Seiten und 345 Abbildungen), 1982. DDR 84,00 M. *Band II: Wirbeltiere* (512 Seiten und 208 Abbildungen), 1983. DDR 82,00 M. Beide Bände 1. Auflage, Gustav Fischer Verlag, Jena, DDR.

Ein zweibändiges, vom Verfasser mit Verständnis des Verlages grosszügig konzipiertes und mit zahlreichen up to date Angaben versehenes Kompendium des Verhaltens der Tiere. Es gibt kaum ein ähnliches Werk der Verhaltensbiologie, dass so konsequent, in diesem Falle nach Funktionskreisen, die nach den Worten des Verfassers „die Modalitäten von Organismus-Umwelt-Interaktionen auf Grund Klasse (Modalität) des jeweils gegebenen Zustandsverhaltens kennzeichnen", und unter Druck der Evolution konzipiert ist. Einleitend werden im I. Band aus der Sicht der Verhaltensbiologie die „Allgemeine Bewegungsformen" im Tierreich geschildert (41 Seiten). Es folgt das Kapitel „Die Funktionskreise des Verhaltens" (108 Seiten), das dem Leser die Funktionskreise (Verhalten im Dienst der orientierung, Stoffwechselbedingtes Verhalten, Schutzbedingtes Verhalten, Intraspezifische Kompetition — Konkurieren, Migrationsverhalten, Biosozialverhalten, Spielverhalten und lernbedingtes Verhalten, Verhaltensontogenese) erörtert und so die Grundlagen für die folgenden Kapital der „Speziellen Ethologie" (360 Seiten) bildet. Es werden so die Funktionskreise der Protozoa, Parazoa, Coelenterata, Plathelminthes und Aschelminthes, der Mollusca, von den Gliedertieren die Funktionskreise der Annelida und Arthropoda („Oncopoda", Chelicerata, Crustacea, Myriapoda und Hexapoda) und die der Tentaculata behandelt. Band II ist der speziellen Ethologie der Wirbeltiere (Fische, Amphibia, Reptilia, Aves und Mammalia) gewidmet (269 Seiten) und enthält ein einmaliges Literaturverzeichnis (165 Seiten !), sowie Autorenregister, Tiernamenverzeichnis und Sachwörterverzeichnis. Jeder Tiergruppe ist eine kurze systematische Einleitung beigefügt. Der Text ist sachlich und kurz gefast, durch zahlreiche Literaturangaben objektivisiert und mit einfachen, übersichtlichen und aufklärenden Federzeichnungen bereichert. Bewusst ist der II. Band nur den Wirbeltieren gewidmet, da sich auf diese Tiergruppe dem Verfasser nach „schätzungsweise drei Viertel aller ethologischen Arbeiten beziehen", obwohl die Wirbeltiere „etwa nur ein Dreisigstel aller heute lebenden und bekannten Tierarten" darstellen. Die evolutive Bedeutung des Verhaltens ist ausschlaggebend, da zur Evolution der Struktur und Funktion oft die Änderung im Verhalten Impulse gibt. Diese Einheit von Bau, Funktion und Verhalten der tierischen Struktur begleitet konsequent das ganze Werk. Aus diesem Grunde ist dieses Lehrbuch nicht nur den Verhaltensforschern gewidment, es ist aber als Nachschlagewerk auch für alle Zoologen und Studenten der Zoologie unentbehrlich geworden.

