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ERSTER FUND DES NEMATODEN PTERYGODERMATITES KOLIMENSIS (GUBANOV ET FEDOROV, 1967) IN NAGETIEREN DER FAMILIE MICROTIDAE IN DEN ÖTZTALER ALPEN — ÖSTERREICH

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Eingegangen am 18. Mai 1971

Abstrakt: Bei dem Studium der Helminthenfauna über Nagetiere in den Ötztaler Alpen (Tirol) sind bei *M. nivalis* und *Cl. glareolus* Nematoden aus der Familie Rictulariidae gefunden. Systematisch gehören diese in die Gattung *Pterygodermatites* Wedl, 1861. Vom zoogeographischen Gesichtspunkt aus, handelt es sich um einen sehr interessanten Fund und zwar deshalb, weil die festgestellte Art *P. kolimensis* bisher nur aus dem sibirischen Teil der UdSSR (Jakutsk) bekannt ist. Dort wurde sie bei den Nagetieren aus den Gattungen *Microtus*, *Clethrionomys* und *Myopus* festgestellt. In unserem Material kam die Art *P. kolimensis* bei zwei neuen Wirten vor (*M. nivalis*, *Cl. glareolus*), die in der alpinen Zone des europäischen Teiles des paläarktischen Gebietes — in den Ötztaler Alpen gefangen wurden.

Da der Nematode *P. kolimensis* bei neuen Wirten festgestellt wurde, ist es notwendig die ursprüngliche Beschreibung dieser Art, wie sie Gubanov und Fedorov (1967) anführen, in einigen Details zu präzisieren, und im Weiteren geben wir eine eingehende Redeskription nach unserem eigenen Material.

BESCHREIBUNG DES FESTGESTELLTEN MATERIALS

Pterygodermatites kolimensis (Gubanov et Fedorov, 1967)

Synonym: *Rictularia kolimensis* Gubanov et Fedorov, 1967.
Wirte und Lokalitäten: a) *Microtus nivalis*, Obergurgl — Hohe Mut, 2670 m, b) *Clethrionomys glareolus*, Obergurgl, 2000 m.
Lokalisierung in den Wirten: Dünndarm.
Material: Bei zwei *M. nivalis* wurden 4 und 28 Nematoden festgestellt; 1 Männchen — die übrigen Weibchen; in zwei *Cl. glareolus* wurden je ein Exemplar festgestellt, beide Stücke waren Weibchen.

Material aus der Schneemaus *M. nivalis* (Martins, 1842):

Es sind dies Nematoden mittlerer Grösse, gelblicher Farbe. Die Kutikula ist deutlich quer gerillt. Die Mundöffnung ist mehr apikal situiert, umgeben von einem Kranz von 18—20 Zähnchen mit scharfen Spitzen. Der innere Kranz der zephalischen Papillen wird von sechs deutlichen Papillen und zwei amphidamen gebildet, den äusseren Kranz bilden 8 Papillen die in Paaren verteilt sind. Die Mundkapsel hat deutliche pseudochitinisierte Wände. Aus dem Boden treten 3 Schlundzähne mit fein gezahntem Kamm heraus. Der Schlund ist in einen muskulösen vorderen und einen drüsigen hinteren

Teil geteilt. Über die ganze Körperlänge ziehen sich in lateroventralen Linien 2 Reihen kutikularer dornartiger Elemente hin. Die zervikalen Papillen sind zwischen dem 6. und 7. Dorn angebracht.

Männchen: Der Körper ist 10,6 mm lang und am Niveau des Schlundendes 0,33 mm breit. Die Mundkapsel ist 0,058 mm tief und maximal 0,087 mm breit. Das Nervenganglion ist 0,037 mm und die zervikalen Papillen sind 0,58 mm von dem vorderen Körperende situiert. In der Längslinie sind ingesamt 44 Kutikulardorne vorhanden. Die Länge des ersten Dornes misst

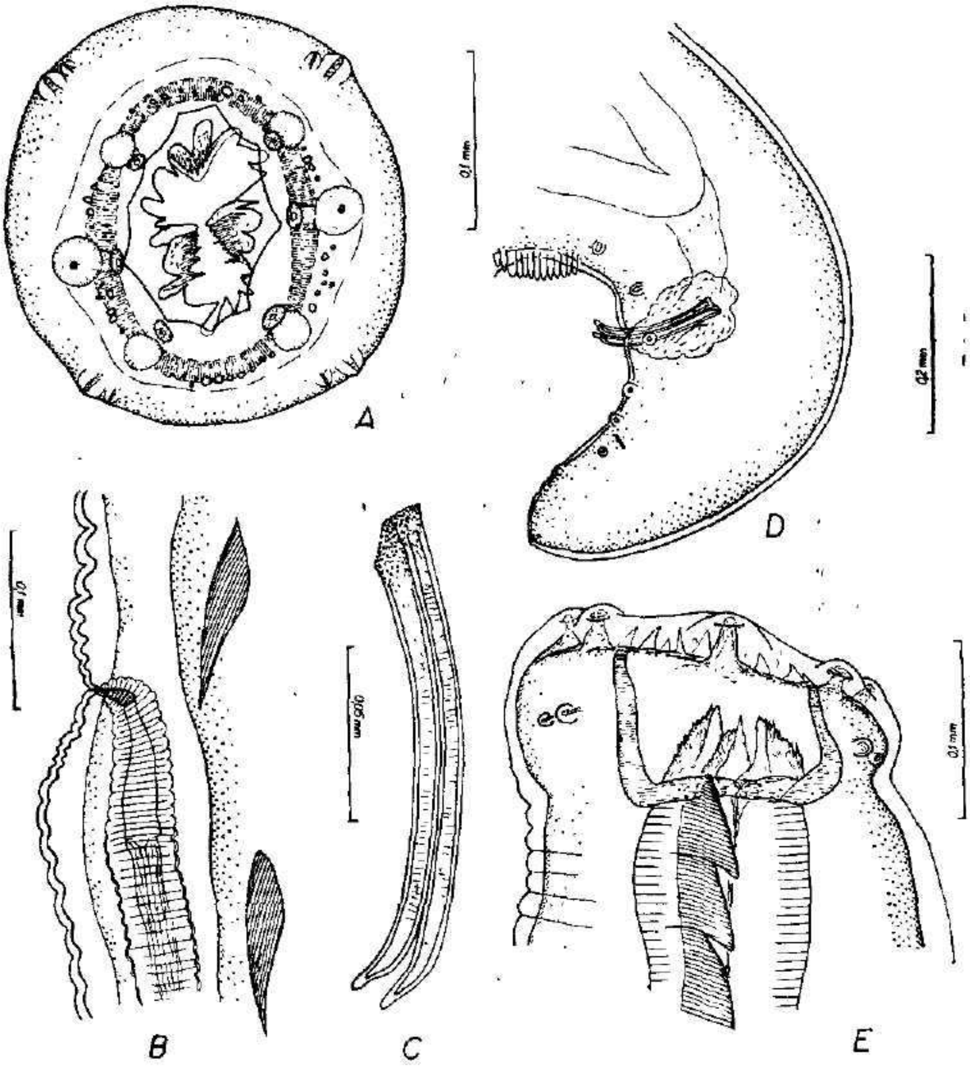

Abb. 1: *Pterygodermatites kolimensis* (Gubanov et Fedorov, 1967) aus dem Dünndarm des Wirtes *Microtus nivalis*. A — Vorderer Körperteil des Weibchens (apical); B — Bereich der Vulva (lateral); C — Spikula (lateral); D — Hinterer Körperteil des Männchens (lateral); E — Vorderer Körperteil des Weibchens (lateral). Original.

0,051 mm, die des zwanzigsten 0,16 mm und die des letzten 0,11 mm. Der Schlund ist 2,34 mm lang und maximal 0,11 mm breit. Das hintere Körperende ist abgerundet. Die Kloake hat mässig austretende Ränder und ist in einem Abstand von 0,25 mm von dem Schwanzende gelegen. Kaudale Papillen sind insgesamt 9 Paare vorhanden. Von diesen sind 2 praekloakal, eine parakloakal und 6 postkloakal situiert. Anwesend sind 2 Spikula gleicher Länge und Form. Sie sind 0,135 mm lang und in ihrem proximalen Teil 0,007 mm breit.
Weibchen: Der Körper ist 18,06—22,74 mm lang und am Niveau des Schlundendes 0,39—0,47 mm breit. Die Mundkapsel ist 0,080—0,109 mm tief und maximal 0,109—0,131 mm breit. Der dorsale Schlundzahn ist 0,043—0,050 mm lang. Das Nervenganglion ist in einem Abstand von 0,43—0,47 mm, und die zervikalen Papillen sind 0,50—0,73 mm vor dem vorderen Körperende gelegen. Die Gesamtlänge des Schlundes misst 2,44 bis 3,27 mm, der muskulöse Teil ist 0,62—0,83 mm lang. Die Vulva hat mässig austretende Ränder und ist in einem Abstand von 2,65—3,90 mm von dem vorderen Körperende angebracht. Die Eier haben eine glatte und dicke Umhüllung. Sie messen 0,035—0,039 mm × 0,022—0,026 mm. Sie enthalten eine eingedrehte Larve. Das hintere Körperende ist kegelförmig. Der Anus befindet sich 0,47—0,61 mm von dem Schwanzende entfernt. Die Zahl der kutikularen Dorne ist in der Längslinie 64—65, von diesen praevulvar 32—33; postvulvar 32 situiert. Die Länge des ersten Dornes beträgt 0,058 mm, die letzte 0,138 mm.

Material aus *Cl. glareolus* (Schreber, 1780):

Im Hinblick darauf, dass von den zwei festgestellten Weibchen eines juvenil ist, sind auch die durchschnittlichen Abmessungen des Körpers geringer. Ihr Körper ist 10,6—16,22 mm lang. Am Niveau des Schlundes 0,32—0,46 mm breit. Die Mundkapsel ist 0,058—0,080 mm tief und maximal 0,083—0,116 mm breit. Der Schlund ist 1,56—2,88 mm lang und maximal 0,12—0,14 mm breit. Die Vulva misst 2,18—2,96 mm, das Nervenganglion 0,36 mm und die zervikalen Papillen sind 0,54 mm vor dem vorderen Körperende zu finden. Betreffend die morphologischen Merkmale ist das Material der Art *P. kolimensis* aus *Cl. glareolus* zur Gänze übereinstimmend mit dem Material aus *M. nivalis*. Auch die Zahl der Mundzähnchen (18—20), der Schlundzähnchen (3) und die Anzahl der praevulvaren Dorne (32) sowie der postvulvaren Dorne (32) sind mit dem Material aus *M. nivalis* identisch.

DISKUSSION

Die Art *P. kolimensis* (Gubanov et Fedorov, 1967) wurde ursprünglich in das Genus *Rictularia* Froelich, 1802, eingereiht. Quentin (1969) analysierte die Systematik der Familien Rictulariidae und kam zu dem Schluss, dass die Art *R. kolimensis* in das Genus *Pterygodermatites* Wedel, 1861, und in das Subgenus *Paucipectines* Quentin, 1969, gehört.

Unser Material der Art *P. kolimensis* weist im Vergleich mit der ursprünglichen Beschreibung eine ausdrucksvolle morphologische und metrische Übereinstimmung auf. Dennoch haben wir einige Fakten festgestellt, welche die Individuen, die wir in *M. nivalis* und *Cl. glareolus* festgestellt haben, sich von den Individuen unterschieden, die aus Nagetieren aus Sibirien bekannt sind (siehe Gubanov et Fedorov). Solche Merkmale sind:

1. Die Anwesenheit der drei Schlundzähne (in der ursprünglichen Beschreibung sind nur 2 angeführt).
2. Die Anwesenheit eines Paares parakloakaler Papillen (in der ursprünglichen Beschreibung sind diese nicht angeführt).

Wir haben leider keine Möglichkeit Vergleichsmaterial der Art *P. kolimensis* aus den ursprünglichen Wirten zu erhalten.

Daher nehmen wir an, dass die vorherangeführten Merkmale bei der Zusammenstellung der ursprünglichen Beschreibung übersehen wurden und legen diesen nicht den Wert bei, der auf Grund der neuen Taxonomie in Betracht gezogen werden könnte. Der Vollständigkeit halber führen wir an dass aus dem Subgenus *Paucipectines* Quentin, 1969, von den Nagetieren der Familie Muridae und Microtidae — ausser der Art *P. kolimensis* noch 3 weitere Arten bekannt sind und zwar *P.* (*P.*) *quinqueflabellum* (Sadovskaja, 1965), *P.* (*P.*) *baicalensis* (Spasskij, Ryžikov, Sudarikov, 1952) und *P.* (*P.*) *sibiricensis* (Morozov, 1959). Es handelt sich um Arten, die morphologisch und metrisch merklich verwandt sind und deren Unterscheidung in der gegenwärtigen Zeit vor allem nur auf Grund des Materials der Männchen möglich ist und zwar nach den Spikulalängen und ihres Verhältnisses. Bei einigen Arten und zwar bei: *P. quinqueflabellum*, *P. baicalensis* und *P. kolimensis* sind die Spikula gleich lang. Bei der letztgenannten Art messen sie 0,079 mm, bei den weiteren 0,026 mm und bei der letzten 0,132—0,136 mm. Ungleiche Spikulalängen sind nur bei der Art *P. sibiricensis* bekannt — die kürzeren Spikula messen 0,053 mm, die längeren 0,106 mm. Zur Unterscheidung aller vorgenannten Arten können auch einige weitere Merkmale verwendet werden, die für die einzelnen Arten unterschiedlich sind. Es sind dies z. B. einige Körperabmessungen, die Form der Schlundzähne, evtl. auch der Unterschied in der Anzahl der kutikularen Dorne. Das letztgenannte Merkmal zeigt sich jedoch zu der Unterscheidung der Arten als weniger ausdrucksvoll.

Zu der vorher angeführten Problematik bemerken wir überdies, dass Dimitrova, Genov, Karapshanski (1962) im *M. nivalis* in Bulgarien (im Pirin-Gebirge), ein Exemplar eines Weibchens feststellten, das als *Rictularia sibiricensis* Morozov, 1956 (= *Pterygodermatites sibiricensis*) bestimmt wurde. Im Hinblick auf die vorangeführten Fakten, welche die Unterscheidung der einzelnen Arten aus der Gattung *Pterygodermatites* betreffen, muss bemerkt werden, dass sich nach dem Material der Weibchen zur Zeit die Arten *P. kolimensis* und *P. sibiricensis* nicht exakt unterscheiden lassen. Unterschiede sind nur bei den Männchen (siehe Text vorher). Auf Grund des Materials der Männchen ist es notwendig, in Zukunft die Existenz der Art *P. sibiricensis* in Bulgarien nachzuweisen. Andererseits ist es notwendig zu überprüfen, ob in Bulgarien in *M. nivalis* auch die Art *P. kolimensis* schmarotzt.

Wenn auch ausführlichere Angaben über die Ausbreitung der Art *P. kolimensis* bisher fehlen, kann real angenommen werden, dass es sich um ein boreo — alpines Element handelt.

Eine ähnliche Analogie finden wir z. B. bei einigen Floharten von Nagetieren. Rosický (1957, 1966) weist diesen Fall für die Art *Megabothris rectangulatus* (Wahlgren, 1903) nach, die sich in den österreichischen Alpen (in Nordtirol, Salzburg) und in der Tatra bei den Wirten *Microtus nivalis* Schafer, *Pitymys tatricus* Krat., *M. agrestis* L., und *Clethrionomys glareolus* Schr. als glaziales Relikt erhalten hat.

ZUSAMMENFASSUNG

1) Die Studie handelt von der Feststellung der Art *Pterygodermatites kolimensis* (Gubanov et Fedorov, 1967) in *M. nivalis* und *Cl. glareolus* — Ötztaler Alpen (Tirol) Österreich.

2) Festgestellt wurde, dass die ursprüngliche Beschreibung dieser Art vieleicht ungenau war und zwar im Hinblick darauf, dass bei dem Material der Art *P. kolimensis* aus den Ötztaler Alpen (Tirol) 3 Schlundzähne festgestellt wurden (in der ursprünglichen Beschreibung sind nur 2 angeführt), sowie die Anwesenheit eines Paares parakloakaler Papillen, die in der ursprünglichen Beschreibung nicht angeführt sind.

3) In der Arbeit wird darauf hingewiesen, dass es heute sehr schwierig ist, nur auf Grund der Kenntnisse des Materials der Weibchen die einzelnen Arten des Genus *Pterygodermatites* Wedel, 1891, sensu Quentin, 1969 zu unterscheiden.

4) Die Analyse der Merkmale zeigte, dass es nich ausgeschlossen ist, dass die Art *P. kolimensis* auch bei *M. nivalis* in Bulgarien schmarotzt. Dort sind Funde von Weibchen der Art *P. sibiricensis* angeführt, die sich jedoch zur Zeit von den Weibchen der Art *P. kolimensis* nicht genau unterscheiden lassen.

5) Die Wirte *Microtus nivalis* und *Clethrionomys glareolus* sind für die Art *P. kolimensis* gänzlich neue Wirte und zwar deshalb, weil diese Art bis jetzt nur aus dem sibirischen Teil der UdSSR (Jakutsk) bekannt war und zwar bei anderen Arten aus dem Genus *Microtus*, *Clethrionomys* und *Myopus*.

Abschliessend danken wir dem Institut fur Zoologie und der Alpinen Forschungsstelle Obergurgl der Universitat Innsbruck Vorstande: Univ. Prof. Dr. H. Janetschek und Univ. Prof. Dr. W. Heissel fur die bereitwillige Unterstutzung dieser Arbeit.*)

LITERATUR

Dimitrova E., T. Genov, I. Karapchanski, 1962: The helminth fauna of rodents in the Petrich and Gotse Delchev areas. *Bulgar. Akad. Nauk. Biol.* 6: 81—120.

Gubanov N. M., K. P. Fedorov, 1967: Novyje vidy gelmintov ot myševidnych gryzunov Jakutii. Materialy k nauč. konf. Vsesojuz. obšč. gelm. dkabr. 1966 : 117—126.

Morozov Ju. F., 1959: Dva novych vida nematod ot gryzunov. *Trudy gelm. labor. AN SSSR* 9: 196—202.

Quentin J. C., 1969: Essai de classification des nematodes rictulaires. *Mem. Mus. Nat. Hist. Nat., ser. A. Zool.* 2: 55—115.

Rosický B., 1957: Fauna ČSR, sv. 10. Blechy — Aphaniptera. Nakl. ČSAV Praha, pp. 1—439.

Rosický B., 1966: On the structure of the distribution area of flea species (Aphaniptera) of the superfamily Ceratophylloidea. *Fol. parasit.* (Praha) 13 (1) : 64—72.

Sadovskaja N. P., 1954: Parazitičeskije červi gryzunov i nasekomojadnych Primorskogo kraja. *Tr. gelm. lab. AN SSSR* 7: 388—390.

Spasskij A. A., K. M. Ryzikov, V. E. Sudarikov, 1952: Gelmintofauna dikich mlekopitajuščich zony ozera Bajkal. *Tr. gelm. lab. AN SSSR* 6: 85—113.

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*) Die Sammlungen fuhrte Kristian Pfaller im Rahmen der Verbreitungen seiner Dissertationsarbeit durch.

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THE SYSTEMATIC POSITION AND THE DISTRIBUTION OF NEMATODES OF THE GENUS CRENOSOMA MOLIN, 1861 PARASITIC IN THE HEDGEHOG (ERINACEUS EUROPAEUS)

VLASTIMIL BARUŠ AND JAN PROKOPIČ

Received June 1, 1971

Abstract: *An analysis has been made of the taxonomic position of nematodes of the genus Crenosoma, parasitizing hosts of the genus Erinaceus.* Two species of crenosomes were identified in the area of distribution of these hosts; these are *C. striatum* and *C. lophocara*. The differentiating characters of these species and their geographical distribution are discussed. The form *C. caucasicum* Rodonaja, 1956 has been placed in synonymy with the species *C. lophocara* Gerichter, 1951.

Adult nematodes of the genus *Crenosoma* Molin, 1861 exhibit considerable host specificity to members of the orders *Carnivora* and *Insectivora* (see Dougherty 1945; Kontrimavičus 1969). The lungs of hosts of the genus *Erinaceus* L. are parasitized by three *Crenosoma* species: *C. striatum* (Zeder, 1800), *C. lophocara* Gerichter, 1951 and *C. caucasicum* Rodonaja, 1956. The taxonomic revision of the latter species *C. caucasicum* (the material was obtained by courtesy of Dr. G. V. Macaberidze), revealed the necessity of placing this species in synonymy with the species *C. lophocara*. The species *C. striatum* was studied on extensive material collected in Czechoslovakia.

RESULTS

Fam. *Crenosomatidae*

1. *Crenosoma striatum* (Zeder, 1800) (Fig. 1 F, G)

Syn.: *Strongylus striatum* Zeder, 1800; *Filaria erinacei* Rudolphi, 1819; *Strongylus erinacei* (Rudolphi, 1819) Diesing, 1851.

Dougherty (1945) stated in his comprehensive survey that *C. striatum* is the oldest species known of the genus *Crenosoma*. This species was first discovered by Redi (1684) and later described by Zeder (1800) under the name *Strongylus striatum*. Molin (1861) assigned it to the new genus *Crenosoma*, in which this species is the genotype. The species described by Rudolphi (1819) as *Filaria erinacei*, was placed by Stossich (1898) in synonymy with *Crenosoma striatum*. The definitive hosts of this species are *Erinaceus europaeus europaeus* L. and *E. europaeus centralrossicus* Ognev, 1926. The species is a member of the European fauna (the typical locality seems to be Germany).