Leo Sigmund

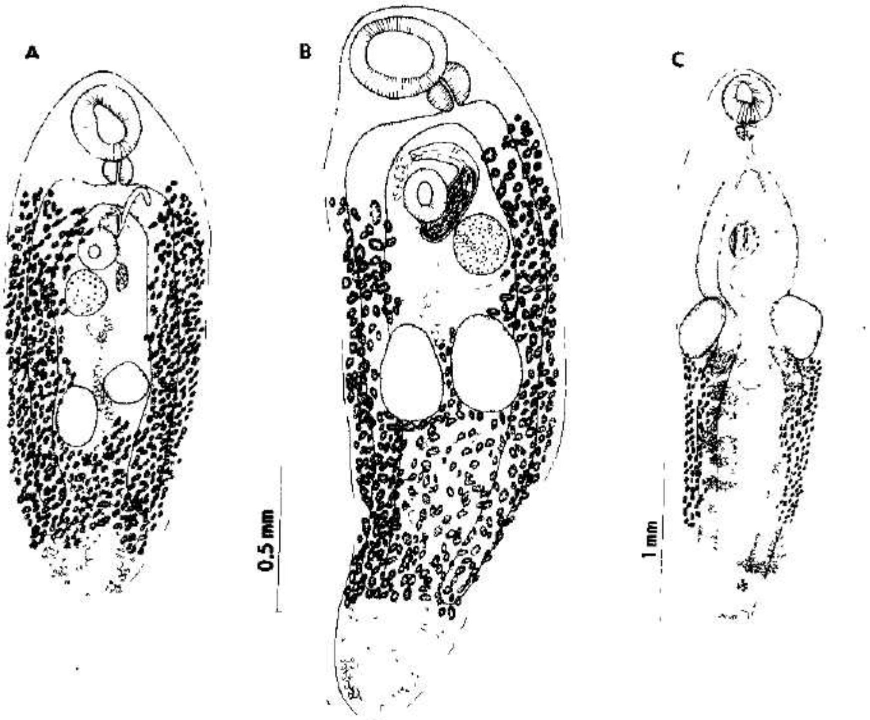


Fig. 1. A, B — *Plagiorchis (Metaplagiorchis) momplei* Dollfus, 1932 (A — from *Bufo regularis*, B — from *Rana mascareniensis*); C — *Anchitrema sanguineum* (Sonsino 1894).

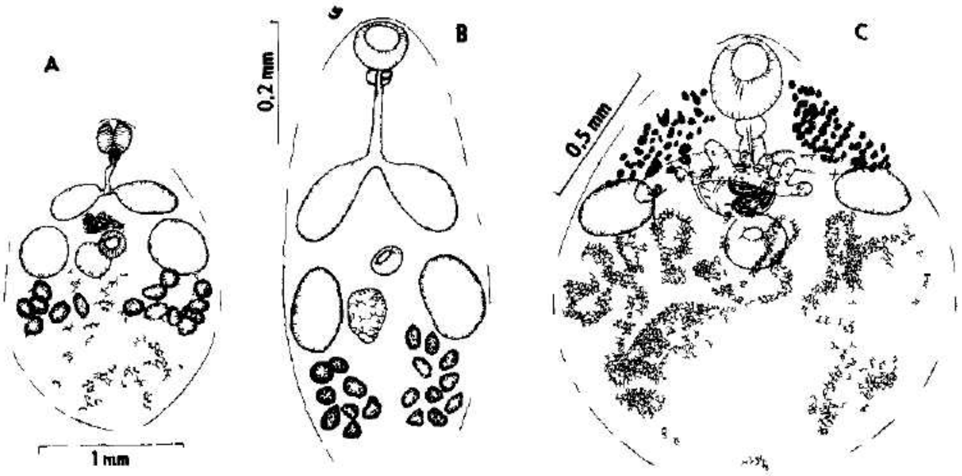


Fig 2 A – *Lecithodendrium hirsutum* (Looss, 1896), B — *Lecithodendrium* sp juv from *Hemidactylus turcicus*, C — *Prosthodendrium (Paralecithodendrium) obtusum* (Loos, 1896)