A detailed modern redescription of this taxon was given by Skrjabin and Petrow (1928). In connection with the development of helminthology in Europe, this species was recorded more frequently within the last twenty years. Stammer (1955) reported this species from Germany, Prokopič (1957, 1959) and Mituch (1964) from Czechoslovakia, Furmaga (1961) from Poland, Dollfus (1961) from France, Karasev (1966) and Merkuševa (1966) from the Belorussian S.S.R., Viktorov, Golovin and Savinov (1964) from the Kalinin area, Davydov (1963) from the Ukrainian S.S.R. and Kadenacii (1957) from the Crimea. In addition to the subspecies *E. europaeus europaeus* and *E. europaeus centralrossicus*, also *E. europaeus roumanicus* Barret-Hamilton, 1900 was confirmed as the host of *C. striatum*.

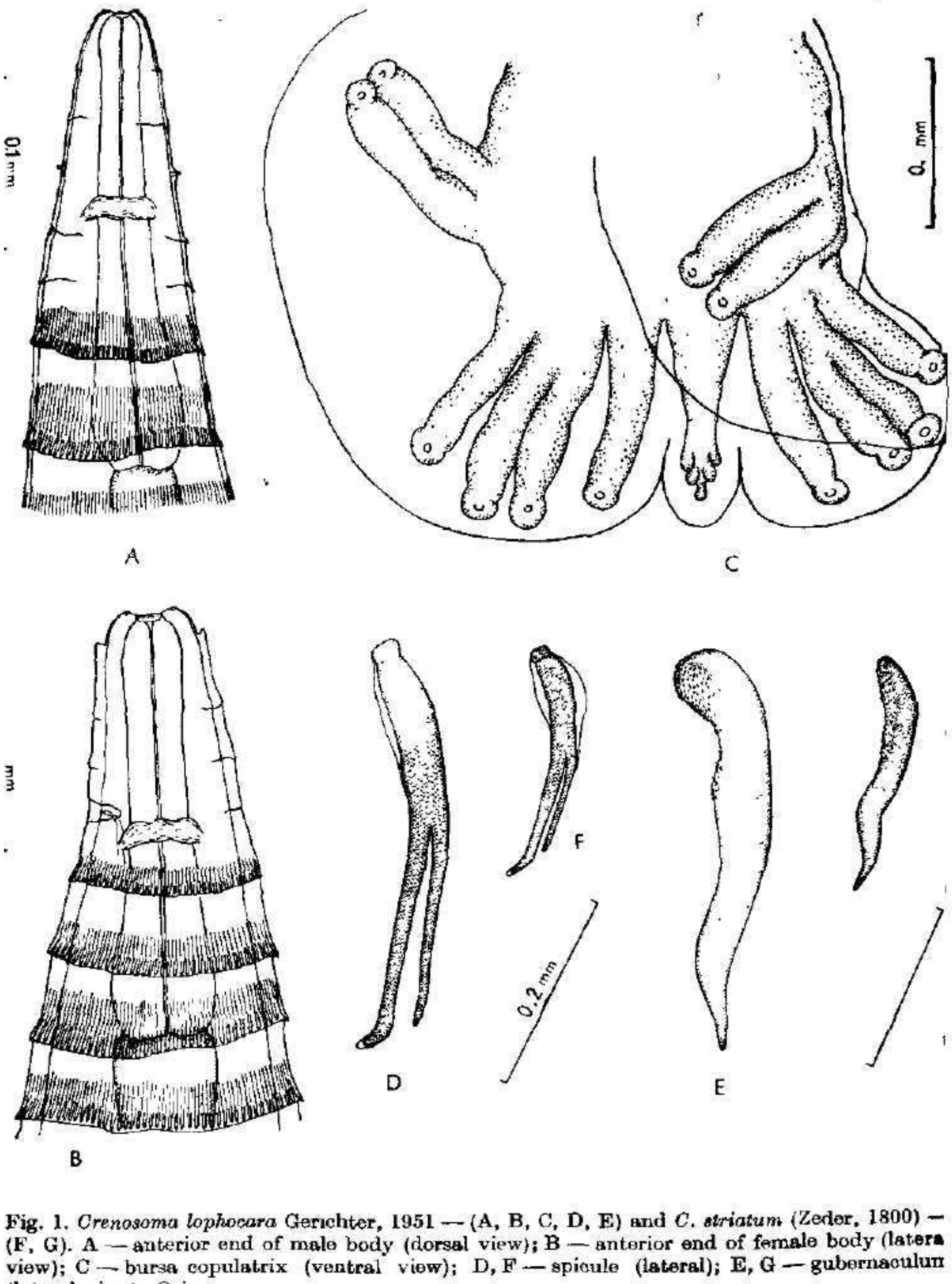

Fig. 1. *Crenosoma lophocara* Gerichter, 1951 — (A, B, C, D, E) and *C. striatum* (Zeder, 1800) — (F, G). A — anterior end of male body (dorsal view); B — anterior end of female body (lateral view); C — bursa copulatrix (ventral view); D, F — spicule (lateral); E, G — gubernaculum (lateral view). Orig.

Morphologically and biometrically, our material from the host *E. europaeus europaeus* from Czechoslovakia is in complete agrement with the redescription by Skrjabin and Petrow (1928) based on material of *E. europaeus* (ssp. *centralrossicus*) from the European parts of the U.S.S.R. Therefore, we refrained from giving a complete description of this species based on our own material. In our opinion, the most important characters of this species are: the spicule length (0.17—0.24 mm); the gubernaculum length (0.073 to 0.087 mm) and the size of the eggs (0.073—0.082 × 0.042 — 0.048 mm). Another important character is the ratio of the length of the dorsal branch of the spicule to the length of the undivided part of the spicule (the dorsal branch of the spicule is always shorter than the undivided portion of the spicule).

2. *Crenosoma lophocara* Gerichter, 1951 (Fig. 1 A—E)

Syn.: *Crenosoma caucasicum* Rodonaja, 1956

Gerichter's (1951) original description of this species is based on material from the hosts *E. europaeus transcaucasicus* Satunin, 1905 (= *E. roumanicus sacer* Thomas, 1918) from northern Syria (no closer determination of the locality). Rodonaja (1956) described the species *C. caucasicum* from the host *E. europaeus transcaucasicus* from Georgia (the natural reservation of Lagodech). Macaberidze (1966, 1967), using the same designation for this species (*C. caucasicum*), reported findings from eastern Georgia. Our morphological and metrical analysis based on material from Georgia (locality Samslo-Bakurini) disclosed that the form described

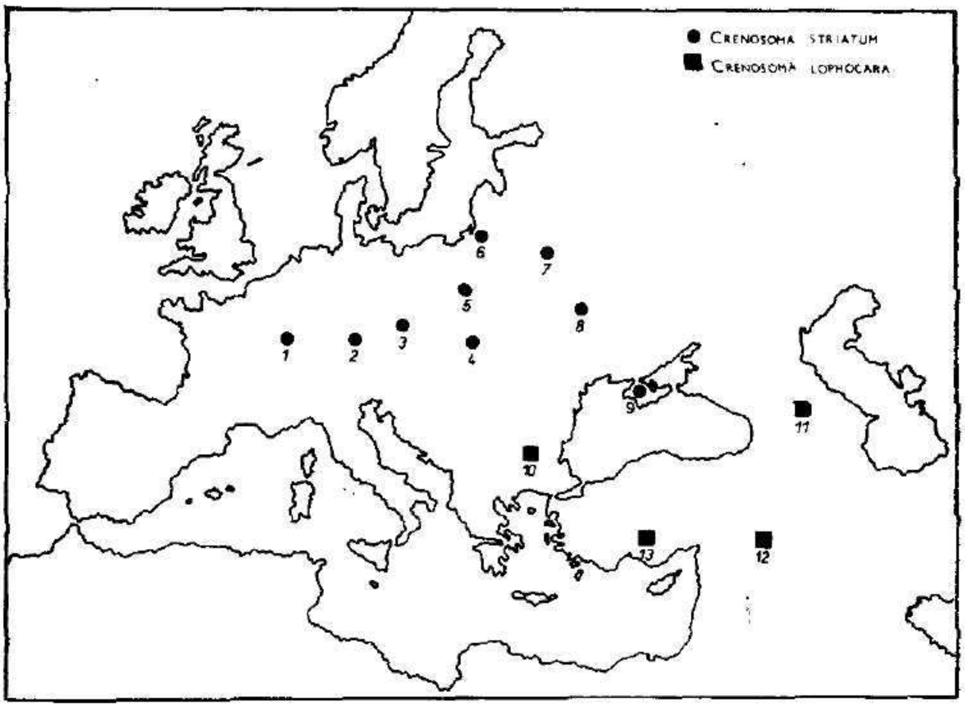

Fig. 2. Survey of findings of the species *Crenosoma striatum* (no. 1—9) and *C. lophocara* (no. 10 to 13). 1 — France; 2 — Germany; 3 — Czechoslovakia (Bohemia); 4 — Czechoslovakia (Slovakia); 5 — Poland; 6 — Kalinin district; 7 — Belorussian S.S.R.; 8 — Ukrainian S.S.R.; 9 — Crimea (?); 10 — Bulgaria; 11 — Georgian S.S.R.; 12 — Syria; 13 — Turkey (?).

Table 1. A survey of the most important measurements of the males of the species *Crenosoma striatum* (Zeder, 1800) and *C. lophocara* Gerichter, 1951 (in mm)

Species	*Crenosoma striatum*		*Crenosoma lophocara*		
Authors	Skrjabin and Petrow (1928)	our data	Gerichter (1951)	Rodonaja (1956)	our data
body length	5.0—6.75	5.30—6.70	5.6—6.3	7.2—8.0	6.55—7.33
maximum width	0.24	0.16—0.18	0.27—0.31	0.32—0.33	0.22—0.33
oesophagus length	—	0.21—0.24	0.24—0.31	0.24—0.30	0.23—0.26
spicule length	0.24	0.17—0.22	0.33—0.37	0.356—0.360	0.33—0.39
gubernaculum length	0.085	0.073—0.087	0.11—0.12	0.10—0.12	0.11—0.12

by Rodonaja (1956) as *C. caucasicum* is identical with the species *C. lophocara* and, hence, its synonym.

Dimitrova and Genov (1961) found an infection of *E. europaeus roumanicus* with *C. striatum* in Bulgaria. As indicated by the spicule length (0.35—0.42) their material contained the species *C. lophocara*. Schad, Kuntz and Wells (1960) recorded the finding of crenosomes in *Erinaceus europaeus concolor* Martin, 1833 from Turkey. Although these authors did not describe this material it appears that the species concerned was *C. lophocara*.

We are adding a brief redescription of *C. lophocara* based on the material from Georgia (we measured 10 ♂♂ and 10 ♀♀): nematodes of whitish colour. The body moderately attenuated towards both ends. Cuticle with distinct longitudinal and transverse striation. Cuticular combs present on the cuticle in both sexes, being more distinct in the anterior, less distinct in the posterior portion of the body. Mouth circular, surrounded by 6 papillae on the inner circle and 4 papillae and 2 amphids on the outer circle. Buccal cavity small. The cuticle shows a distinct groove at the site of the excretory pore. Cervical papillae close under the nerve ring.

The bursa copulatrix of the male has a small dorsal lobe and two wide lateral lobes. The dorsal rib divided in its distal part into one median and two externolateral extensions. The mediolateral and posterolateral ribs proceed in parallel direction, the externolateral rib follows its individual

Table 2. A survey of the most important measurements of the females of the species *Crenosoma striatum* (Zeder, 1800) and *C. lophocara* Gerichter, 1951 (in mm)

Species	*Crenosoma striatum*		*Crenosoma lophocara*		
Authors	Skrjabin and Petrow (1928)	our data	Gerichter (1951)	Rodonaja (1956)	our data
body length	12.0—13.0	9.51—12.94	13.3—15.6	14.6	10.92—14.03
maximum width	0.34	0.22—0.33	0.42—0.44	0.40	0.52—0.56
oesophagus length	—	0.21—0.27	0.31—0.33	0.28—0.30	0.26—0.29
vulva-anterior body end	anterior half of body	3.12—4.83	anterior half of body	anterior half of body	3.12—4.68
anus	0.22	0.16—0.21	0.16—0.20	0.18	0.21—0.24
eggs	0.082 × 0.048	0.073—0.078 × 0.042—0.047	0.056—0.067 × 0.043—0.051	—	0.062—0.068 × 0.041—0.046

course. The ventral ribs run in parallel direction. The spicules are equal in length and shape, well pseudochitinized. The length of the undivided part of the spicule is 0.124—0.167 mm. The dorsal extension of the spicule is 0.182—0.197 mm long. Gubernaculum present. (For measurements of the male see Table 1).

The posterior end of the female's body is cone-shaped. Two distinct tail papillae are at 0.029—0.043 mm from the tip of the tail. The vulva is situated in the anterior portion of the body. The uteri are occupied by eggs containing a coiled larva. (For measurements of the female see Table 2).

DISCUSSION

The results of our analysis indicate that hosts of the genus *Erinaceus* are parasitized by 2 nematode species of the genus *Crenosoma* (*C. striatum* and *C. lophocara*) in the area of their distribution. According to data in the literature *C. striatum* occurs not only in the western subspecies of *E. europeaus*, but also in the so-called eastern subspecies of this host found in the European part of its area of distribution. The Asian subspecies of *E. europaeus* are hosts of the species *C. lophocara* (Fig. 2). It has been impossible as yet to draw an exact line of contact between these nematode species, because morphological and metrical data on crenosomes mainly from the area of distribution of the host *E. europaeus roumanicus* are still incomplete.

Both nematode species (*C. striatum* and *C. lophocara*) show considerable similarity in their morphology. They can be distinguished reliably from one another by the size of their spicules and the gubernaculum of the males (see Table 1) and by the ratio of length of the dorsal extension of the spicules to the undivided part of the spicule (see Fig. 1 D, F) and the shape of the gubernaculum (see Fig. 1 E, G). Less distinct are metrical differences in the eggs of both species.

REFERENCES

Davydov, O. N., 1963: Materialy k gelmintofaune nasekomojadnych USSR. *Problemy parazitologii AN USSR (Kijev)* : 182—183.

Dimitrova, E., T. Genov, 1961: Chelmintofaunata na *Erinaceus rumanicus* Bar.-Ham. ot Strandža. *Sb. eksp. Strandža planina* (BAN — Sofija), 123—134.

Dollfus, R. Ph., 1961: Contribution a la faune parasitaire de la région de Richelieu (Liste des parasites par hôtes). *Ann. Parasitol.* **36:** 174—261.

Dougherty, E.C., 1945: A review of the genus *Crenosoma* Molin, 1861 (Nematoda: *Trichostrongylidae*): its history, adult morphology, and distribution. *Proc. Helm. Soc. Washington* **12:** 44—62.

Furmaga, S., 1961: Materials to the helminth fauna of hedgehogs *Erinaceus roumanicus* Barret-Hamilton. *Acta Parasit. Polonica* **9** : 441—445.

Gerichter, Ch. B., 1951: Two new lung nematodes from Near-East mammals. *Parasitology* **41** : 184—188.

Kadenacii, A. N., 1957: Gelmintofauna mlekopitajuščich Kryma i opyt ozdorovlenija domašnych životnych ot osnovnych gelmintozov. Omsk 137 pp.

Karasev, N. F., 1966: Gelminty mlekopitajuščich Berezinskogo zapovednika. Avtoreferat diss. na soisk. uč. step. kand. biol. nauk (VIGIS, Moskva), 28 pp.

Kontrimavičus, V. L., 1969: Gelmintofauna kunich i puti jeje formirovanija. Izdat. Nauka, Moskva, 432 pp.

Macaberidze, G. V., 1966: Gelminty mikromammalij vostočnoj Gruzii. Avtoreferat diss. na soisk. uč. step. kand. biol. nauk (Tbilis. Gos. Univ.-Tbilisi), 22 pp.

Macaberidze, G. V., 1967: Materialy k izučeniju gelmintofauny nasekomojadnych Vostočnoj Gruzii. *Sb. Gelmintofauna životnych i rastěnij Gruzii* (Tbilisi): 69—71.

Merkuševa, I. V., 1966: Invazavanasc zvyčajnata vožyka (*Erinaceus europeus* L.)gelmintami u Belarusi. *Vestn. Akad. nauk Belarus. SSR* 4 : 119—121.

Mituch, J., 1964: Beitrag zur Erkenntnis der Helminthenfauna des Igels (*Erinaceus europaeus roumanicus* Bar.-Hamilton, 1900). *Studia Helminthologica* (Košice) **1** : 101—104.
Prokopič, J., 1957: Výsledky helmintofaunistického výzkumu našich ježků. *Věstn. Čs. zool. spol.* **21** : 97—111.
Prokopič, J., 1959: Cizopasní červi našich hmyzožravců. *Čs. parasit.* (Praha) **6** : 87—134.
Rodonaja, T. E., 1956: Gelmintofauna dikich mlekopitajuščich Lagodechskogo gosudarstvennogo zapovednika. *Trudy in-ta Zool. AN Gruz. SSR* **14** : 147—187.
Schad, G. A., R. E. Kuntz, W. H. Wells, 1960: Nematode parasites from Turkish vertebrates. *Canad. J. Zool.* **38** : 949—963.
Skrjabin, K. I., A. M. Petrow, 1928: A description of the genus *Crenosoma* Molin, 186 (*Metastrongylidae*, Nematoda). *Parasitology* **20** : 329—335.
Stammer, H. J., 1955: Die Parasiten deutscher Kleinsäuger. *Verh. Deutsch. Zool. Gesel. Erlangen* 362—390.
Viktorov, L. V., O. V. Golovin, V. A. Savinov, 1964: Materialy k gelmintofaune nasekomojadnych mlekopitajuščich Kalininskoj oblasti. *Uč. zap. Kalininskogo gos. ped. in-ta* **31** : 289—292.

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The Prague Zoological Garden

SCENT MARKING AND COURTSHIP IN SIBERIAN CHIPMUNK, TAMIAS SIBIRICUS LINEATUS (SIEBOLD, 1824), WITH NOTES ON THE TAXONOMIC RELATIONS OF CHIPMUNKS (MAMMALIA)

Luděk J. Dobroruka

Received June 8, 1971

Abstract: Scent marking and courtship in *Tamias sibiricus lineatus* (Siebold, 1824) are described and compared with equivalent behaviour in other *Sciuridae*. It closely resembles that of tree squirrels and therefore the taxonomic relationships of chipmunks are discussed.

In addition to my previous short observations on *Tamias sibiricus striatus* (Pallas, 1778), three pairs of adult *Tamias sibiricus lineatus* (Siebold, 1824) were studied in the Prague Zoological Garden during the mating season in April—May 1971.

MARKING

The main method of *Tamias sibiricus* is marking with urine. This marking takes place in both sexes but in a different manner. The males drop urine on some prominent places in their range, as on stones, knobs of branches, etc. Sometimes they mark by rubbing the urine-wet scrotum along the branch, to that a urine spur is well visible. Very often the males urinate when eating, so that their feeding places are marked, too (Fig. 1).

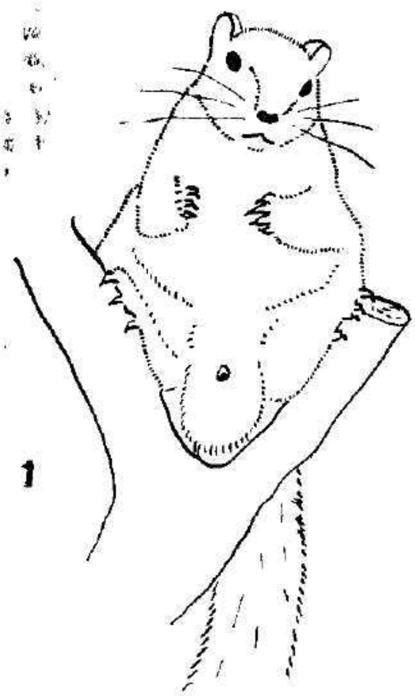
The females urinate mostly on the ground on constant places (Fig. 2). Exceptionally only they drop urine on the marking places of males.

The marking points are not individual and all males and/or females use the same marking points. It seems that there is not developed a territorium sensu stricto but each individual tends to drive off any other which approaches it too closely, and is keeping a certain individual distance, rather than defending a particular area. This phenomenon is not unique in squirrels and was observed in *Citellus armatus* by Balph & Stokes (1963).

Another method of the scent marking is marking with the secretion of cheek-glands. This marking method is seen exceptionally only and it is perhaps not used at all during the mating season, in which we observed the marking with urine only.

COURTSHIP

At the beginning of the mating season lasting from April to the end of May the females chase the males away. During the chase the males give a "baby call" (Ewer, 1968) which has an inhibiting effect on the females' aggressive tendencies (Eibl-Eibesfeldt, 1951, 1958). After several days the intensity of chasing decreases and only a short, symbolic chase is performed. In this period the male approaches the female in the courtship tail-display ritual in which he slowly waves the tail horizontally, with a moderate piloerection (Fig. 3). When the female does not show aggressivity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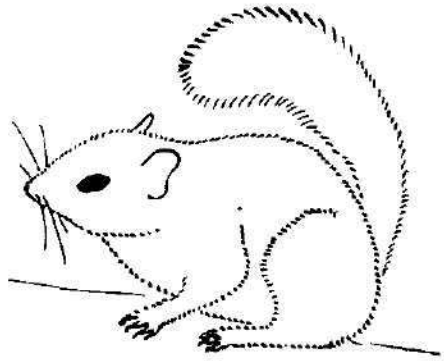
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Fig. 1. Male Siberian Chipmunk marking with urine at the feeding place.
Fig. 2. Posture of female Siberian Chipmunk during micturation at the marking place.

and does not chase the male away, he tries to make an olfactory check on her genitalia and cheek-gland. If the female is not receptive, a short symbolic chase follows and the female does not allow the male to mate her.