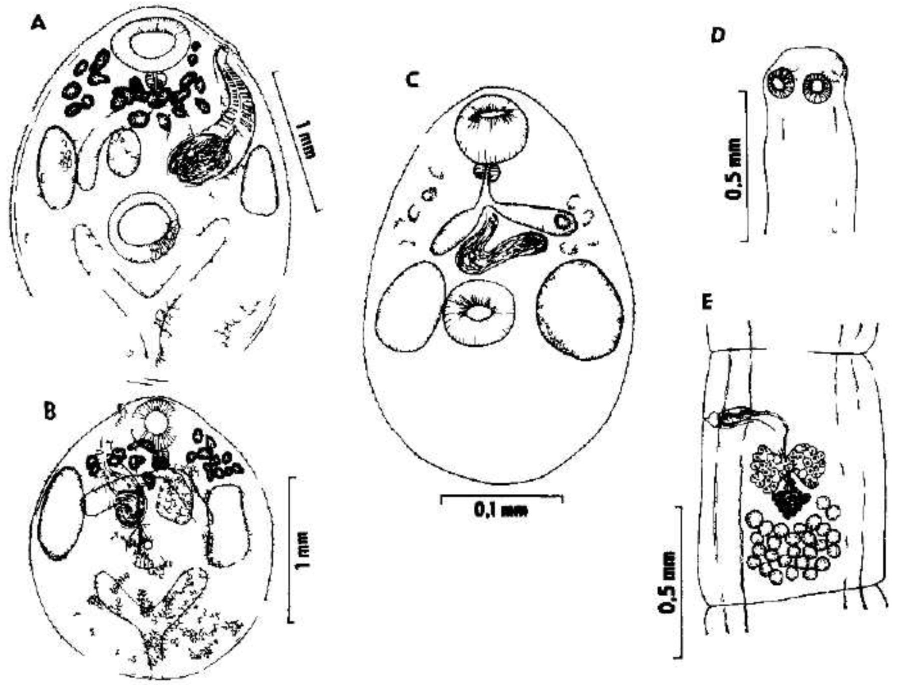
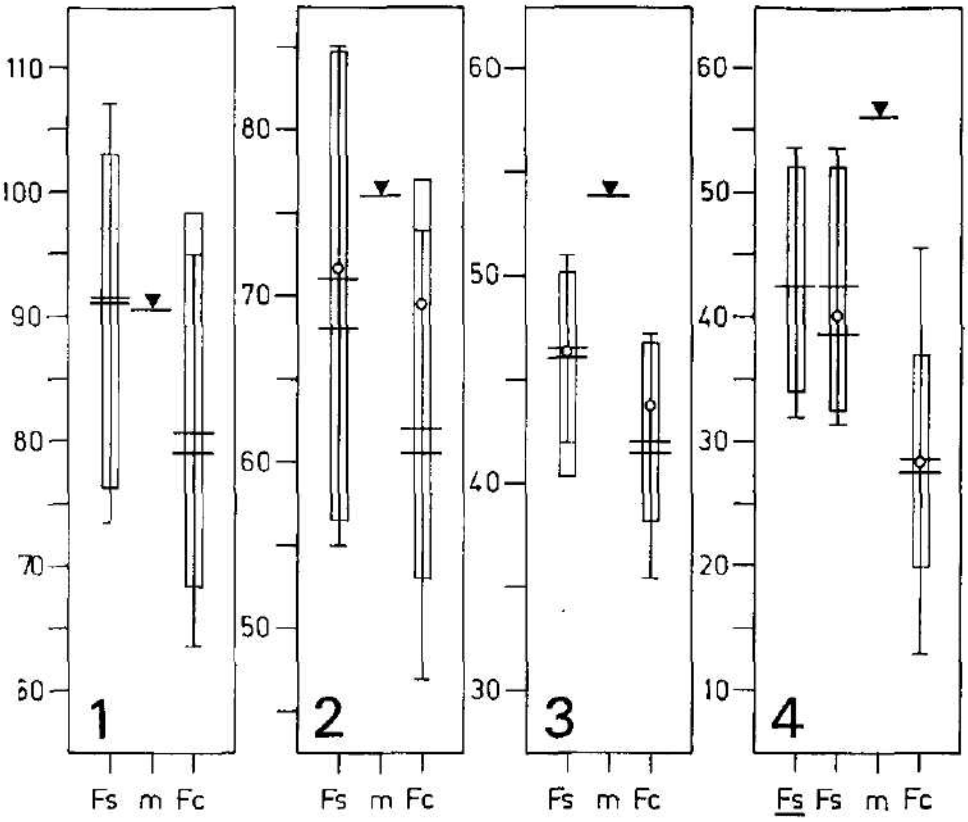
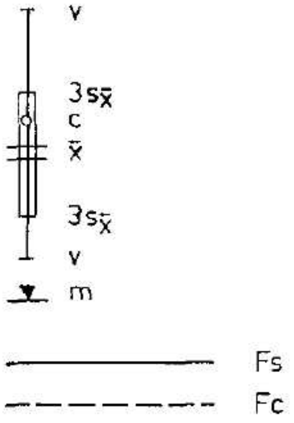