A receptive female assumes a strength position with the head bent upwards and with the tail, showing maximal piloerection over her back (Fig. 4). Females in this posture do not chase males away and the males approach them without any olfactory checking.

The males' tail-display is often done at marking places and the males approach in the same manner the urinating places of the females. Therefore we suppose that this behaviour is olfactorily stimulated, but effects an optical stimulus for the receptive position of the female.

DISCUSSION

If compared with other Sciuridae the scent marking and courtship of *Tamias sibiricus* are similar to those of *Sciurus vulgaris* or *Sciurus carolinensis*.

The main method of scent marking in all these species is marking with the urine. The animals mark in such a way prominent places in their home range, feeding places and their routes on branches (Eibl-Eibesfeldt, 1958; Taylor, 1968; Dobroruka, 1970). Also the rubbing of cheek-glands is done by all species mentioned (Frank, 1952; Eibl-Eibesfeldt, 1951; Bürger, 1959; Dobroruka, 1970).

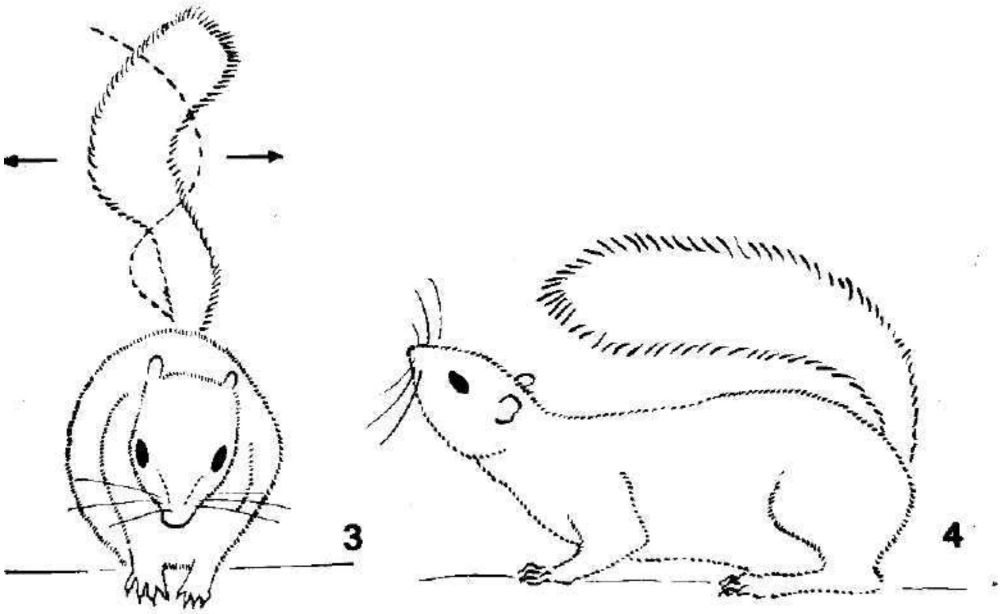

Fig. 3. Tail-display ritual in male Siberian Chipmunk. Tail waves horizontally.
Fig. 4. Receptive position of female Siberian Chipmunk.

In ground squirrels and marmots the most important method of scent marking is marking with the secretion of cheek-glands (Linsdale, 1946; King, 1955; Mülle-Using, 1956; Koenig, 1957; Eibl-Eibesfeldt, 1958; Münch, 1958; Ewer, 1968). In *Marmota marmota* and *Cynomys socialis* urination was observed as means of intimidation or defense only (Koenig, 1957; Altmann, 1969).

In the courtship ritual of *Sciurus carolinensis* the male approaches the female flicking his tail in vertical direction. The female moves off and the male follows, wavig his tail slowly. When she finally stops, the male displays for a moment, waving his tail in a circle (Bakken, 1959). In *Sciurus vulgaris* the male display is more ritualised. Stopping a foot or so away from the female, the male turns broadside on to her, waves his tail horizontally a few times, then round in a wide circle and finally, with hairs maximally erected, he brings his tail down over his back in a slow impressive movement and stands this, displaying to the female for up to a full minute (Eibl-Eibesfeldt, 1951). In *Tamias sibiricus* the principle of the display is the same. The tail waves horizontally but not in a circle, and the male does not show the lateral display posture.

In the ground squirrels and marmots another courtship ceremony is developed, in which the most important phenomenon is the oro-oral contact

(Linsdale, 1946; Psenner, 1957; Eibl-Eibesfeldt, 1958). In Alpine Marmot, *Marmota marmota*, the males show during the mating season an intimidation display with short, quick whipping movements of the tail in vertical and/or horizontal directions (Koenig, 1957). We observed the same in the Antelope Ground Squirrel, *Ammospermophilus leucurus*.

According to most of the modern autors chipmunks are closely related to marmots (Simpson, 1945; Brynat, 1945; Moore, 1959; Gromov, 1965 a.o.). Black (1963) feels that the chipmunks differ from the marmots and the spermophiles as much as from the tree squirrels, and gave them a taxonomical rank equivalent to he groups mentioned above. However, some older authors emphasized on the affinities of the chipmunks to the tree squirrels (Brand, 1843; Major, 1893).

It is possible to compare behavioural characters as morphological ones and thus ascertain homological lines according to which we can trace the phylogeny of behavioural expressions (Eibl-Eibesfeldt, 1969). If the marking behaviour and courtship in the Siberian Chipmunk are compared with the same behaviour in the tree squirrels and marmots and/or spemophiles, a close ethological relationship with the former group is evident; this supports Black's (1963) taxonomical proposals. However, more observations on other species of chipmunks and Nearctic spermophiles are needed.

LITERATURE

Altmann, D., 1969: Einige Bemerkungen zum Verhalten von Präriezieseln, Citellus richardsoni. im Vergleich zu Prärienhunden, Cynomys socialis. *Der Zool. Garten (NF)* **36** : 337—340,

Bakken, A., 1959: Behavior of gray squirrels. Symp. on gray squirrel. Cont. 162, Maryland Dept. Res. Ed.: 393—407.

Balph, D. E. & A. W. Stokes, 1963: On the ethology of a population of Uinta ground squirrels. *Amer. Midl. Nat.* **96** : 106—126.

Black, C. C., 1963: A review of the North American Tertiary Sciuridae. *Bull. Mus. Comp. Zool.* **130** : 109—248.

Brand, I., 1843: Observations sur les différentes espèces des Sousliks de la Russie. *Bull. Acad. Sci. Classe Phys. Math., St. Petersbourg II*, 23—24 : 81—116.

Bryant, M. D., 1945: Phylogeny of Nerctic Sciuridae. *Amer. Midl. Nat.* 33, 2 : 257—390.

Bürger, M., 1959: Eine vergleichende Untersuchung über Putzbewegungen bei Lagomorpha und Rodentia. *Der Zool. Garten (NF)* **24** : 434—506.

Dobroruka, L. J., 1970: Verständigungsmittel der Tagaktiven Sciuriden. Sarus, Bratislava: 169—178.

Eibl-Eibesfeldt, I., 1951: Beobachtungen zur Fortpflanzungsbiologie und Jugendentwicklung des Eichhörnchens. *Z. Tierpsychol.* **8** : 370—400.

Eibl-Eibesfeldt, I., 1958: Das Verhalten der Nagetiere. Handb. der Zoologie 8 (10) 6 : 1—88.

Eibl-Eibesfeldt, I., 1969: Grundriss der vergleichenden Verhaltensforschung. Ethologie. R. Piper Verl., München.

Ewer, R. F., 1968: Ethology of Mammals. Logos Press, Ltd., London.

Frank, H., 1952: Über die Jugendentwicklung des Eichhörnchens. *Z. Tierpsychol.* **9** : 12—22.

Gromov, I. M. & coll., 1965: Ground Squirrels (Marmotinae). In: *Fauna SSSR* III, 2 : 466 pp. Moskva-Leningrad.

King, J. A., 1955: Social behavior, social organization and population dynamics in a black-teiled prairiedog town in the Black Hills of South Dakota. *Contr. Lab. Vertebr. Biol. Univ. Michigan* **67** : 1—123.

Koenig, L., 1957: Beobachtungen über Reviermarkierung sowie Droh- und Kampf- und Abwehrverhalten des Murmeltieres, Marmota marmota L. *Z. Tierpsychol.* **14** : 510—521.

Lindsdale, J. M., 1946: The California Ground Squirrel. Mus. Calif. Press, Berkeley & Los Angeles: 475 pp.

Major, Ch. I. F., 1893: On some Miocene Squirrels, with remarks on the dentition and classification of the Sciuridae. *Proc. Zool. Soc. London* 00 179—215.

Moore, J. C., 1959: Relationship among the living squirrrels of the Sciuridae. *Bull. Amer. Mus. Nat. Hist.* **118** : 153—206.

Muller-Using, D., 1956: Zum Verhalten des Murmeltieres (Marmota marmota L.). *Z. Tierpsychol.* 13 : 135—142.
Münch, H., 1958: Zur Ökologie und Psychologie von Marmota marmota. *Z. Säugetierkunde* 23 : 129—138.
Psenner, H., 1957: Neues vom Murmeltier, Marmota m. marmota Linné, 1758. *Saugetierkdl. Mitt.* 5 : 4—10.
Simpson, G. G., 1945. The principals of classification and classification of mammals. *Bull. Amer. Mus. Nat. Hist.* 85 : 1—350.
Taylor, J. C., 1968: The use of marking points by Gray Squirrels. *J. Zoology, London* 155 : 246 to 247.

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EXPERIMENTAL INFECTIONS OF SEVERAL SPECIES OF APHIDS BY SPECIMENS OF THE GENUS ENTOMOPHTHORA

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Received March 2, 1971

Abstract: Experiments were carried out with infections of several species of aphids by means of conidia or resting spores of specimens of the genus *Entomophthora*. The conidia caused a much higher percentage mortality owing to mycosis as compared with the resting spores

INTRODUCTION

Of natural hosts, several species of aphids were used in the experiments with infectious material to evaluate the specificity of individual species of the genus *Entomophthora*. The animals were infected either with conidia or by spraying with a suspension of resting spores from a submerged culture.

MATERIAL AND METHODS

The following species of aphids served as experimental material: *Megoura viciae* Buckt., on *Vicia faba* L., *Aphis fabae* Scop., on *Sambucus nigra* L., and *Aphis forbesi* Weed, on *Fragaria vesca* L. We tried to infect the aphids with fungi such as *Entomophthora virulenta* Hall et Dunn, strain No 1 and 2, *Entomophthora thaxteriana* (Petch) Hall et Bell, *Entomophthora destruens* Weiser et Batko, and *Entomophthora coronata* (Costatin) Kevorkian.

The species *E. virulenta* No 1, *E. thaxteriana*, *E. destruens*, and *E. coronata* were from the collection of Hall and Dunn (University of California, Citrus Experiment Station Riverside U.S.A.). The strain No 2 of *E. virulenta* we obtained from E. Müller-Kogler (Institut für Biologische Schädlingsbekampfung Darmstadt DBR) (Krejzová 1971d). All species of *Entomophthora* us d for this study have been maintained for a fairly long period in our laboratory.

Part of the experiments were run at the laboratory using conidia discharg d from inverted cultures on coagulated yolk (Fig. 1, 2), the animals being infected with discharg d conidia, while the other experim nts with the infection through conidia and suspensions of resting spores were carried out in a garden on shrubs and trees. Cultures 3–5 days old (Krejzová, 1971b) fixed over the twigs with aphids, so as to enable the conidia to be discharg d onto the aphids, but to prevent the culture from touching the twig. Vials were closed by cotton over the inserted twig. This was maintained for 2 days. After that the twigs were cut off, transferred to the laboratory and placed into vials with water to avoid their early decay. They were fixed inside the neck of each flask by means of cotton wool; this also prevented the aphids from dropping into water. All this was covered with a cylinder. After the transfer to the laboratory, those aphids which had been already dead at that time were removed and further dead bodies collected during the following days. During infection by spraying with resting spores, (Krejzová, 1970; Krejzová, 1971c), the colonies of aphids on the twigs were first sprayed, then covered with flasks to prevent them from spreading and kept till the second day. On the third day, they were transferred to the laboratory and treated in the same way as described above. All the experiments with aphids, with the exception of *M. viciae* from a laboratory breeding, were made in the course of May.

The controls for outdoor experiments with conidia on twigs were covered with flasks in the same way as were the experimental specimens. The controls for the experiments with the spraying of spores were sprinkled with water prior to covering.

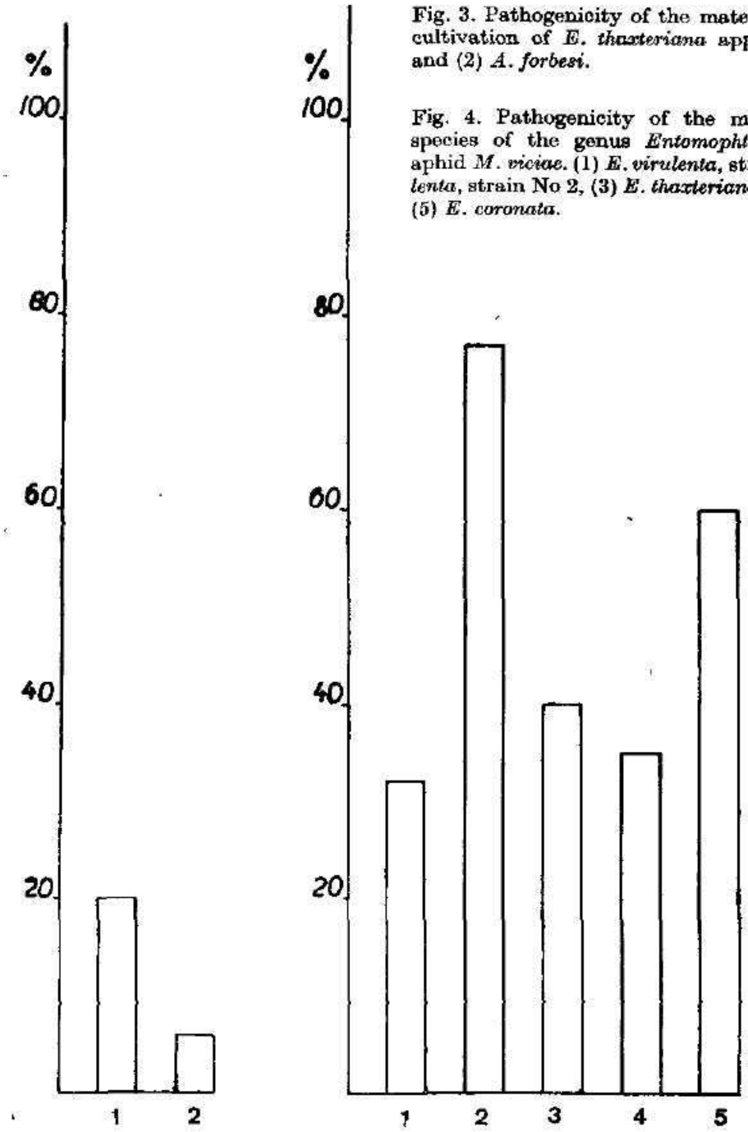

Fig. 3. Pathogenicity of the material from submerged cultivation of *E. thaxteriana* applied to (1) *A. fabae* and (2) *A. forbesi.* ◄◄

Fig. 4. Pathogenicity of the material of conidia of species of the genus *Entomophthora* applied to the aphid *M. viciae.* (1) *E. virulenta*, strain No 1, (2) *E. virulenta*, strain No 2, (3) *E. thaxteriana*, (4) *E. destruens* and (5) *E. coronata.* ◄

Dead individuals from both, the experiments and the controls, were kept in petri dishes on moistened filter paper and, after a period of 24 hours, examined for mycosis externally and by dissection. Infected individuals usually became overgrown with conidiophores and conidia within 24 hours, their body cavity being full of hyphal bodies. In single cases, the body cavity was full of resting spores and no conidia were found to grow on the surface.

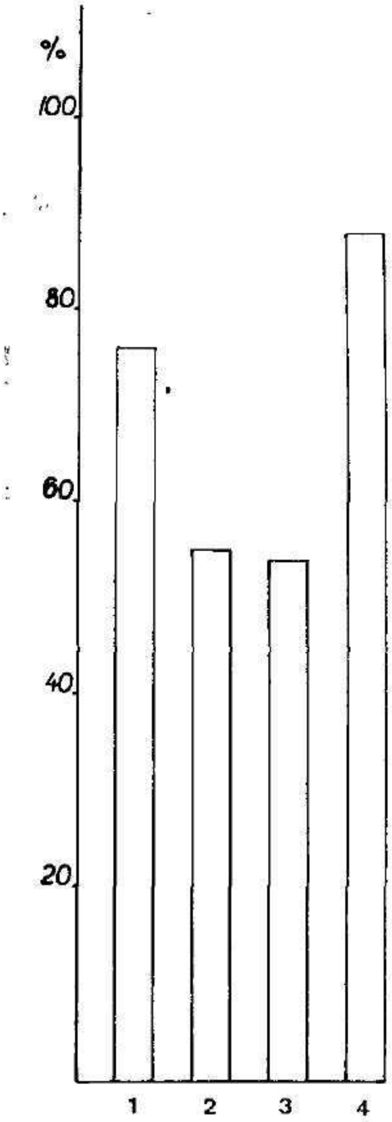

Fig. 5. Pathogenicity of the material of conidia of species of the genus *Entomophthora* applied to the aphid *A. fabae*. (1) *E. virulenta*, strain No 1, (2) *E. thaxteriana*, (3) *E. destruens* and (4) *E. coronata*.

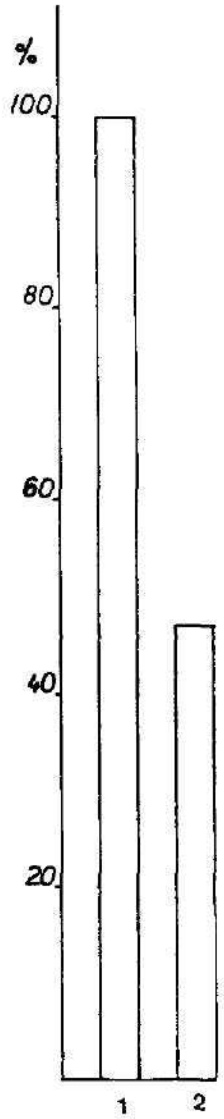

Fig. 6. Pathogenicity of the material of conidia of species of the genus *Entomophthora* applied to the aphid *A. gossypii*. (1) *E. thaxteriana* and (2) *E. virulenta*, strain No 2.

RESULTS

The application of the suspension of resting spores of *E. thaxteriana* (1 vol. of centrifuged material from a submerged culture and 10 vol. of water) to *A. fabae* resulted in a 20 percentage mortality; if the same suspension was applied to *A. forbesi*, a 6 percentage mortality was obtained (Fig. 3).

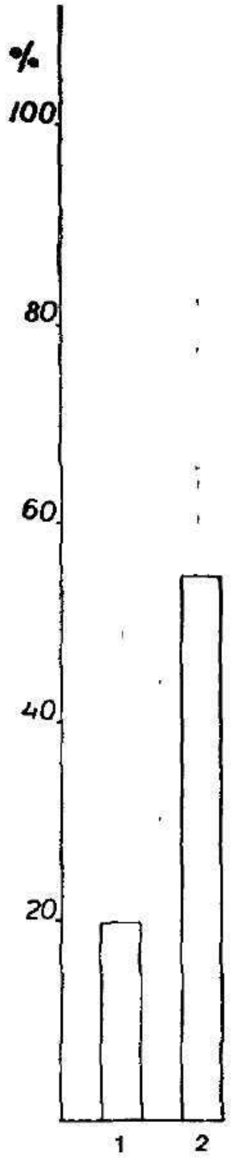

Fig. 7. Pathogenicity of the material from submerged cultivation and of conidia of *E. thaxteriana* applied to *A. fabae*; (1) spore material and (2) material of conidia.

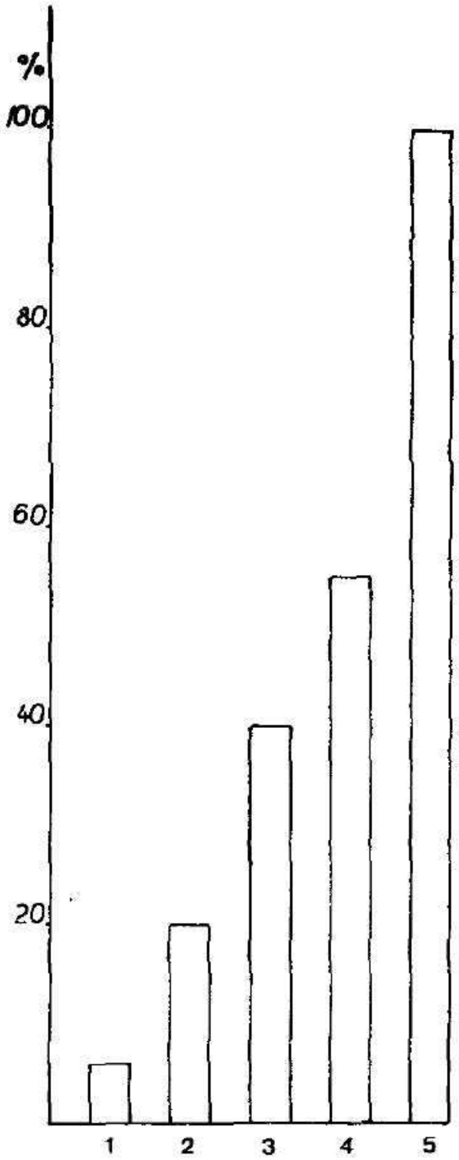

Fig. 8. Pathogenicity of the material from submerged cultivation and of conidia of *E. thaxteriana* applied to aphid species: (1) *A. forbesi*, spore material, (2) *A. fabae*, spore material, (3) *M. viciae*, material of conidia, (4) *A. fabae*, material of conidia, and (5) *A. gossypii*, material of conidia.