Fig 3 A B — *Pleurogenoides tener* (Loos, 1898) (A — from *Rana esculenta*, B — from *Chamaeleo chamaeleon*), C — *Lecithodendriidae* gen sp juv from *Ptyodactylus hasselquisti*, D, E — *Oochoristica tuberculata* (Rudolphi, 1819) from *Chalcides ocellatus* (D — scolex, E — mature segment)





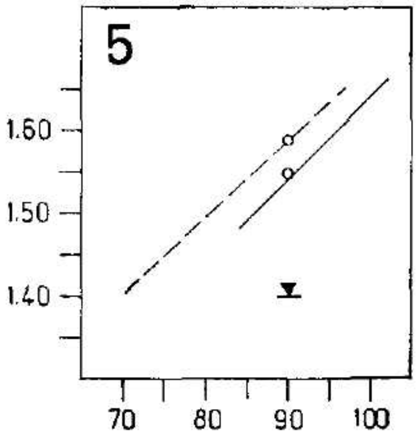


Fig. 1—4: Values of condylobasal length (1), zygomatic breadts (2), breadth of braincase (3) and braincase capacity (4) in *Felis silvestris* (Fs), *Felis catus* (Fc) and in skull described (m)

ig. 5. Ratio zygomatic breadth to breadth of braincase in material explored; bscisse. Cb-length. ordinate: ratio zygomatic breadth to breadth of braincase. xplanation to figs. 1—5: v — extreme values of variation stated in various mples see Heráň and Porkert, 1976). $3 s_{\bar{x}}$ — extreme values of theoretical