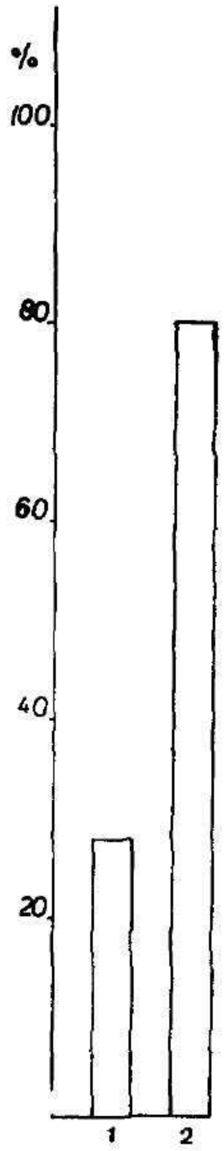

Fig. 9. Pathogenicity of the material from submerged cultivation and of conidia of *E. virulenta*, strain No 1, applied to *A. fabae*; (1) spore material and (2) material of conidia.

The percentage mortality of the material used instantly after completed cultivation was almost the same as was that of the material which had been stored in the refrigerator for 6 to 8 weeks. After the same application of *E. virulenta* to *A. fabae*, the percentage mortality varied about 28 per cent (Fig. 9).

In the following series of experiments, conidia of *E. virulenta*, strain 1 and 2, *E. thaxteriana*, *E. destruens*, and *E. coronata* were applied to *M. viciae*, *A. fabae* and *A. gossypii*.

Most effective on *M. viciae* (Fig. 4) was *E. virulenta*, strain No 2, with a 77 percentage mortality and *E. coronata* with a 60 percentage mortality, while the percentage mortality caused by *E. thaxteriana* was 40 per cent, by *E. destruens* 35, and by *E. virulenta*, strain No 1 32.

Most effective on *A. fabae* (Fig. 5) was *E. coronata* with an 88 percentage mortality and *E. virulenta*, strain No 1, with a 76 percentage mortality, while *E. thaxteriana* resulted in a 55 and *E. destruens* in a 54 percentage mortality. *E. thaxteriana* caused a 100 percentage mortality and *E. virulenta*, strain No 2, a 47 percentage mortality of *A. gossypii* (Fig. 6).

In almost all instances, even at a very low mortality of some species of aphids on the given fungi, mortality was always higher after the application of the given material of conidia as compared with the material of resting spores as the source of infection (Fig. 7, 8, and 9).

DISCUSSION

In nature, resting spores are a form by which mycosis survives over the period of hibernation or under other unfavourable conditions. Under favourable conditions, resting spores produce the infection of further individuals, as well as the development of the vegetative stage, the death of victims, and a further spread of the infection by conidia. The authors differ considerably in the question which of the conditions are most favourable for the germination of the resting spores (Hall and Halfhill, 1959). Their percentage ability to germinate in nature is also unknown.

At the beginning of the infection with resting spores, probably no infection on a large scale takes place; on the contrary, mycosis occurs only in a small number of the animals in the immediate surroundings of the dead bodies, which contain resting spores and spread out slowly by infected individuals. This may also explain why in the spring months the infection by specimens of the genus *Entomophthora*, e.g. in aphids, occurs only in single instances being rarely apprehensible. Only in late summer or even during an earlier period, a rapid and strong distribution of the infection takes place and epizooties occur. Until that time, the infected hosts spread the source of mycosis owing to external conditions, on the other hand, the host population was weakened by the unfavourable conditions, mainly during a cold period and strong precipitation.

If we consider the above mentioned spread of mycosis through resting spores in nature, we may attribute the relatively low mortality, obtained by the application of the spore material, to the character of the stage of the resting spores, on the one hand, and to the insufficient knowledge of the conditions of their maximum percentage germinability in nature, on the other hand. The material of conidia on a small scale may be of greater effect than the material of resting spores. The application of conidia on a large scale, however, is connected with considerable technical difficulties. The vials for the growing of the cultures should be of smaller dimensions and lighter material, so as to fix them easily onto the plants. The culture should be neither dissolved nor divided. The material may be prepared in a limited quantity and should be in a fresh state. The spore material, however, may be prepared in a large quantity; it can be preserved for even a rather long period of time and grown as reserve material. Also the spraying technique is more easily performable as compared with the above mentioned spreading of mycosis by conidia. The application of the spore material, however, requires a through knowledge of the conditions necessary for a maximum percentage germinability of the resting spores in nature.

CONCLUSION

It was found that the suspension of resting spores was much more effective in aphids, which are the natural hosts of a considerable number of specimens of *Entomophthora*, as compared with the larvae of *Galleria mellonella* (Krejzová, 1971a). The given suspension, however, was much less effective even in aphids, as compared with the material of conidia. Nevertheless, the application of the resting spores by spraying offers a certain possibility for the use in biological control. Resting spores may be prepared in a greater quantity and the material can be stored.

Not only individual species of the genus *Entomophthora*, but also the different strains of the same species (2 strains of *E. virulenta*), cultured for a relatively long period in vitro, differed by pathogenicity, similarly as in earlier artificial infections of *Galleria* larvae and the workers of termites (Krejzová, 1971a,b,d).

Individual species of aphids also differed by their sensitivity to various kinds of mycosis of the genus *Entomophthora*.

LITERATURE

Hall, I. M., J. V. Bell, 1963: The synonymy of Empusa thaxteriana Petch and Entomophthora ignobilis Hall et Dunn. *J. Insect Pathol.*, 5 : 182—186.

Hall, I. M., P. H. Dunn, 1957: Entomophthorous fungi parasitic on the spotted alfalfa aphid. *Hilgardia*, 27 : 159—166.

Hall, I. M., J. C. Halfhill, 1959: The germination of resting spores of Entomophthora virulenta Hall et Dunn. *J. Econ. Entomol.*, 52 : 30—35.

Kevorkian, A. G., 1937: Studies in Entomophthoraceae, I. Observations on the genus Conidiobolus. *J. Agr. Univ. Puerto Rico*, 21 : 191—200.

Krejzová, R., 1970: Submerged cultivation of Entomophthora virulenta Hall et Dunn 1957. *Česká mykologie* 24 : 87—94.

Krejzová, R., 1971a. Versuchsinfektionen der Raupen von Galleria mellonella L. und Antheraea pernyi L. durch Vertreter der Entomophthora-Gattung. I. *Věst. Čs. spol. zool.* 35 : 107—113.

Krejzová, R., 1971b: Versuchsinfektionen der Raupen von Galleria mellonella L. und Antheraea pernyi L. durch Vertreter der Entomophthora-Gattung. II. *Věst. Čs. spol. zool.* 35 : 114—117.

Krejzová, R. 1971c: Submerse Kultivation der insektenpathogenen Pilzarten Entomophthora thaxteriana (Petch) Hall et Bell und Entomophthora destruens Weiser et Batko. *Česká mykologie*.

Krejzová, R. 1971d.: Infektionsversuche mit einigen Entomophthora-Arten bei den Termiten Coptotermes formosanus (Shiraki) und Reticulitermes lucifugus (Rossi). *Entomophaga*.

Weiser, J., A. Batko, 1966: A new parasite of Culex pipiens L., Entomophthora destruens sp. nov. (Phycomycetes, Entomophthoraceae). *Folia parasit.* (Praha), 13 : 144—149.

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

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STUDIES ON THE FRESHWATER PLANKTON OF A FISH-POND IN KALYANI, W. BENGAL, INDIA

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Abstract: Regular plankton hauls were made in a local freshwater fish-pond, during the period October to March, 1964—65. Observations on seasonal distribution and fluctuations of the plankters are recorded for the first time from Bengal waters and are discussed in the present communication.

INTRODUCTION

Planktological studies in India so far, have been generally confined to marine waters. Job (1943), Alikunhi, Ganapati and Thivy (1948), Alikunhi, Chaudhury and Ramachandran (1955), Chacko and Krishnamurthy (1954), and Ganapati and Chacko (1951) have however, studied the plankton of some freshwater bodies in India, but these studies have little significance because if the plankton investigations are to be made satisfactory in any freshwater body, then these collections and observations should be made at all seasons since many organisms are plastic and vary greatly with the environmental conditions; and therefore the discriptions of stray samples as recorded by them are likely to obscure rather than elucidate the biology of the water bodies.

Das and Srivastava (1956—1959) in a series of papers have added largely to existing knowledge in this field. The present studies have been initiated with a view to fill the lacuna in the biology of lentic waters of Bengal, a preliminary account of which is discussed in the present communication.

MATERIAL AND METHODS

Regular weekly hauls were made in a local fish-pond, Kalyani, from October 1964 to March 1965, with a One-metre Nensen's Plankton Net. The samples were taken in the morning and one standard haul was made in the middle of the lake under observation in all the operations.

The haul was washed out from the bucket and the net, and brought to the laboratory in wide-mouthed collection bottles. The total plankton volume was determined by the 'Standard displacement method' (Eddy, 1934). The plankton was then fixed in 5% formalin and stored for subsequent studies. Qualitative studies of the plankton were made under a microscope while the percentage composition was determined by the 'Point's method' (Hynes, 1950).

THE DOMINANT PLANKTON

The occurrence of the plankters, the plankton volumes and the percentage composition of the plankton are shown in Tables 1 and 2 respectively.

Table 1. Showing occurrence of Plankters in a fish pond at Kalyani, during October—March, 1965

Name	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
Algae:						
Diatome vulgare Bory.	p	p	p	p	p	p
Synedra ulna (Nitzch) Fhr.	p	p	p	p	p	p
Bacillaria paradoxa Gmel.	p	—	—	p	—	p
Gyrosigma kutzingii (Grun) Cl.	p	p	p	p	—	p
Frustulia rhoimboides (Ehr.) Det.	p	p	p	—	—	p
Navicola rodisa Kutz.	—	—	—	—	p	—
Cymbella cistula Kirchh.	—	—	—	p	p	p
Coelostrum chodati Ducell.	p	p	pp	pp	pp	p
Anacystis cynnea (Kutz.)	p	p	pp	pp	pp	p
Ulothrix zonata Kutz.	p	p	pp	pp	pp	pp
Volvox aureus Ehr.	—	—	—	—	p	p
Excentrosphaera viridis G. T. Moore	—	p	—	p	p	p
Crustacea:						
Diaptomus caducus Light.	p	p	p	p	p	p
Cyclops viridis (Jurine).	p	p	p	p	p	p
Canthocamptus staphylinoides Pearse.	p	p	p	—	—	—
Leptodora kindtii (Foeke)	p	—	—	p	p	p
Ophryoxus gracilis Sars.	—	p	—	—	—	—
Bosmina longirostris (O. F. Muller)	p	p	p	p	p	p
Bosmina coregoni Baird.	p	p	p	p	p	p
Alonella diaphana (King)	p	p	—	—	—	—
Macrothrix laticornis (Jurine)	p	p	—	—	—	—
Chydorus sphaericus (O. F. Muller)	—	p	—	—	—	—
Rotifera:						
Keratella vulga Bory de St. Vincent.	p	p	p	—	—	—
Brachionus calyciflorus Pallas	p	p	p	p	p	—
Brachionus havenensis Pallas.	p	p	p	p	p	—
Filinia longiseta (Ehr.)	p	p	p	—	—	—
Trichocera cylindrica Lamark (Jennings)	—	—	p	—	—	—
Horaella horaella Donner.	—	—	p	p	p	p
Asplanchna priodonta Gosse.	—	p	p	p	—	p

p: present; pp: abundant; —: absent.

In October the zooplankton predominated in the samples (89%). It was composed of crustaceans and rotifers, *Cyclops viridis* being the dominant form. Phytoplankton constituted 11% and was represented by unicellular and filamintous algae. (Table 2.)

The zooplankton registered a decline (72%) in November and was represented by crustaceans and rotifers. Phytoplankton was unicellular and filamentous algae.

In December there was a sharp fall in zooplankton volume (23.65%). Crustaceans registered only 10%. Cladocera was represented by *Bosmina longirostris* and *B. coregoni* and was numerically very few. Rotifers recorded 13.65%. Phytoplankton registered a peak value (76.35%).

The zooplankton increased to 57.5% during January while the phytoplankton declined to 42.5%. Crustaceans recorded 21.22% and rotifers 36.22% respectively. Amond the copepods *Cyclops viridis* was common.

Asplanchna priodonta was the dominant rotifer while *Brachionus calyciflorus* and *B. havenensis* were common. Phytoplankton recorded 42.5%.

In February zooplankton declined to 37.5% while the phytorotifers plankton increased to 62.5%. Crustaceans constituted 15.22% and rotifers 22.32% thus recording a fall. *Cyclops viridis* and *Diaptomus caducus* were common. Clodocera was represented by *Bosmina longirostris* & *B. coregoni* although numerically few. Among rotifers *Asplanchna priodonta* and *Horaella horaella* were common. Phytoplankton was composed of unicellular and filamintous algae.

Table 2. Average volume and percentage composition of plankton during October to March 1964—1965, in a fish-pond at Kalyani

Months.	Av. Plankton volume in ccs.	Phyto-plankton	Zoo-plankton	Uni. algae	Fil. algae	Crustaceans	Rotifers
October	3.75	11	89	5	6	64	25
November	8.5	28	72	2	26	58	14
December	5.3	76.35	23.65	1.35	75	10	13.65
January	8.0	42.5	57.5	11.22	31.3	21.22	36.32
February	9.5	62.5	37.5	1.0	61.5	15.22	22.32
March	9.0	60.0	40.0	1.0	59.0	35.0	5.0

A slight increase in zooplankton volume was recorded in March (40%) along with a decline in phytoplankton volume (60%). Crustaceans were common (35%) and rotifers few (5%). Cladocera was represented by *Bosmina longirostris* & *B. coregoni*. *Cyclops viridis* and *Diaptomus caducus* were the common copepods. Rotifers were represented by *Asplanchna priodonta* and *Horaella horaella*. Phytoplankton was represented by unicellular and multicellular algae.

DISCUSSION

Sewell (1934) recorded 10 species of rotifers, 15 cladocerans, 10 copepods, 1 ostracod and 3 polyzoans from a freshwater tank in Bengal. Chacko and Krishnamurthy (1954) reported a few copepods and cladocerans from some ponds in South India. Alikunhi et al (1955) recorded 11 rotifers, 2 copepods, 3 cladocerans and some ostracods in the plankton from some nursery ponds in Cuttack, India. In the present studies, however, 3 copepods, 7 cladocerans and 7 rotifers have been recorded.

Moore (1956) observed a scarcity of zooplankton in lake Providence in which rotifers were the dominant group. Sloka (1962) observed 68 forms of zooplankton in some lakes on the Vidzemskaya plateau. According to Gorduva (1962) the basic zooplankton in Noril'sk lakes consisted of copepods (12 species), rotifers (20 species), cladocerans (27 species). Dengina (1962) found 126 forms of zooplankton comprised of 63 rotifers, 45 cladocerans, 18 eucopepods from the Shkhern region of lake Ladoga.

It appears therefore, that the Indian freshwater bodies support fewer species although numerically they may be large.

Canapati and Chacko (1951) found only three species of bluegreen algae in the phytoplankton of freshwater ponds in South India, while Alikunhi et al. (1955) have reported 34 forms from the phytoplankton of nursery ponds in Cuttack. Das and Srivastava (1959) have recorded 17 phytoplankton components from some freshwater-bodies in Lucknow. In the present investigations 13 phytoplankton components have been recorded thus indicating poor productivity of the fish-ponds at Kalyani.

The phytoplankton in our waters compare well with those obtained in South India but are not as rich in species in North Indian freshwaters as reported by Das and Srivastava (1959).

The commonest zooplankters recorded from the fish-pond at Kalyani during the course of the present studies are shown in Table 1. The bulk of the zooplankton consisted of copepods and cladocerans, an observation similar to that in South Indiat freshwater ponds (Ganapati and Chacko, 1951; Chacko and Krishnamurthy, 1954). Further, the zooplankton of the freshwaters of Bengal appears to differ from that of North Indian freshwaters (Das and Srivastava, 1959).

The green algae were represented by 2 genera only viz., *Ulothrix zonata* and *Volvox aureus*. These were well represented during the colder months of November, December and January. In February, March and October, however, the number declined greatly although they were never completely absent in the collections.

The commonest diatoms obtained in the course of the present studies are shown in Table 1. These were however, numerically few. A peak was attained in January after which a steady decline was registered during

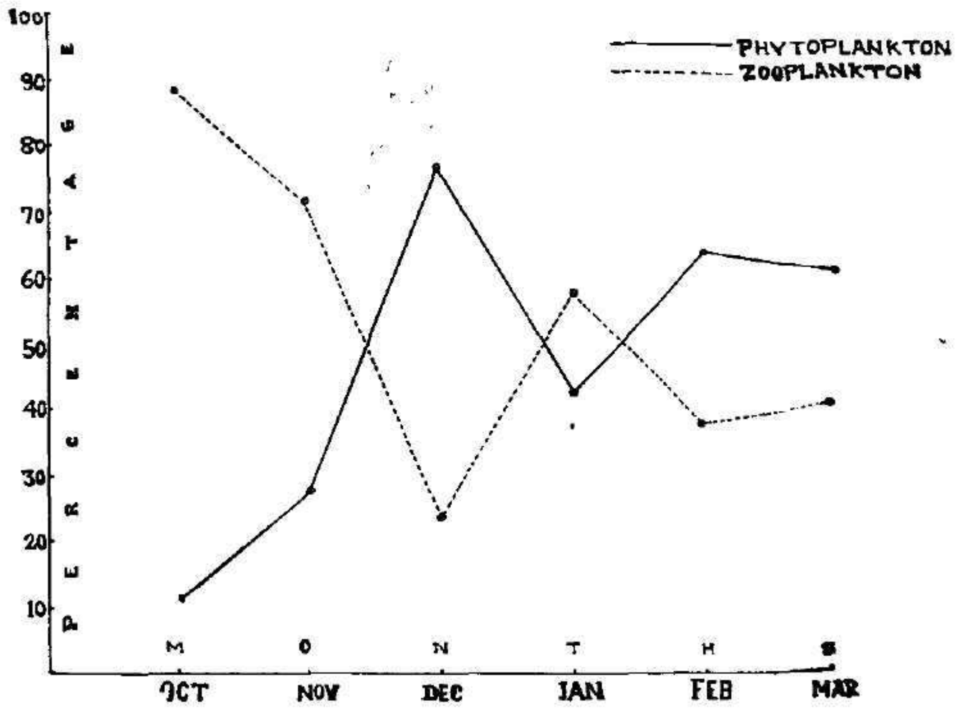

Fig. 1 — Percentage relation of the population dynamic between phyto- and zooplankton.

February and March. **Chacko and Krishnamurthy (1954)** noticed that in South Indian ponds *Melosira*, *Nitzchia* and *Synedra* were predominant during November to March. Alikunhi et al. (1955) found *Navicula* and *Melosira* to be most common in the nursery ponds at Cuttack. Chacko and Krishnamurthy (1954) observed that a pond had an almost permanent bloom of *Microcystis*. Alikunhi (1955) observed *Microcystis* to be the most common alga in freshwater nurseries in Cuttack. In the present studies however, *Anacystis cyanea* appeared to be common throughout the period of investigations but predominationg in October and November. Das and Srivastava (1956) recorded an inverse correlation between the zooplankton and phytoplankton volumes during the year in freshwater ponds of North India. A similar relation has been found in the present studies also (Fig. 1). Phytoplankton attained a peak value in December (76.35%) when zooplankton registered a minimum (23.65%) and again, zooplankton was at a peak in October (89%) when phytoplankton registered a minimum.

SUMMARY

Plankton hauls were made regularly in a freshwater fishpond in Kalyani, W. Bengal, India, during the period October to March 1964—1965. Detailed qualitative observations on seasonal distribution and fluctuations of the plankters have been recorded, as follows: —

1. 3 species of copepods, 7 cladocerans, 7 rotifers, 6 algae and 7 diatoms have been recorded.
2. The lowest average volume of plankton was recorded in October.
3. A maximum volume of plankton due to a phytoplankton peak was recorded in February.
4. A zooplankton peak was observed in October and this coincided with the phytoplankton through thus indicating an inverse relationship between each other.
5. The fish-pond under investigation was poor in planktonic organisms compared to North Indian lentic waters, although it compares favourably with South Indian freshwater bodies.
6. Plankters showed a cyclical appearance during the period of studies.

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REFERENCES

Alikunhi, K. H., S. V. Ganapati, & F. Thivy, 1948: Limnology of Otacamund Lake, Nilgiris. II Summer Conditions. Proc. 35th. Indian Sci. Cong. Assn., Part III, Calcutta.

Alikunhi, K. H., H. Chaudhury & V. Ramachandran, 1955: On the mortality of carp fry in nursery ponds and the role of plankton and their survival and growth. *Indian Jour. Fish.*, 2 : 257—313.

Chacko, P. I. & J. B. Krishnamurthy, 1954: On the plankton of three freshwater ponds in Madras City, India. Symp. Mar. Freshw. Plankton. Indo-Pacif. Fish. Coun., Bankok, 103—107.