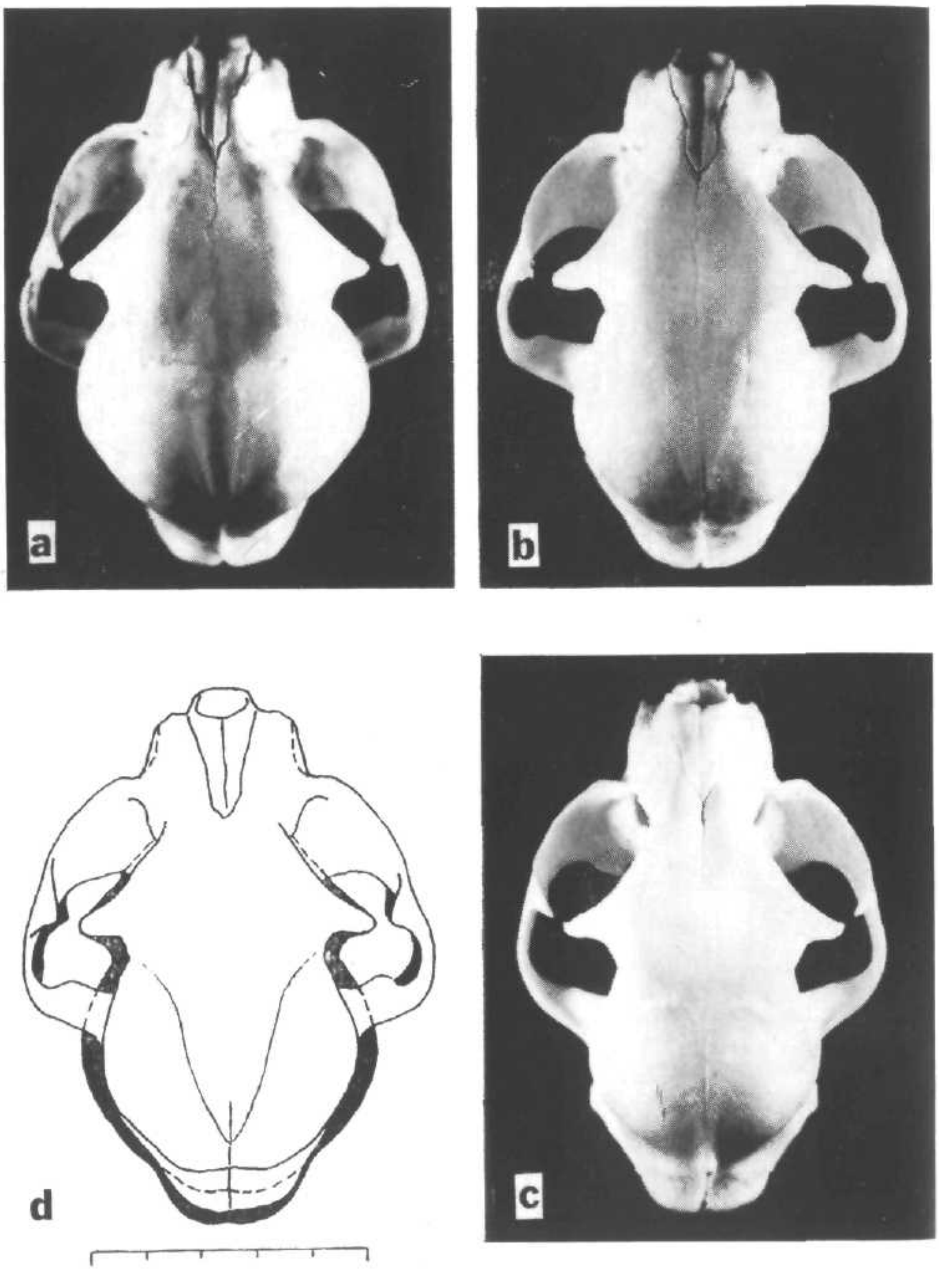


Plate I: Comparison of skull described (a) with equally sized skulls of *Felis silvestris* (b) and *Felis catus* (c); vertical view. d. — combined outline drawing of skulls a (shaded contour, dotted line) and b; vertical projection, scale represents the length of 50 mm.
(Figs. by I. Heráň)

Tonner M., Vávra Vl., Syrovátka O., Soldán T.: Einfluss der Luftbespritzung gegen den Grauen Lärchenwickler auf die Entomofauna des Rhithrons in Krkonoše

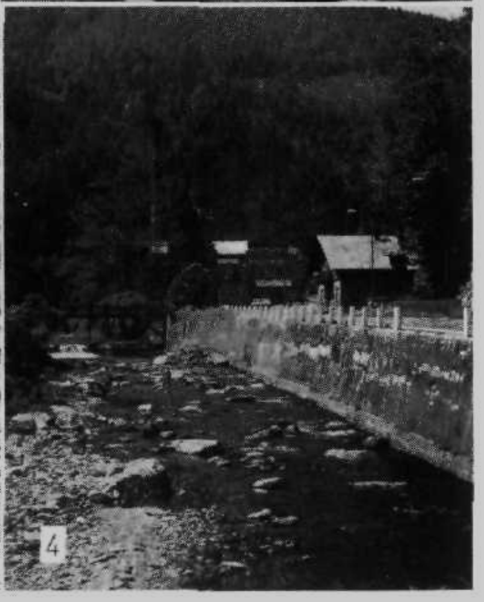


Abb. 1. Luftbespritzung der Fichtenbestände gegen den Grauen Lärchenwickler in der Tal Zelený důl.
Abb. 2. Das Driftnetz an der Lokalität (Zelený důl)
Abb. 3. Eine von den bespritzten Lokalitäten, Bach Zelený in Zelený důl.
Abb. 4. Úpa, Horní Maršov, eine unbespritzte Lokalität, wo die Driftproben entnommen wurden.

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