Das, S. M. & V. K. Srivastava, 1955: Flowering of Volvox in a freshwater Lake in Lucknow, India. *Curr. Sci.*, 24 : 342—343.

Das, S. M. & V. K. Srivastava, 1956. Quantitative studies on freshwater plankton. I. Plankton of a fish-tank in Lucknow, India. *Proc. Nat. Acad. Sci., India*, **26** (4) : 85—92.
Das, S. M. & V. K. Srivastava, 1956: Quantitative studies on freshwater plankton. II. Cor relations between plankton and hydrological factors. *Ibid.*, **26** (4) : 243—254.
Das, S. M. & V. K. Srivastava, 1959: Studies on freshwater plankton. IV. The fishfood and the role of plankton components. *Ibid.*, **29** (4) : 190—196.
Dengina, R. S., 1962: Biology of Inland bodies of water in the Baltic region. Akad. Nauk. SSR, Moscow. 242—248.
Eddy, S., 1934: A study on freshwater plankton communities. *Illinois Biol. Monogr.*, **21** : 7—92.
Ganapati, S. V. & P. I. Chacko, 1951. Investigations on plankton production in pond of Chetput Fish-farm, Madras. Proc. Internat. Assoc. Theor. & Applied Limnology. II, 111—112.
Gorduva, L. N., 1962: Special characteristics of zooplankton from Noril'sk Lakes as releated to their geographical position. *Voprosy ekologii* Moscow, 5 : 37—39.
Hynes, J. B. N., 1950: The food of freshwater sticklebacks (Gasterosteus aculeatus and Pygosteus pungitius) with a review of the methods used in the studies of the food of fishes. *J. Anim. Ecol.*, **19** (1) : 36—58.
Moore, W. G., 1950: Limnological studies of Louisiana Lakes, I. Lake Providence. *Ecol.*, **31** : : 86—99.
Pruthi, H. S., 1933: An ecological study of the fauna of Khewra Gorge and some other salt waters in Salt Range *Punjab. Rec. Indian Mus.*, 35 : 87—119.
Preethi, H. S., 1933: Studies on the bionomics of the freshwaters in India. I. Seasonal changes in the physical and chemical conditions of waters of the tank in the Indian Museum Compound. *Internat. Rev. Ges. Hydrobiol.*, **28** : 46—67.
Sewell, R.B.S., 1934: Studies on the bionomics of freshwaters in India. II. On the fauna of the tank in the Indian Museum Compound and seasonal changes. *Ibid.*, **31** : 314—336.
Sloka, N. A., 1962: Zooplankton of some lakes on the Vidzemskaya plateau. Akad. Nauk. SSSR, Moscow: 183—185.

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GENERAL CHARACTERIZATION OF THE NEMATODE GENUS RHABDOCHONA WITH A REVISION OF THE SOUTH AMERICAN SPECIES

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Abstract: The present paper deals with the general characteristics of nematodes of the genus *Rhabdochona* Railliet, 1916. The author having studied the morphology of a total of 31 species of this genus, discusses the taxonomic value of the individual determining signs and corrects some errors in the literature. In addition, he revised data on intermediate and definitive hosts and on the geographical distribution. He suggests to divide the genus *Rhabdochona* into three subgenera by the type of their eggs — 1. the subgenus *Rhabdochona* Railliet, 1916 (smooth eggs); 2. the subgenus *Filochona* Saidov, 1953 (filamented eggs); 3. the subgenus *Globochona* subgen. n. (eggs with "floats"). The species originally described as *Rhabdochona beatriceinsleyae* has been transferred to the genus *Cystidicola* Fischer, 1798 as *C. beatriceinsleyae* (Holloway & Klewer, 1969) comb. n. On the basis of morphological studies of 31 species the writer concludes that Choquette's (1951) definition of the genus *Rhabdochona* is the most suitable; this diagnosis has been completed and re-arranged in accord with the new knowledge available. The second part of the paper contains a revision of members of the genus *Rhabdochona* parasitizing fishes of South America. The only species of this area considered to be valid, are *R. acuminata* (Molin, 1860) and *R. uruyeni* Díaz-Ungría, 1968; these have been redescribed and figured. *Rhabdochona elegans* Travassos, Artigas et Pereira, 1928, *R. fasciata* Kloss, 1966, *R. australis* Kloss, 1966 and *R. siluriformis* Kloss, 1966 have been placed in synonymy with *R. acuminata*.

The genus *Rhabdochona* Railliet, 1916 is one of the most perplexing groups of fish nematodes; at present, it comprizes as many as 65 nominal species, and descriptions of new species are added almost every year. Descriptions and figures are often inadequate, full of errors and discrepancies and these render it impossible to identify members of this genus satisfactorily. More confusion is added by the considerable variation in the number of tail papillae of the conspecific males, by difficulties in determining the exact number of teeth in the prostom, and by the occurrence of these nematodes in atypical hosts.

Although the systematic position of the genus and some of the morphological signs important in the species identification have been discussed by various authors of whom the papers of Gustafson (1949), Choquette (1951), Campana-Rouget (1961), Rojtman, Trofimenko (1964) and Rasheed (1965) are worth mentioning, no attempt has ever been made to study all available type materials of this enormous number of species in this genus. However, without comparative studies, a specific differentiation seems baseless.

In recent years the writer has tried to obtain all materials available of nematodes of the genus *Rhabdochona* in order to revise this genus and to form a basis for future studies on this very interesting group of nematodes. Until the present he has studied individuals of 31 species of the genus *Rhabdochona* from Europe, Asia, North, Central and South America, and from Africa. This work, however, is still incomplete, because it is often extremely difficult to obtain specimens for study (type materials of many species are not preserved*)) and it may take several years to finish this work. Therefore, the author decided to publish the revision of the genus *Rhabdochona* in a series of papers.

MATERIALS AND METHODS

The majority of specimens of the genus *Rhabdochona* have been obtained from various musea and private collections (the origin of the material will be given in the pertinent parts of the revision) and therefore the preservation of the worms was different. Some worms were studied on materials kept in alcohol, alcohol glycerine or formalin, others as wholemounts in glycerine jelly or stained preparations embedded in Canada balsam. The following procedure was used for the author's own material· The nematodes were fixed in 4% formalin (preferably hot to prevent the worms from shrinking) and kept in this fixative. The worms were inspected either directly in formalin or, more frequently, cleared with glycerine. The eggs were dissected from the uteri for examination. *En face* views were prepared either with a razor blade only or according to Anderson's (1958) method. In many cases, however, the nematodes could not be studied *en face*, because the limited number of borrowed individuals could not be destroyed for these purposes. The revision of South American species is based on specimens borrowed from the collections of· Naturhistorisches Museum, Vienna; Museu de Zoologia, Universidade de Sao Paulo; Museum d'Histoire Naturelle, Paris.

GENERAL CHARACTERS

The genus *Rhabdochona* was established by Railliet (1916) for the species *Dispharagus denudatus* Dujardin, 1845 from *Scardinius erythrophthalmus*. Later Saidov (1953) divided the genus into two subgenera: the subgenus *Rhabdochona* to receive species without filamented eggs and the subgenus *Filochona* for the species with eggs provided with filaments. Janiszewska (1955), however, assigned greater value to the filaments and established for the species with filaments the new genus *Rhabdochonoides* together with the new subfamily *Rhabdochonoidinae*. Campana-Rouget (1961) suppressed *Rhabdochonoides* as a synonym of the genus *Rhabdochona*. On the contrary Yamaguti (1961) elevated the subgeneric status of *Filochona* to the generic status and suggested the name *Filochoninae* instead of *Rhabdochonoidinae* Janiszewska, 1955. Skrjabin, Sobolev, Ivaškin (1967) and Baruš, Coy Otero (1968) accepted the genus *Filochona* within the subfamily *Rhabdochoninae*. This concept was not accepted by Rasheed (1964, 1965) who shared the opinion of others that the presence or absence of filaments is not a character of generic value and that there are no characters of generic value by which these taxa may be separated. We are inclined to concur with Rasheed's opinion in accepting only the genus *Rhabdochona* s. l., but at the present stage it appears opportune to divide the species into three subgenera according to the type of eggs. This is only a preliminary division, because in many species the true character of the eggs is still unknown.

I. Subgenus *Rhabdochona* Railliet, 1916 — the surface of mature eggs

*) I should like to emphasize the necessity of depositing and keeping type specimens in recognized collections where they will be accessible to the subsequent workers.

is smooth or covered with a thin, feebly distinguishable gelatinous layer. For the time being we have assigned to this subgenus all species in which neither filaments nor floats had hitherto been observed on the eggs:

1. *R. denudata* (Dujardin, 1845) (typical species); 2. *R. acuminata* (Molin, 1860); 3. *R. amago* Yamaguti, 1935; 4. *R. anguillae* Spaul, 1927; 5. *R. baylisi* Rai, 1969; 6. *R. beaufortis* (Liu et Wu, 1941); 7. *R. bosei* Sahay, 1966; 8. *R. brevispicula* Akhmerov, 1965; 9. *R. cascadilla* Wigdor, 1918; 10. *R. chabaudi* Mawson, 1965; 11. *R. congolensis* Campana-Rouget, 1961; 12. *R. coronocauda* Belouss, 1965; 13. *R. crassa* Finogenova, 1967; 14. *R. dasi* Sahay et Prasad, 1965; 15. *R. decaturensis* Gustafson, 1949; 16. *R. euchiloglanis* Wu, 1949; 17. *R. fujiii* (Fujita, 1921); 18. *R. garuai* Agrawal, 1965; 19. *R. girellae* Yamaguti, 1935; 20. *R. gnedini* Skrjabin, 1946; 21. *R. gymnocranius* Yamaguti, 1935; 22. *R. kidderi* Pearse, 1936; 23. *R. longispicula* Belouss, 1965; 24. *R. macrolaima* Gendre, 1921; 25. *R. mazeedi* Prasad et Sahay, 1965; 26. *R. oncorhynchi* Fujita, 1921; 27. *R. optensis* Hsu, 1933; 28. *R. ostertagi* (Dinulescu, 1942); 29. *R. paski* Baylis, 1928; 30. *R. pellucida* Gustafson, 1949; 31. *R. phoxini* Moravec, 1968; 32. *R. salvelini* Fujita, 1927; 33. *R. sarana* Karve et Naik, 1951; 34 *R. srivastavai* Chabaud, 1970; 35. *R. tridentigeris* Yamaguti, 1941; 36. *R. turkestanica* (Skrjabin, 1917); 37. *R. uca* Pearse, 1932; 38. *R. uruyeni* Diaz-Ungría, 1968; 39. *R. zacconis* Yamaguti, 1935.

II. Subgenus *Filochona* Saidov, 1953 — eggs provided with filaments. This subgenus comprizes the species:

1. *R. sulaki* Saidov, 1953 (typical species); 2. *R. barbi* Karve et Naik, 1951; 3. *R. chodukini* Osmanov, 1957*); 4. *R. cotti* Gustafson, 1949; 5. *R. ergensi* Moravec, 1968; 6. *R. filamentosa* Bykhovskaya-Pavlovskaya, 1936; 7. *R. fortunatowi* Dinnik, 1933; 8. *R. glyptothoracis* Karve et Naik, 1951; 9. *R. hellichi* (Šrámek, 1901); 10. *R. hospeti* Thapar, 1950; 11. *R. humili* Roytman et Trofimenko, 1964; 12. *R. kashmirensis* Thapar, 1950; 13. *R. latifilamentosa* Chiaberashvili, 1969; 14. *R. longicauda* Djalilov, 1964; 15. *R. macrostoma* Moravec et Mikailov, 1970; 16. *R. milleri* Choquette, 1951; 17. *R. ovifilamenta* Weller, 1938; 18. *R. penangensis* Furtado, 1965; 19. *R. smythi* Agrawal, 1965.

Remark. The list does not contain *R. marina* Roytman, 1963, allegedly also possessing filaments on the eggs. Rojtman (1963) established this species by indication, basing on inadequate descriptions by Ljajman (1930), Isakova-Keo (1952) and Žukov (1960) who had assigned these nematodes to the species *R. denudata* (Dujardin, 1845). This species was neither described nor figured by Rojtman who omitted also to give its differential diagnosis. Therefore, according to the rules of the International Code of Zoological Nomenclature adopted by the XV International Congress of Zoology in London in 1958 (chapter IV, § 13 a), the name *R. marina* Roytman, 1963 cannot be used and consequently is invalid.

III. Subgenus *Globochona* subgen. n. — eggs with special hemispherical floats. Until the present, this subgenus has been represented by 3 species:

1. *R. gambiana* Gendre, 1921 (typical species), 2. *R. singhi* Ali, 1956; 3. *R. barusi* Majumdar et Deb, 1971.

Remark: Rojtman (1963) figured similar formations on the eggs of *R. longispicula*, however, later these were found to be artefacts only (Dr. Rojtman's personal communication).

The value of the individual determining signs of the genus *Rhabdochona* has been discussed by various authors of whom Choquette (1951), Rojtman, Trofimenko (1964), Rasheed (1965) and Holloway, Klewer (1969) are worth mentioning. The number of species in our material surpassed by far that of all previous authors whose disagreement in opinions seems to warrant our detailed comments on some of the characters of nematodes in this genus.

Body size

The measurements of the body show considerable variation: some species are small, their adult females measure about 6 mm (e. g. *R. coronocauda*),

*) While Džalilov (1964) noted filaments on the eggs of *R. chodukini*, Osmanov (1957) did not mention them in his original description of this species.

others attain a length of up to 34 mm (*R. cotti*). However, we agree with Choquette (1951) and Rasheed (1965) that the body size may be considerably variable and, therefore, may be used only as a complementary character to morphological features.

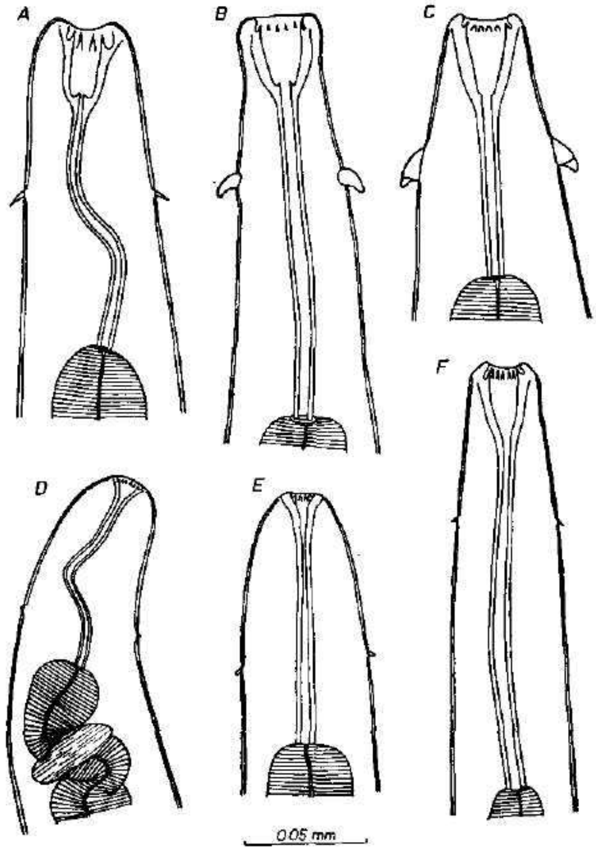

Fig. 1. Various types of the cephalic end in *Rhabdochona* species (dorsal view). A — *R. congolensis* (♀), B — *R. fortunatovi* (♀), C — *R. onifilamenta* (♀), D — *R. gambiana* (♂), E — *R. cotti* (♂), F — *R. canadensis* (♀). Orig.

Buccal cavity and teeth

The cephalic end is provided with two small, lateral, rounded elevations, which may be considered as pseudolabia. These are relatively distinct in some species, while in others they may be almost absent. The mouth is rounded or hexagonal in shape. The vestibule is relatively long, its anterior extended end representing a funnel-shaped prostom. The prostom shows considerable variation in shape, thickness and size and that even among the nematodes of the same species. The inner surface of the prostom is lined with several longitudinal ridges ending near the anterior end as small teeth protruding into the prostomal cavity. These teeth vary from species to species.

In some they are large and prominent, in others very small, either individually separated or coupled together. Their number in each species seems to be constant, ranging, according to the various authors, from 6 to 22. It is necessary to emphasize that the exact number of teeth in the prostom can be established correctly only in *en face* preparations. This procedure, however, has been used only with a very limited number of species and consequently the number

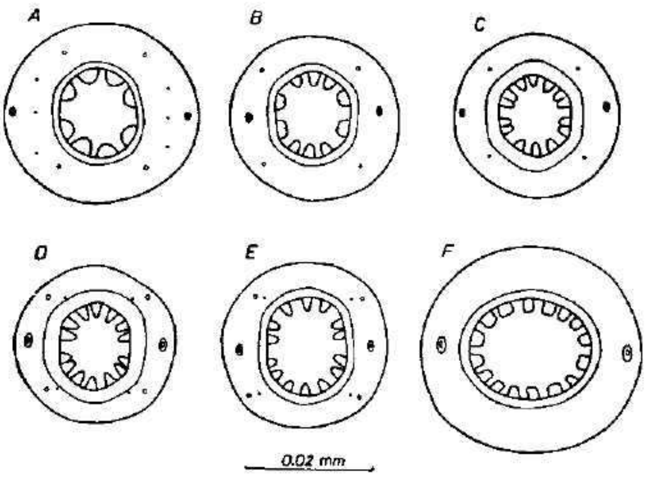

Fig. 2. Differences in the number and arrangement of teeth in the prostom of various species of *Rhabdochona*. A — *R. congolensis*, B — *Rhabdochona* sp., C — *R. humili*, D — *R. ergensi* E — *R. canadensis*, F — *R. ovifilamenta*. Orig.

of teeth given for many species seems to be doubtful. We also cannot agree with the statement by Rojtman, Trofimenko (1964) that the number of teeth in the prostom of all species of the genus *Rhabdochona* is 14. Although most of the species examined by us had 14 teeth, some possessed 8, 10 or 16. In some species the base of the prostom is strengthened by similar thickenings, which are seen to project out into the cavity as conical processes or teeth. In this we are inclined to agree with Rasheed's (1965) suggestion that these so-called "basal teeth" represent the pointed ends of the individual ridges supporting the prostom. These basal teeth are well-developed in some species, in others they are absent. In several species (i.g. *R. denudata*) we found specimens with basal teeth feebly outlined, while in other conspecific nematodes these teeth were lacking. Accordingly, the basal teeth can serve only as a complementary feature of the species. It should be emphasized that the character of the prostom (shape, number of anterior teeth, presence or absence of basal teeth) should be studied on adult worms only and that best on gravid females. The character of the prostom of a fourth-stage larva is completely different. This has been confirmed experimentally in fourth-stage larvae of *R. ergensi* and *R. phoxini* the prostom of which is provided with distinct basal teeth and the number of anterior teeth is only 6; in the adults of these nematode species basal teeth are absent from the prostom and the number of anterior teeth is 14. The same applies to the species *R. humili*.

Deirids

The cervical papillae or deirids are a very suitable morphological feature of nematodes of the genus *Rhabdochona*, although either little or even no attention has been paid to this sign in descriptions of the various species. Their size and shape are very suitable characters. In some species dereids are large and prominent (e.g. in *R. fortunatovi* and *R. ovifilamenta*), in others small and indistinct (e.g. in *R. gambiana*, *R. uruyeni*). Their shape may be simple, forked or complicated (e.g. in *R. ovifilamenta*). A useful sign is also

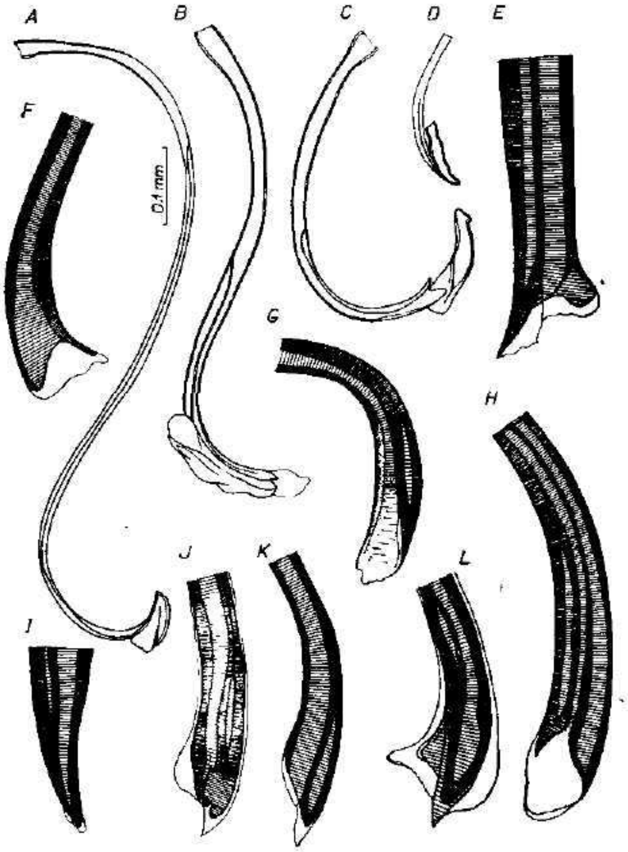

Fig. 3. A—D — variation in the size and length ratio of spicules in various *Rhabdochona* species (the same magnification) (A — *R. decaturensis*, B — *R. longispicula*, C — *R. hellichi*, D — *R. congolensis*); E—L — various types of distal tips of the larger spicule in *Rhabdochona* (E — *R. macrostoma*, F — *R. hellichi*, G — *R. gambiana*, H — *R. longispicula*, I — *R. sulaki*, J — *R. humili*, K — *R. ergensi*, L — *R. denudata*). Orig.

their position in relation to the vestibule. They may be located either close beyond the prostom, in the middle of the vestibule or near to its posterior end (in the males they are placed slightly more anteriorly than in the females).

Oesophagus

This is always divided into a muscular and a glandular portion. The ratio between the two portions, similar as the ratio of oesophagus length to body length, are often stressed in the literature as specific signs. However, we observed a considerable variation of these ratios among the nematodes of the same species and, therefore, we consider this character to be unsuitable for differentiation of the species.

Tail

The tail is often a good specific character. In various species its shape may be conical, with a sharp terminal cuticular spike or with a rounded tip, or the whole tail may be bluntly rounded. Various modifications such as small mucronate points, spikes etc. are present on the tail tips of the females of some species.

Eggs

The character of the eggs in the genus *Rhabdochona* and its importance have repeatedly been discussed. In some species the surface of mature eggs is smooth or covered with a very thin, indistinct gelatinous layer, or the eggs possess filaments. The eggs of some species have special lateral "globules",

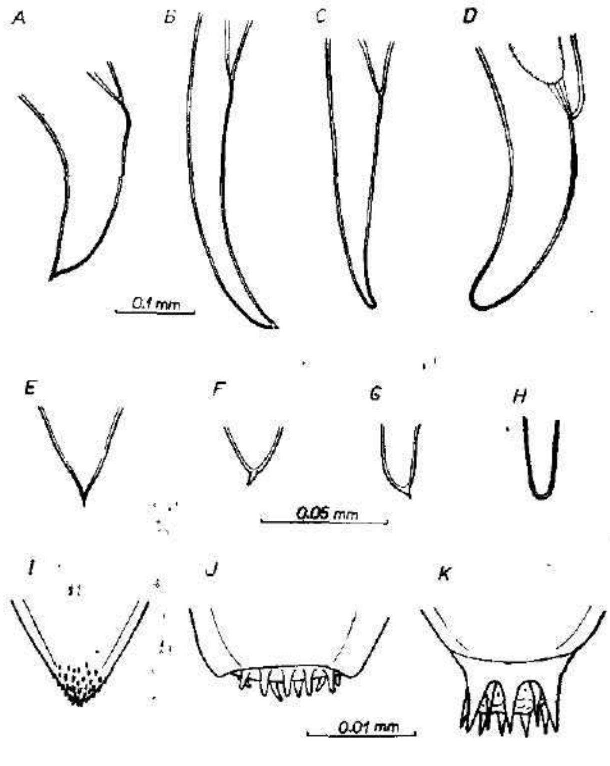

Fig. 4. A—D — various shapes of the tail in females of *Rhabdochona* (A — *R. milleri*, B — *Rhabdochona* sp., C — *R. cotti*, D — *R. paski*), E—K — various types of the female's tail tip (E — *R. canadensis*, F — *R. milleri*, G — *Rhabdochona* sp., H — *R. cotti*, I — *R. gambiana*, J — *R. congolensis*, K — *R. barusi*). Orig.

which are often designated as floats. Our studies of all three types of eggs showed quite clearly that the presence of filaments on the eggs is not a generic character as suggested by Izjumova (1962) and Džalilov (1964). We should like to stress, however, that only completely developed eggs containing an already formed larva have to be used in these studies. The eggs must be teased out of the uterus, as the filaments are not usually visible within the cleared body of the nematode. Younger eggs do not possess filaments at all or these are considerably shorter and thinner than those of the more advanced eggs. The filaments may be a good specific feature, but for this purpose it is necessary to inspect numerous eggs and to choose eggs with undamaged filaments. Mostly, only polar filaments are present — always one, two or a whole tuft on each pole; these may be short or long, filiform or ribbon-shaped. In some species (*R. ovifilamenta, R. chodukini*) filaments sprout from the whole surface of the egg.

The three types of eggs (smooth, filamented or provided with floats) appear to be associated with the life cycles of the individual species and with the external environment, but very little is known about this at the present time. Rojtman (1963) and Trofimenko (1967) speculated that the filaments enabled the egg to float and, hence, concluded that the intermediate hosts of these species were plankton invertebrates, while those of the species without filaments were benthic animals. It seems more likely, however, that these filaments are utilized to secure better attachment of the egg to the surface of various objects or plants in flowing water, and that the intermediate hosts of both nematode types (with and without filamented eggs) are benthic animals.

Tail wings and caudal papillae

The results of our studies indicate that the male nematode does not possess wings. According to Holloway and Klewer (1969), however, narrow tail wings are developed in 5 species of the genus *Rhabdochona: R. chodukini* Osmanov, 1957, *R. ovifilamenta* Weller, 1938, *R. smythi* Agrawal, 1965, *R. beaufortis* (Liu et Wu, 1941) and *R. beatriceinsleyae* Holloway et Klewer, 1969. Very narrow tail wings were reported also for males of the species *R. garuai* Agrawal, 1965. However, it is necessary to point out that the cuticle is often torn off during fixation or clearing of nematodes of the genus *Rhabdochona*, giving the impression of narrow tail wings. We found this to occur frequently in glycerine-gelatinous preparations especially when the nematodes were damaged. The illustrations of *R. smythi*, *R. garuai* and *R. beaufortis* (the latter being described on a male fragment only) indicate such cases. The original description of *R. chodukini* does not give the presence of the tail wings; the drawing indicates a torn off cuticle. Recently, we had the opportunity to study type specimens of the remaining two species (*R. ovifilamenta* and *R. beatriceinsleyae*) for which the tail wings had been reported. In the first species, we could not confirm the presence of tail wings; in the second species wide wings were present, but the general morphology of the species under consideration (especially the structure of the anterior end of body) was not consistent with that of the genus *Rhabdochona* and, therefore, we transferred this species provisionally to the genus *Cystidicola* as *C. beatriceinsleyae* (Holloway et Klewer, 1969) comb. n. It is obvious from this discussion that, within the genus *Rhabdochona*, the tail wings are not present in males.

The postanal papillae appear to be more or less constant for the entire genus. Generally, there are 6 pairs present, the second pair being lateral, the remaining subventral. Occasionally 7 or 5 pairs are found. The preanal papillae, however, vary considerably in number and arrangement even within the same species. There are numerous subventral papillae and one, two or

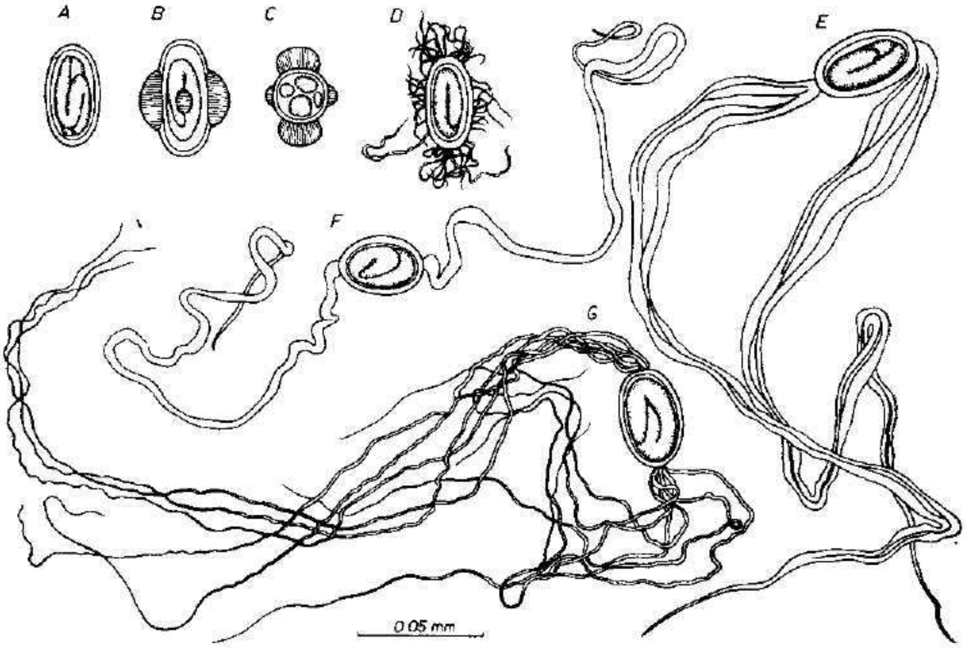

Fig. 5. Various types of the mature egg in *Rhabdochona* species. A — *R.* (*Rhabdochona*) *denudata* B, C — *R.* (*Globochona*) *barusi* (lateral and apical view), D — *R.* (*Filochona*) *ovifilamenta*, E — *R* (*Filochona*) *humili*, F — *R.* (*Filochona*) *hellichi*, G — *R.* (*Filochona*) *ergensi*. Orig.

up to five pairs of lateral papillae. The lateral papillae occur always in pairs the subventral papillae being either paired or asymmetrical (their number on one side often differs from that on the other side) within one species. Consequently it is obvious that the number and arrangement of the preanal papillae is not a reliable character for species differentiation.

In several species of the genus *Rhabdochona*, special ventral cuticular ridges, located in the area in front of the tail papillae, have been described. This sign is of little importance in the identification of the species, because these ridges may or may not be present in specimens of the same species.

Spicules

The spicules are a very important feature in species determination. They are always of unequal length. The larger (left) spicule is slender, with the distal part provided generally with a special cuticular sheath; sometimes, this part is referred to as a "blade" or "alate portion". The distal tip of the longer spicule, often typical of the species, is usually of complicated structure; it may be roughly lanceolate, cone-shaped or bifurcate. The form of the spicular tips can be studied more accurately when these are protruded out of the body. The shorter (right) spicule is generally wider, often with a barbed distal end. Important is also the length ratio of spicules, which, sometimes, is small (in *R. paski* only 1 : 2.1—2.6), sometimes considerably high (in *R. decaturensis* 1 : 11.9).

Life histories (intermediate hosts)

Although little is known at present about the life cycles of members of the genus *Rhabdochona*, it appears that mostly various mayfly larvae (see Gustafson, 1939, 1942; Štejn, 1959; Moravec, 1969), and only occasionally other larvae of aquatic insects, such as stone- and caddis-flies (Gustafson, 1949; Vojtková, 1971), are utilized as intermediate hosts. Weller's (1938) data on experimental infection of the amphipod *Hyalella knickerbockeri* with the eggs of *R. ovifilamenta* do not seem to be very reliable, because the morphology of the larvae found by this writer indicates that these were members of the *Tilenchata* (presence of a stylet). The same applies to larvae found by Janiszewska (1960) in *Tubificidae* and considered to be the invasive larvae of *Rhabdochonoides barbi* (= *Rhabdochona hellichi*); their morphology is completely different from that of members of the genus *Rhabdochona*.

An interesting feature of the development of various *Rhabdochona* species has been observed by Gustafson (1942) and later confirmed also by our experiments: the development of the larvae does not cease in the intermediate host after attaining the invasive stage; if remaining in the intermediate host long enough, the larvae may almost complete their development (the males have spicules and tail papillae, the females unfertilized eggs). Sometimes, intermediate hosts harbouring these advanced larvae or juveniles are ingested by vertebrates which normally cannot become definitive hosts of the pertinent *Rhabdochona* species. The nematodes can survive in these hosts for a certain length of time and that is why various *Rhabdochona* species or their larvae are frequently found even in such atypical hosts as frogs or bats (Baruš and Tenora, 1970).

Hosts

All known members of the genus *Rhabdochona* are parasites of fishes with the exception of *R. uca* Pearse, 1932, found in the crab. However, it is obvious that this species was described on the basis of a more advanced larva and consequently the crab may be considered as its intermediate host; moreover, there are some doubts whether this pecies shad been, in fact, a member of the genus *Rhabdochona*.

The individual species of the genus *Rhabdochona* seem to be more host specific than generally believed. Some species have been recorded from a large number of fish hosts often belonging to various families. Re-examination of some of the materials, however, revealed erroneous specific identification or the fact that several species had been considered to be a single species. In addition the *Rhabdochona* species and their larvae may be found in atypical hosts, in which the adult nematodes can survive only, but in which their larvae cannot mature. These atypical hosts are either predatory fishes (e.g. *Esocidae*, *Percidae*, *Salmonidae*) which acquire these nematodes by feeding on infected typical hosts (fishes) or other fishes which ingest infected intermediate hosts (invertebrates).

Geographical distribution

All known species of the genus *Rhabdochona* are exclusively parasites of freshwater fishes; the species *R. beatriceinsleyae*, described recently from the marine fish *Rhigophila dearborni*, has been placed in the genus *Cystidicola* in this paper.

Valid members of the genus have been recorded from all zoogeographical zones except the Australian zone. The only species described from Australia and the two species from the Antarctic region have subsequently been transferred to *Ascarophis jaenschi* (Johnston et Mawson, 1940) Rasheed, 1965, *Johnstonmawsonia coelorhynchi* (Johnston et Mawson, 1945) Campana-Rouget, 1955, and *Cystidicola beatriceinsleyae* (Holloway et Klewer, 1969) comb. n.

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Our survey indicates that of the existing definitions of the genus *Rhabdochona* the most suitable is that of Choquette (1951). This, however, should be modified as follows:

Mouth with small lateral pseudolabia, circumoral membrane bounding a funnel-shaped prostom supported by longitudinal thickenings projecting anteriorly as teeth, the number of which is variable, mesostom long and narrow. Oesophagus composed of two unequal parts. Deirids simple or bifurcate. Male: several pairs of postanal papillae; preanal papillae numerous, arranged often asymmetrically; no caudal alae, spicules unequal and dissimilar; gubernaculum absent; tail conical, its tip rounded or provided with a cuticular spike. Female: uteri opposed; vulva about middle of body; tail rounded or ending in a spike, sometimes with numerous spines, spikes or small mucronate points at the tip; eggs elliptical, embryonated, their shells either smooth, filamented or provided with floats. Parasites of freshwater fishes.

Typical species: *R. denudata* (Dujardin, 1845) Railliet, 1916.

South American species of *Rhabdochona*

From South America six species belonging to the genus *Rhabdochona* have been described. Many of the original descriptions of these species are inadequate or erroneous. This not only complicated the correct identification of nematodes from South America, but even led to confusions resulting in mistaking South American nematodes for species occurring in Europa or Africa. An attempt has therefore been made to study and compare the individual species on the basis of various borrowed materials. The present review indicates that only two of the South American species may be regarded as valid; it may, however, be expected that more new species of this genus will be described from this area, because many parts of South America have not been investigated adequately.

1. *Rhabdochona (Rhabdochona) acuminata* (Molin, 1860) (Fig. 6)

Syn.: *Rhabdochona elegans* Travassos, Artigas et Pereira, 1928; *R. fasciata* Kloss, 1966; *R. australis* Kloss, 1966; *R. siluriformis* Kloss, 1966.

The following description is based on specimens from *Astyanax bimaculatus* and *A. fasciatus* (*Characidae*) from the River Mogi-Guassu near S. Paulo, Brazil, lent by Dr. G. R. Kloss.

Male (5 specimens): Length of body 6.30—10.22 mm, maximum width 0.081 — 0.122 mm. Pseudolabia almost absent. Prostom of medium size, funnel-shaped, relatively short: length 0.015—0.027 mm, maximum width 0.009—0.015 mm. The inner surface of the prostom is supported by longitudinal ribs ending near the anterior end as small pointed teeth, their number being 14. The lateral teeth are arranged in pairs. The base of the prostom is armed with distinct basal teeth. The vestibule including the prostom measures 0.123—0.150 mm, the muscular

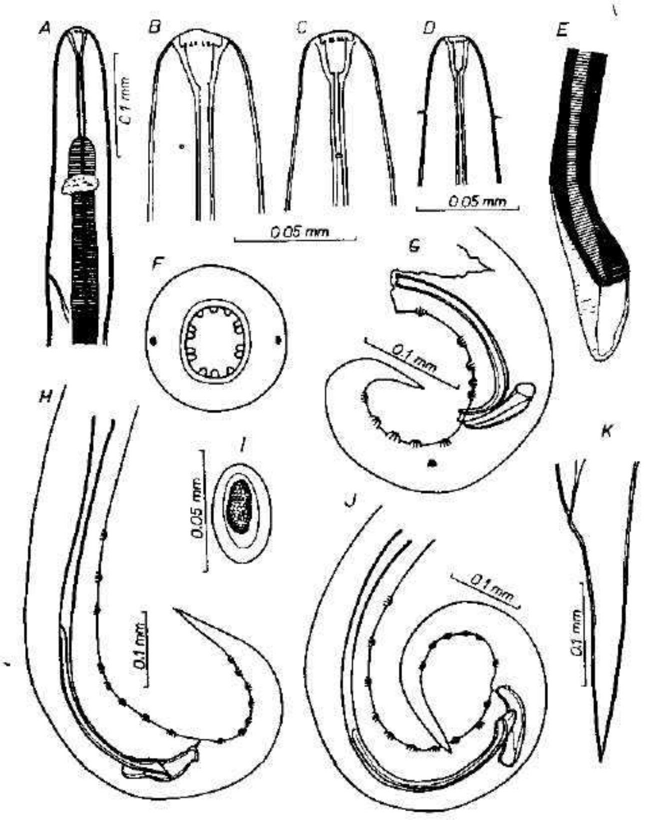

Fig. 6. ***Rhabdochona acuminata*** (Molin, 1860). A, B — anterior end of male (type specimen) (lateral view); C, D — anterior end of male (dorsal and lateral views); E — distal tip of longer spicule; F — anterior end of female (*en face* view); G — posterior end of male (type specimen) (lateral view); H, J — posterior end of male (lateral view); I — immature egg (type specimen); K — tail of female (lateral view). Orig.

oesophagus 0.270—0.360 mm, the glandular oesophagus 1.18—1.96 mm. Deirids slender, simple, situated 0.015—0.051 mm from the anterior end of the body. The nerve ring surrounds the muscular oesophagus at 0.156—0.207 mm from the anterior end of the body, the excretory pore is situated at a distance of 0.237 mm. The subventral preanal papillae vary in number in the specimens examined: these occurred in the combinations 8 + 8 and 10 + 11. In addition to these, there is one preanal pair placed laterally in the space between the third and fourth subventral pair (counted from the cloaca). There are 6 pairs of postanal papillae, the second pair is lateral, the others subventral; only in the largest male the arrangement of the subventral papillae was asymmetrical — 5 papillae on one side of the tail, 7 on the other. Spicules unequal: the larger spicule of adult males measured 0.576 to 0.591 mm, of the juvenile male only 0.360 mm. Its distal end is blunt with a wide membraneous sheath on the dorsal side. The short spicule measuring 0.081—0.120 mm is provided with an indistinct dorsal barb on its distal end. Length ratio of spicules 1 : 4.91 — 5.18. The tail conical, 0.243—0.375 mm long, with a sharp terminal cuticular spike.

Female (2 specimens). Length of body 10.69—20.54 mm, maximum width 0.095—0.272 mm. Prostom shape identical with that of the male; its length 0.021—0.036 mm, maximum width 0.012—0.030 mm. Measurements of vestibule including prostom 0.144—0.156 mm, of the muscular *oesophagus 0.321—0.476 mm, of the glandular oesophagus 1.44—4.41 mm*. Deirids identical with those of the male, situated 0.060 mm from anterior end of body; nerve ring at a distance of 0.204—0.270 mm. The excretory pore was not located. Vulva postequatorial, 4.27—8.19 mm from posterior end of body. Eggs were present in the larger female only, but these had been inspected only inside the uterus. The eggs were deformed, their size was 0.030 × 0.021 mm; no filaments were observed on their surface. Tail conical, 0.225—0.240 mm long, with a sharp terminal cuticular spike.

Location: In the intestine; only Vaz and Pereira (1934) found one male nematode in the gall bladder of *Pimelodella laterstriga*.

Hosts: Typical hosts of *R. acuminata* are members of the family *Characidae (Brycon falcatus, Astyanax bimaculatus, A. fasciatus, Tetragonopterus* sp.); Vaz and Pereira (1934) reported also *Pimelodella laterstriga (Pimelodidae)* and *Glanidium neivai (Auchenipteridae)*: it is obvious that the infection of the latter two hosts is accidental, this being suggested also by the atypical location in *P. laterstriga*.

Distribution: Molin (1860) described this species from Brazil (Matogrosso); from there it was recorded also by Travassos, Artigas and Pereira (1928), Vaz and Pereira (1934) and Kloss (1966) (the Rivers Tietê, Grande and Mogi-Guassu,-tributaries of the River Paraná).

Specimen: Naturhistorisches Museum, Wien, No. A. N. 4985 and Museu de Zoologia, Universidade de Sao Paulo, No. 2074, 2076, 2090, 2093, 2094.

Comments: Our description is based on specimens from *Astyanax* spp. In addition, we studied Molin's original material, borrowed from the Museum of Natural History in Vienna. Although these individuals were in very poor condition (they consisted mostly of fragments only) it was possible to confirm that these were identical with the nematodes from *Astyanax* spp.

The species originally described by Molin (1860) as *Spiroptera acuminata* on the basis of worms collected by Natterer in 1826 in Brazil, was later redescribed by Drasche (1884). In 1922, Gendre ascribed to this species nematodes collected from *Barbus* sp. in Africa. Campana-Rouget (1961), however, considered Gendre's specimens as an independent species — *R. gendrei*, to distinguish it from the South American species *R. acuminata* by its geographical distribution and by some minor morphological differences. The writer, having studied the specimens of both species is declined to confirm Campana-Rouget's (1961) opinion that the African nematodes should be considered as an independent species; the latter differs from the South American species mainly in the absence of basal teeth in the prostom, in the shape of the distal end of the larger spicule, and in the shape of the small spicule.

In 1940, Osmanov found nematodes in *Barbus tauricus* in the USSR (near Sevastopol), assigning them to the species *R. acuminata*. On the basis of this erroneous identification, other authors recorded this species from European fishes of the genus *Barbus* (e.g. Markevič, 1951; Roman, 1955; Izjumova, 1962, Žitňan, 1967; Kakačeva-Avramova, 1969); Ergens (1965) reported it even from the host *Noemacheilus barbatulus*. All these European nematodes were typified by the presence of long filaments on the eggs and this was the reason for the later transfer of the species *R. acuminata* to the genus *Filochona* (see Yamaguti, 1961). The eggs of the South American specimens of *R. acuminata* are, however, smooth, without filaments. As pointed out by Moravec in earlier papers (1968, 1971) the nematodes from European fishes belong, in fact, to the species *Rhabdochona (Filochona) hellichi* Šrámek, 1901 and *R. (F). ergensi* Moravec, 1968, but possibly also to other species.

Three species of the genus *Rhabdochona* were described from fishes collected in the basin of the River Paraná in Brazil: *R. elegans, R. australis* and *R. fasciata*. In addition, the species *R. acuminata* was found by Vaz and Pereira (1934) from the same area; Kloss (1966) considered these nematodes to be an independent species and designated it *R. siluriformis*. The writer, however, having had the opportunity to study the type specimens of the species *R. australis* and *R. fasciata*, disclosed that these nematodes were conspecific with Molin's individuals of *R. acuminata*. He was unable to obtain the type specimens of *R. elegans* and *R. siluriformis*. A comparison of the more important characters of all these species (Table 1) revealed no significant differences among these nematodes. The differences in the number of tail papillae and in the ratio of oesophagus length to body length may be considered to be a variability within the same species which is considerable in nematodes of this genus. Metrical differences (e.g. spicule lengths) may be due either to erroneous data in the original descriptions or to the fact that juvenile nema-

Table 1. Comparison of some important features of *R. acuminata*, *R. elegans*, *R. australis*, *R. fasciata* and *R. siluriformis*

	R. acuminata after DRASCHE 1884 (own data in brackets)	*R. elegans* after TRAVASSOS ARTIGAS, PEREIRA 1928	*R. australis* after KLOSS 1966 (own data in brackets)	*R. fasciata* after KLOSS 1966 (own data in brackets)	*R. siluriformis* (= *R. acuminata*) after VAZ, PEREIRA 1934
Approximate length ratio of entire oesoph. and body	? (1 : 3)	?	1 : 5 (1 : 4—5)	1 : 4 (1 : 4)	1 : 6—7
Length of larger spicule	? (0.480—0.492)	0.423—0.446	0.353—0.494 (0.576—0.591)	0.383 (about 0.36)	0.34
Length of smaller spicule	? (0.069—0.081)	0.138—0.146	0.110—0.128 (0.081—0.120)	0.068—0.071 (0.087)	0.14
No. of preanal pairs of papillae	11 (?)	10	9 (11, 12)	11 (8)	6
No. of postanal pairs of papillae	6 (6)	5	5 (5, 7)	5 (6)	5
Hosts	*Brycon falcatus*	*Tetragonopterus* sp.	*Astyanax bimaculatus*	*Astyanax bimaculatus* *A. fasciatus*	*Pimelodella laterstriga* *Glanidium neivai*
Family	*Characidae*	*Characidae*	*Characidae*	*Characidae*	*Pimelodidae* and *Auchenipteridae*
Occurrence	Matogrosso	basin of River Paraná (Rivers Mogi-Guassu and Tietê)	basin of River Paraná (River Mogi-Guassu)	basin of River Paraná (River Mogi-Guassu)	basin of River Paraná (Rivers Grande and Tietê)

todes were measured. Moreover, all species under consideration were collected in the same localities and, with the exception of *R. siluriformis*, from related hosts of the same family. Consequently the writer considers the names *R. elegans* Travassos, Artigas et Pereira, 1928, *R. australis* Kloss, 1966, *R. fasciata* Kloss, 1966 and *R. siluriformis* Kloss, 1966 to be synonyms of *R. acuminata* (Molin, 1860).

2. *Rhabdochona* (*Rhabdochona*) *uruyeni* Díaz-Ungría, 1968 (Fig. 7)

The description is based on type specimens from the host *Piabucina* sp from Venezuela.

Male (a fragment of the posterior part of body): Length of fragment 6.5 mm, maximum width 0.150 mm. Tail conical, 0.225 mm long, with distinctly rounded tip. i.e. without usual cuticular spike. Of a total of 10 pairs of preanal papillae present, 9 pairs are subventral and one

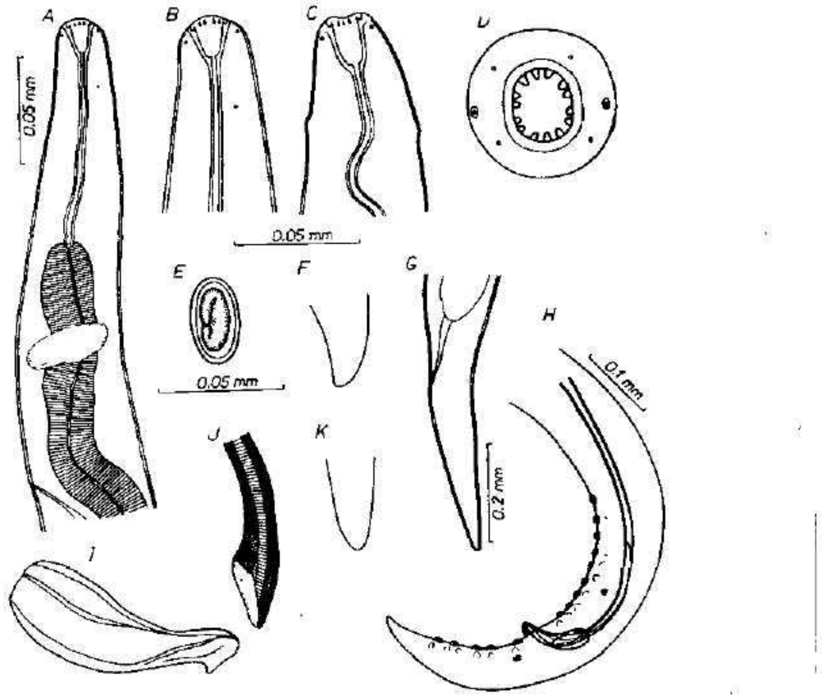

Fig. 7. *Rhabdochona uruyeni* Díaz-Ungría, 1968. A — anterior end of female (lateral view); B, C, D — anterior end of female (lateral, dorsal and *en face* views); E — mature egg; F — tip of male tail; G — tail of female (lateral view); H — posterior end of male (lateral view); I — smaller spicule; J — distal tip of longer spicule; K — tip of female tail. Orig.

pair lateral; the latter lies approximately at the level of the fourth subventral pair (counted from the cloaca). Subventral postanal papillae asymmetrical — 5 papillae on one side of the body, 6 papillae on the opposite side. In addition to the subventral papillae there is one pair of lateral postanal papillae placed slightly behind the first subventral pair. The ventral surface of the male body bears longitudinal cuticular ridges situated in front of the preanal papillae. The larger spicule is slender, 0.456 mm long, its distal end slightly distended. The short spicule with a reflected barb at its posterior end is 0.102 mm long. The length ratio of spicules is 1 : 4.47.

Female (2 complete specimens and a fragment of the anterior part of body). Length of body 11.60 mm, maximum width 0.136—0.163 mm. Pseudolabia almost absent. Prostom relatively small, funnel-shaped, with basal teeth; prostom length 0.018 mm, maximum width 0.012 to

0 015 mm. Prostom lined internally with longitudinal ribs protruding into the cavity as small teeth. Number of teeth 14, lateral teeth "coupled" in pairs. The vestibule including prostom measures 0.126—0.135 mm, the muscular oesophagus 0.240 mm, the glandular oesophagus 2.09 mm. Nerve ring at 0.168—0.186 mm, excretory pore at 0 237—0.279 mm from anterior end of body. Deirids reduced, very small, simple, situated at 0 042 mm from anterior extremity. Vulva postequatorial, at 4.49—6 32 mm from posterior end of body. Mature eggs (containing larvae) smooth, without filaments, size 0.036—0.039 × 0 018—0.021 mm. Tail conical, slightly rounded at the tip, without cuticular spike

Location: Intestine.

Host: Typical host — *Piabucina* sp. (*Characidae*).

Distribution: This species has been recorded from Venezuela (Uruyen, Auyantepui) only.

Specimen: Muséum National d'Histoire Naturelle, Paris.

Comments: The morphological characters of *R uruyeni* are very similar to those of the preceding species and also the hosts of both species belong to the same family — *Characidae* Although Diaz Ungría (1968) gives 13 anterior teeth in the prostom of *R. uruyeni*, we observed 14 teeth. this is consistent with the number of teeth in the prostom of *R acuminata*. The only morphological differences between these two forms, which may be considered to be of specific value, are only found in the size and shape of the deirids and in the shape of the tail.

A key to South American species of *Rhabdochona* parasitic in fishes

1. Deirids well developed, stiletto-shaped; tail tip of both sexes provided with a sharp cuticular spike . . . . *R. acuminata*
— Deirids reduced, hardly visible; tail tip of both sexes moderately rounded, without a cuticular spike . . . . *R. uruyeni*

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REFERENCES

Agrawal, V., 1965: Some new nematode parasites from fresh water fishes of Lucknow. *Ind. J. Helminthol.* 17 : 1—17.

Anderson, R. C., 1958: Méthode pour l'examen des nematodes en vue apicale. *Ann parasitol.* 33 : 171—172.

Baruš, V., A Coy Otero, 1968: Freitasia teixeirai gen. n. et sp. n. and other nematodes parasitizing Anolis equestris (Squamata: Iguanidae). *Folia parasit. (Praha)* 15 : 41—54.

Baruš, V, F. Tenora, 1970. Further discoveries of nematodes in the bats of Afghanistan. *Sbor. VŠZ v Brně, A*, 18 · 133—141.

Campana-Rouget, Y., 1955: Sur deux nouveaux genres de spirurides parasites de poissons: discussion systematique des genres voisins. *Ann. parasitol* 30 · 346—362.

Campana-Rouget, Y., 1961: Nématodes de poissons. *Résultats scientifiques de l'exploration hydrobiologique des lacs Kivu, Édouard et Albert* (1952—1954) (*Brussel*) 3 : 1—61.

Choquette, L. P. E., 1951: On the nematode genus Rhabdochona Railliet, 1916 (Nematoda· Spiruroidea). *Canad J. Zool.* 29 · 1—16.

Díaz-Ungría, C., 1968: Helmintos de peces de Venezuela, con descripcion de un genero y tres especies nuevas. *Bol Soc. Venezol. Cienc. Natur.* 27 · 537—549

Drasche, R , 1881 Revision der in der Nematoden-Sammlung des k. k. zoologischen Hof-cabinetes befindlichen Original Exemplare Diesing's und Molin's. *Verhandl zool. bot. Ges. Wien* 33 : 193—218.

Džalilov, U. D , 1964: Materialy po rabdochonam (Rhabdochona Railliet, 1916) ryb r. Vachš i pojmennych ozer *Izv. AN Tadž. SSR, otd. biol. nauk* 1 (15) : 109—117.

Ergens, R., 1965: Parazitofauna ryb řeky Osoblahy. *Čs. parasitol* 12 : 145—169

Gendre, E., 1922: Notes d'helminthologie africaine (sixième note). *Procès - verbaux de la Soc. Linn Bordeaux* 73 · 148—156

Gustafson, P. V., 1939: Life cycle studies on Spinitectus gracilis and Rhabdochona sp. (Nematoda: Thelazüdae). *J. Paras.* **25** : 12—13. Suppl.

Gustafson, P. V., 1942: A peculiar larval development of Rhabdochona spp. (Nematoda: Spiruroidea). *J. Paras.* **28** : 30, Suppl.

Gustafson, P. V., 1949: Description of some species of Rhabdochona (Nematoda: Thelaziidae). *J. Paras.* **35** : 534—540.

Holloway, H. L., H. L. Klewer, 1969: Rhabdochona beatriceinsleyae n. sp. (Nematoda: Spiruridea. Rhabdochonidae), from the Antarctic zoaroid, Rhigophila dearborni. *Trans. Amer. Microsc. Soc.* **88** : 460—471.

Isakova Keo, M. M., 1952: Parazitofauna ugaja (Leuciscus brandti) i jejo osobennosti. *Uč. zap. Leningr. gos. univ.*, **141**, (ser. biol.) **28** : 230—237.

Izjumova, N. A., 1962: Kruglye červy. In Bychovskij et al. „Opredělitel parazitov presnovodnych ryb SSSR". Izd. AN SSSR, Moskva Leningrad : 522—579.

Janiszewska, J., 1955: Rhabdochonoides barbi g. n., sp. n., subfamily Rhabdochonoidinae subfam. n. (fam. Rhabdochonidae Skrjabin), an intestinal parasite in cyprinid fish. *Acta Parasit. Polon.* **3** : 233— 244.

Janiszewska, J., 1960: Studies on larval nematodes in Tubificidae (A hypothesis on the life-cycle of Rhabdochonidae). *Acta Parasit. Polon.* **8** : 419—425.

Kakačeva - Avramova, D., 1969: Chelminti po ribi ot reki na Zapadna Stara planina II. Trematoda, Cestoda, Acanthocephala, Nematoda. *Izv. Centr. chelmintol. lab.* **13** : 61—74.

Kloss, G. R., 1966: Helmintos parasitos de especies simpátricas de Astyanax (Pisces, Characidae). *Papéis Avulsos, depart. zool. Secret. agricult. (São Paulo)* **18** : 189—219.

Ljajman, E. M., 1930: Parazitičeskie červi ryb zaliva Petra Velikogo. *Izv. Tichook. naučno-promysl. stancii* **3** : 1—120.

Markevič, A. P., 1951: Parazitofauna presnovodnych ryb USSR. Kiev.

Molin, R., 1860: Una monografia del genere Spiroptera. *S. B. Akad. Wiss. Wien, math.-naturwiss. Kl.*, **38** : 911—1005.

Moravec, F., 1968: Species of the genus Rhabdochona Railliet, 1916 (Nematoda: Rhabdochonidae) from fishes of Czechoslovakia. *Folia parasit. (Praha)* **15** : 29—40.

Moravec, F., 1969: Hlístice ryb Československa a vývojové cykly některých druhů, I, II. Kandidát. disertace Paras. ústavu ČSAV, Praha.

Moravec, F., 1971: Nematodes of fishes in Czechoslovakia. *Acta Sc. Nat. Brno* **5** : 1—49.

Moravec, F., H. P. Arai, in press: The North and Central American species of the genus Rhabdochona Railliet, 1916 (Nematoda: Rhabdochonidae) of fishes, including Rhabdochona canadensis sp. nov. *J. Fish. Res. Bd. Canada.*

Osmanov, S. O., 1940: Materialy k parazitofauně ryb Černogo morja. *Uč. zap. Leningr. ped. inst., kaf. zool. i darwinizma* **30** : 187—266.

Osmanov, S. O., 1957: Novaja nematoda iz ryb Amu Darji. *Dokl. AN UzSSR* **1** : 63—65.

Railliet, A., 1916: La famille des Thelaziidae. *J. Paras.* **2** : 99—105.

Rasheed, S., 1964: On Hepatinema karachiensis gen. et sp. nov. (Thelaziidae Railliet, 1916) from a marine fish of Pakistan, with a note on the genus Filochona (Saidov, 1953) Yamaguti, 1961. *J. Helminthol.* **38** : 63—76.

Rasheed, S., 1965: A preliminary review of the genus Rhabdochona Railliet, 1916 with description of a new and related genus. *Acta Parasit. Polon.* **13** : 407—424.

Roman, E., 1955: Cercetări asupra parazitofaunei peştilor din Dunăre. Bucureşti.

Rojtman, V. A., 1963: Nematody ryb bassejna r. Zei. *Tr. GELAN* **13** : 253—300.

Rojtman, V. A., V. Ja. Trofimenko, 1964: Taksonomičeskaja značimosť někotorych morfologičeskich priznakov rabdochon. *Helminthologia* **5** : 135—147.

Saidov, Ju. S., 1953: Revizija semejstva Rhabdochonidae Skrjabin, 1946 i podsemejstva Cyclozoninae Sobolev, 1949. *Raboty po gelmint. Sbor. k 75 letiju K. I. Skrjabina, Moskva*, 622—635.

Skrjabin, K. I., A. A. Sobolev, V. M. Ivaškin, 1967: Spirurаty životnych i čeloveka i vyzyvaemye imi zabolevanija, č. 4 — Teljazioidei. Osnovy nematodologii 16, Moskva.

Štejn, G. A., 1959: K voprosu o žizněnnom cikle i uslovijach obitanija nematody Rhabdochona denudata (Dujardin, 1845). *Dokl. AN SSSR* **127** : 1320—1321.

Travassos, L., P. Artigas, C. Pereira, 1928: Fauna helminthologica dos peixes de agua doce do Brasil. *Arch. Inst. Biol. (São Paulo)* **1** : 5—68.

Trofimenko, V. Ja., 1967: Perestrojka sistěmy semejstva Rhabdochonidae Skrjabin, 1946 na osnonove analiza ego filogenii. *Sbor. rabot po gelm. ryb i ptic* 77—95, Moskva.

Vaz, Z., C. Pereira, 1934: Contribuição ao conhecimento dos nematoides de peixes fluviais do Brasil. *Arch. Inst. Biol. (São Paulo)* **5** : 87—103.

Vojtková, L., 1971: Beitrag zur Erkenntnis der Helminthenfauna der Wasserwirbellosen. III. Cestoda, Nematoda, Acanthocephala. *Věst. Čs. spol. zool.* **35** : 146—155.

Weller, T. H., Description of Rhabdochona ovifilamenta n. sp. (Nematoda: Thelaziidae) with a note on the life history. *J. Paras.* 24 : 403—407.
Yamaguti, S., 1961: Nematodes of vertebrates. Pt. 1, 2. Systema helminthum III. New York London.
Žitňan, R., 1967: Nematoda, Acanthocephala a Hirudinea rýb tečucich vôd Potiskej nížiny. *Biologia* 22 : 845—852.
Žukov, E. V., 1960: Endoparazitičeskie červi ryb Japonskogo morja i Južno Kurilskogo melkovodja. *Tr. Zool. inst. AN SSR* 28 : 3—146.

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SEX RATIO IN SPAWNING SHOALS OF PERCH — PERCA FLUVIATILIS LINNAEUS, 1758 AND ROACH — RUTILUS RUTILUS (LINNAEUS, 1758) IN THE KLÍČAVA VALLEY WATER RESERVOIR WITH REGARD TO THEIR ABUNDANCE

KAREL PIVNIČKA

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Abstract. From five year observations of the sex ratio in spawning shoals of perch and roach during the years 1967—71 it follows that this ratio is influenced, above all, by the age composition as well as by the population number of the said species, the latter being connected with the former, so that the younger and more abundant is the spawning population, the greater percentage of males it comprises and vice versa. However, in a very abundant population even in older classes the number of females taking part in spawning decreases owing to deteriorating food conditions (omission of spawning). In the roach it is the first mechanism of regulating the proportion of males and females in spawning shoals, and in the perch the second mechanism, that make themselves felt to a higher degree.

INTRODUCTION

A varied proportion of males and females of many fish species in individual years and in different waters are often discussed. A summary of studies dealing with these problems has recently been made by Nikolskij (1965). Essentially there exist two groups, or rather two different kinds of explanation of this phenomen. Alm (1946), Hile (1947, cited after Salah El-Din El Zarka, 1959) and Whitney (1958) consider the predominance of perch males as having probably been caused by the use of a certain fishing technique, or perhaps by a greater activity of males at places of spawning, or by their earlier arrival at the places of spawning and their later departure — in *Stizostedion vitreum* — Whitney (l.c.). At the present time there seems to prevail the opinion that it is the matter of a regulative mechanism working through the medium of food amount and thereby conceivably through the medium of population number Nikolskij (l.c.).

In literature there is direct evidence that while the population number increases, the percentage of females in spawning shoals decreases, Hardisty (1954, 1960) in *Lampetra planeri* and Spanovskaja, Savvaitova et Potapova (1964) in *Perccottus glehni* But none of these studies deals with the age composition of the populations investigated. Further different rations of the representation of males and females in spawning shoals of the perch and roach in the Klíčava valley water reservoir will be compared, as well as their changes in connection with the abundance and age composition in the years 1967—1971.

MATERIAL AND METHODS

Simultaneously with the estimation of population number in the Klíčava valley water reservoir during the years 1967—71, data were gathered concerning the proportion of males and females of the roach and perch. Roach specimens were captured in gill nets with the mesh size of 3 cm, the perch in fyke nets with the mesh size of 1 cm The fishing equipment used was the same every year. In the period approximately from April 15th to the end of May of each year all the fishes were recorded according to sex and size. On the whole 7568 specimens of the roach (462, 2748, 1536, 335, 1487), 7578 perch specimens (1872, 4217, 831, 427, 231) were captured in individual years and evaluated according to the proportion of males and females. Most of these fish specimens were marked and released into water for the purpose of further estimation of abundance. Scales were taken from random samples (always on a fixed day, from all the fish specimens, and in case of a numerous catch from some of the fishes selected at random) and used for the analysis of age composition.

RESULTS AND DISCUSSION

The perch

The proportion of males and females in individual years and the abundance of this species ix expressed in Tab. 1. In the perch the very low percentage of females in two years 1967 and 1968 as well as the increase in their proportion in the following years are striking at first sight. The ratio males — females in the perch in the first age group was found by Dyk (1938) and Kříženecký (1940) to be 1.12 : 1.00 and 1.00 : 1.09. Consequently, one cannot assume that the sex ratio had been influenced e.g. at the time of embryonic development, as it was found out by Kanidev (1967) in *Oncorhynchus gorbuscha*, where with a higher temperature at the time of the embryonic development males were predominant. Alm (1946) found a con-

Table 1. Abundance (N), percentage of females (%) and number of fish (n) caught in different years

	1967	1968	1969	1970	1971
Roach					
N	115 100	230 900	89 900	61 600	33 500*
%	44.0	51.0	65.0	39.0	56.5
n	462	2 748	1 536	335	1 487
Perch					
N	27 400	25 200	13 700	10 000	4 300
%	11.2	8.3	19.1	25.1	37.5
n	1 872	4 217	831	427	231

* 3—8 age groups only

siderable prevalence of male perch specimens at the time of spawning, but after that period the ratio changed to 48.5 : 51.5 (males — females). Naturally it is the males — females ratio in the spawning period that we are interested in, for this ratio is decisive for the number of spawned eggs and, consequently, also for the abundance of following age classes.

Before proceeding to the evaluation of the males — females ratio, let us check some objections of a more or less technical character that could influence the total evaluation.

1. Males remain longer at the places of spawning, to which they also come earlier, and thus their percentual representation increases Whitney (1958). The percentage of fish specimens remaining at the spawning places (marked recaptured specimens) can be found out from the estimates e.g. for the year 1968. If we consider them all as males and subtract their number from the total amount of fish captured in separate periods, we obtain for the whole spawning period the value 91.7% of males, but if we do not subtract the number of these specimens, we get the value 93.4% of males. So the difference is very small. In all the years we used values obtained by computation after deduction of marked fish specimens. Moreover this calculation is considerably simplified, since females, too, remain at the spawning places. The spawned females — unspawned females ratio — naturally in a more advanced stage of spawning usually amounts to approximately 1 : 2.

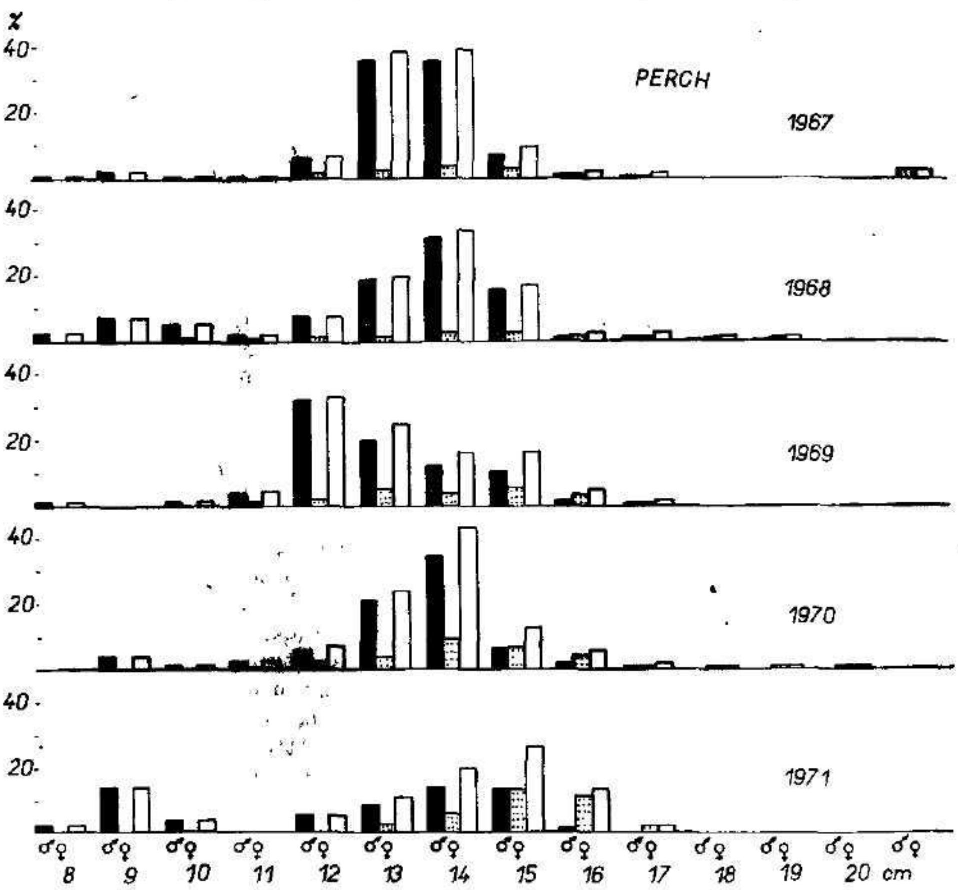

Fig. 1. Length distribution of spawning shoals of perch in different years

2. The higher percentage of males could also be explained se by their greater activity at the time of spawning Hile (1947, cited after Salah El-Din El Zarka, 1959). Spawning activiti of males, however, must be rough the same every year. Besides, marked males from the locality B near an inland were only seldom captured at other localities distant only several hunderd metres.

Holčík (1965) found in 1964 in the Klíčava valley water reservoir 7% of females in a population of 43,500 specimens. It follows from his statement as well as from our data (Tab. 1.) that simultaneously with the rise in the population abundance the percentage of females is falling, very quickly at first, later considerable more slowly. It is an analogy of the relationship between the specific growth rate and the logarithm of population density, as it is stated by Backiel et LeCren (1967).

In Fig. 1., where the length distribution of perch specimens captured at the time of spawning in individual years has been expressed, it can be well seen that the percentage of females increases in accordance with the growing proportion of the perch in longer groups, i.e. even in older ones. Here the decisive part is played by 15 cm-groups and longer ones, as well as by their total share in samples. In these groups one can observe conspicuous increase in the number of females (the 4th, 5th and other age groups are involved here). It is interesting that Holčík (l.c.) found in his sample, containing the lowest number of females (7%) in the 1st age group, 55% of fish specimens. In the years 1967—1971 there were successively 2.2%, 16.9%, 1.0%, 3.9% and 19.9% of fish specimens in the 1st age group. In view of the great abundance of the 1st age group in 1964 and the fact that male perches become sexually mature in the 1st year of their life, their percentual representation in that year was very high. In the following years the population number of the perch was falling, because there were no numerous age classes entering the population, as it was the case in 1964. Another relatively numerous age class came as one-year-old in 1968. The abundance of this age class, born in 1967, was estimated in the autumn of the same year at 240,000 specimens. In 1971 the abundance of the 0 age class amounted only to 4800 specimens (Dr. Černý personal communications). The abundance of the perch population has been very low in the last years and the percentage of females keeps rising — more and more females take part in spawning. One can call it a regulative mechanism of the percentual representation of males and females that works in the following way: A very abundant population consists, above all, of the youngest age groups, in which males automatically predominate. As far as, in the course of further development of the population, no approximately equally numerous age classes continue to enter it, the mortality rate — that is higher in males owing to their earlier sexual maturity (Kříženecký, Kříženecká-Pulánková, 1952) causes accumulation of females. In case of a decrease in abundance it is also the fact that owing to better food conditions more females take part in spawning, that is contributing to an increase of the total number of spawning females. It is in this way that Nikolskij (1965) visualizes the course of the regulation. As to the perch under the conditions of the Klíčava valley water reservoir, it is apparently the considerably abundant roach population that plays a part there and causes the delay — the proportion of females of the perch rises with only after a great decrease of perch abundance.

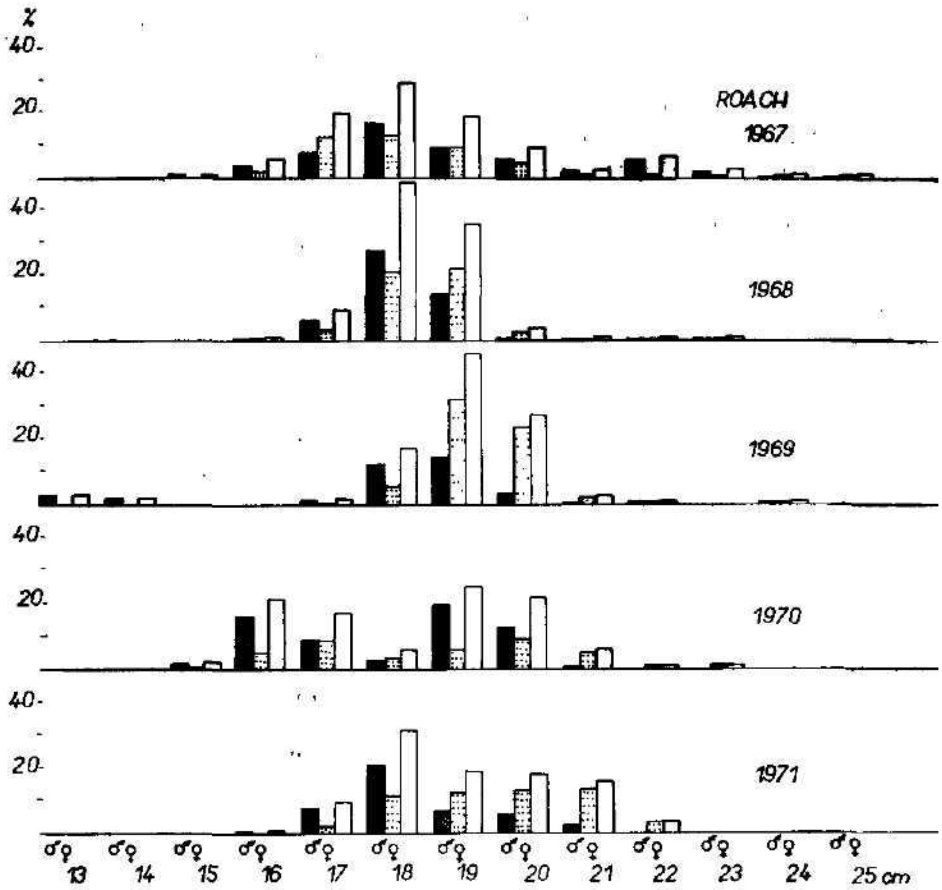

Fig. 2. Length distribution of spawning shoals of roach in different years.

The roach

In the roach, too, one can find a connection between the abundance, age composition and proportion of males and females in spawning shoals (Tab. 1., Fig. 2.). Till 1969, in connection with a decreasing population number of the roach, the percentage of males was decreasing and the number of females was growing. In 1970, however, the percentage of females rapidly fell, and rose again only as late as in 1971. The age composition in the years 1967 (69.5 % of fish specimens in the 4th age group), 1970 (41.3% of fishes in the 3rd age group) and 1971 (60% of fishes in the 4th age group) gives an answer to this question. In these years the greatest number of fishes were included in younger age groups, where again owing to an earlier sexual maturity of males this sex was represented by larger numbers at the places of spawning. The difference between the percentage of females in 1967 (44% of females) and in 1971 (56.5% of females), when most fishes were always in the 4th age group, results from different representation of other age groups. In 1967 there were only 21% of fish specimens in the 5th, 6th, 7th and 8th age groups, while in 1971 there were almost 40% of the fishes in the said groups. From 1967 the population was growing old (there were no new age classes entering the population). The ageing was manifested by a gradual increase in the percentage of females in the years 1968 and 1969. But in 1970 there appeared a new, strong age class born in 1967 and the percentage of females decreased. The predominance of males of the roach in younger age groups (2 and 3) is stated by Lelek (1965).

Expresed in terms of the 4th age class abundance, the age class 1963 represents 53,400 speciemens in 1967 and the age class 1967 represents 20,700 specimens in 1971. In abundant, though older age classes spawning is omitted owing to deteriorated food condition, as it happens in the perch. This was most conspicuous in the year 1970.

CONCLUSIONS

1. In the years 1967—1971 the spawning shoals of the perch and roach in the Klíčava valley water reservoir were observed from the viewpoint of the males — females ratio. Tab. 1., Fig. 1., 2.

2. The males — females ratio is influenced:

a) By the age composition of the population and by abundance that is connected with it. At the time when the population consists mostly of young age groups 1 and 2 in the perch and 2, 3 and 4 in the roach, males automatically predominate owing to their earlier sexual maturity. On the contrary in case of a population consisting of older age groups (at the time when the newly born age classes are not very abundant) females are predominant.

b) But within separate age groups and between them there works another regulative mechanism, connected with the abundance in the following way: The more abundant is the respective age group, the fever females from it take part in spawning owing to deteriorated food conditions (see Nikolskij, 1965).

3. In the roach it is the influence of the age composition upon the males — females ratio (concerning females taking part in spawning in individual years) that makes itself felt more clearly, while in the perch it is more likely a matter of omission of spawning by females under deteriorated food condition caused by the growth of the population number of the perch as well as roach.

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REFERENCES

Alm, G., 1946: Reasons for the occurence of stunted fish populations with special regard to the perch. *Medd. fran Stat. under söknikar och försöranstalt fr söttwattenfisked*, 25 : 5—146.

Backiel, T., et LeCren, E. D., 1967: Some density relationships for fish population parameters. In: Gerking, S. D., The biological basis of freshwater fish production. Blackwell scientific publications, Oxford and Edinburgh: 261—295.

Dyk, V., 1938: Das Geschlechtverhältnis beim Flussbarch (Perca fluviatilis L.). *Archiv für Hydrobiologie*, 33 : 1155—1157.

Hardisty, M. W., 1954: Sex ratio in spawning populations of Lampetra planeri. *Nature*, 173, 874 : 251—252.

Hardisty, M. W., 1960: Sex ratio of amnocoetes. *Nature*, 186, 4729: 988-989.

Holčík, J., 1965: Dynamika rybích populácií vo vodárenskej údolnej nádrži Kličava. Cand. dissert. Nat. hist. fac. Charles Univ., Prague, unpubl.: 1—269.
Kanidev, A. N., 1967: O formirovanii pola i razmerno-vesovoj charakteristiki molodi gorbuši Oncorhynchus gorbuscha (Walbaum) v svjazi s uslovijami rozvitija. *Voprosy ichtiologii*, **7**, 4 : 633—639.
Kříženecký, J., 1940: Zur Frage des Geschlechtverhältnisses beim Flussbarch (Perca fluviatilis L.). *Archiv fur Hydrologie*, **37** : 466—470.
Kříženecký, J., et Kříženecká-Puláncková, A., 1952: K otázce růstu, určování stáří a poměru pohlaví u okouna (Perca fluviatilis L.). *Věstník Král. české spol. nauk, tř. mat.-přírodověd.*: 1—26.
Lelek, A., 1965: Analysa dvou vzorků třecích hejn plotice obecné Rutilus rutilus (L.) z dolního toku řeky Dyje. *Zool. listy* **14**, 1 : 55—70.
Nikolskij, G. V., 1965: Teorija dinamiky stada ryb. Moskva: 1—365.
Salah El-Din El Zarka, 1959. Fluctuations in the population of yellow perch Perca flavescens (Mitchill) in Saginow Bay lake Huron. *Fishery Bulletin of the fish and wildlife service*, **59** : : 365—413
Spanovskaja, V. D., Savvaitova, K. A., et Potapova, T. L., 1964: Ob izmenčivosti rotana pri aklimatizacii. *Voprosy ichtiologii*, **4**, 33 : 665—674.
Whitney, R. R., 1958: Numbers of mature walleyes in Clear lake, Iova, 1952—53, as estimated by tagging. *Iowa state colledge journal of science*, **33**, 1 : 55—79.

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DIE COLLEMBOLEN-FAUNA DER HÖHLEN DES MÄHRISCHEN KARSTES

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Abstrakt: In dieser Arbeit sind die Höhlencollembolen aus dem Mährischen Karst faunistisch, zoogeographisch und ökologisch behandelt. Die grösste Zahl der Arten ist trogloxen und troglophil. Von den Troglophilen sind die demontanen und nordischen Arten zoogeographisch sehr wichtig. Von den Troglobionten wurden *Schaefferia emucronata*, *Mesachorutes quadriocellatus*, *Onychiurus pseudosibiricus*, *Arrhopalites bifidus* und *Neanura tenebrarum* festgestellt. Es handelt sich um Glazial- und Praeglazial- Relikte.

Das Höhlenmilieu ist durch eine ganze Reihe völlig extremer, einförmiger, grundlegender Lebensbedingungen gekennzeichnet. Von Dudich (1932) wurden einzelne Hohlenbiotope gründlich charakterisiert und beschrieben. Für die mitteleuropäischen Höhlen ist eine hohe relative Luftfeuchtigkeit, eine während des ganzen Jahres verhältnismässig gleichbleibende, niedrige Lufttemperatur und völlige Absenz des Lichts charakteristisch. Diese eigentümlichen Lebensbedingungen, denen sich nur die Bedingungen in den feuchten, lockeren Böden der Gebirgswälder etwas annähern, schliessen die standige Anwesenheit der licht-, wärme- und trockenheitsliebenden Arten aus. In den mitteleuropäischen Höhlen können nur solche Formen existieren, die vor allem feuchtigkeits- und kälteliebend sind und kein Licht zum Leben brauchen. Das Hohlenmilieu hat bei den echten Höhlentieren eine ganze Reihe von Veränderungen hervorgerufen, wie z.B. Pigment- und Augenreduktion, oder bei anderen Verlängerung der Antennen, der Beine und der Sprunggabel. Auch die Verlängerung (das Schlankerwerden) der Klauen und einiger Borsten sind Adaptationen an das Leben in den Höhlen. Die Vertreter derselben Gattung oder sogar derselben Art erreichen in Höhlen viel grössere Körperausmasse als in den Biotopen ausserhalb der Höhle (Rusek, 1965). Die Lebensbedingungen in den Höhlen verändern sich während des Jahres nur sehr gering, weshalb die Aussenbedingungen nicht die Fortpflanzung steuern. Wir können in den Hohlen während des ganzen Jahres neben adulten Exemplaren immer auch Exemplare der verschiedensten jüngeren Entwicklungstadien finden, es gibt hier keine abgegrenzten Generationen (Dudich, 1932).

In der letzten Zeit wurden bei den Hohlentieren auch verschiedene ökologische Ansprüche und einige Probleme ihrer Biologie und Physiologie experimentel verfolgt. Bei den Collembolen haben sich mit einigen solcher Probleme Mais (1969) und Thibaud (1970) befasst.

In den Höhlen sind keine Produzenten — grüne Pflanzen — vorhanden. Eine Ausnahme machen nur die künstlich beleuchteten Höhlen, wo geringe Algenrasen und morphologisch veränderte Moose in der Nähe der Reflektoren wachsen. Die Lebensgemeinschaften der Höhlen werden also nur von Konsumenten und Reduzenten gebildet — die Höhlen stellen Biotope mit unvollständigem Stoffkreislauf dar. Die Tierwelt ist in den Höhlen nicht gleichmässig verteilt, was besonders durch die ungleichmässige Verteilung der Nahrung verursacht ist. Diese besteht bei den Höhlentieren grösstenteils aus morschem Holz, Fledermausguano, Bakterien und Pilzen, den Körpern der gestorbenen Tiere und aus verschiedenen Protozoen In den künstlich beleuchteten Höhlen kommen ausserdem die Algen und Moose noch hinzu. Manche Hohlentiere leben karnivor.

Die Höhlentiere kann man in drei Gruppen einteilen (bei einigen Verfassern gibt es auch andere Klassifizierungen):

1. Troglobionte — stenöke Arten, die nur in Höhlen oder ausnahmsweise in ähnlichen Biotopen (z. B. Tierhöhlen) leben. In der vorliegenden Arbeit werden in diese Gruppe auch solche

Arten eingereiht, die ausserhalb der Höhlen disjunkt in der alpinen und subalpinen Stufe der Alpen und Pyrenäen im Boden leben. Sie stellen in den mitteleuropäischen Höhlen Troglobionte in „statu nascendi" dar.

2. Troglophile — euryöke Arten, die ausserhalb der Höhlen im Moos, Boden, unter Steinen, im morschen Holz etc. leben und auch regelmassig in den Höhlen vorkommen. Sie finden hier geeignete Lebensbedingungen und vermehren sich hier regelmassig.
3. Trogloxene-Arten, die in den Höhlen nur als eingeschleppte, fremde Elemente vorkommen. Sie können sich in den Höhlen nicht vermehren.

GESCHICHTE DER ERFORSCHUNG DER HÖHLENCOLLEMBOLEN DES MÄHRISCHEN KARSTES

Die Anfänge der Collembolenerforschung der Tschechoslowakei sind eng mit dem Gebiet des Mährischen Karstes verbunden. Hier begann nämlich Wankel die Erforschung der Hohlefauna im Rahmen einer komplexen Erforschung der Hohlen. Er fand dabei eine ganze Reihe von Höhlentieren, unter denen die Collembolen an der ersten Stelle standen. In seinen zwei Arbeiten (Wankel, 1857, 1858) beschrieb er auch einige neue Collembolen-Arten. In der gleichen Zeit veröffentlichte auch Muller (1858) eine kurze Mitteilung uber die Höhlencollembolen des Mährischen Karstes. Kolenati (1858) beschrieb aus den Sloupské Hohlen *Tritomurus macrocephalus* Kolenati, 1858; es hat sich aber gezeigt (Absolon, 1900e), dass ein solches Tier nicht existiert. Eine gründliche Erforschung der Hohlenfauna in allen grösseren, damals bekannten Hohlen des Mährischen Karstes führte Absolon (1899—1907) durch. Die grosste Aufmerksamkeit widmete er den Collembolen, und schon in seinen ersten Arbeiten sind einige neue Arten, spater einige neue Gattungen beschrieben. Abgesehen von den *Onychiurus*-Vertretern, bei deren Beschreibung die damals gebräuchlichen Merkmale verwendet wurden und die z. Z. zur genauer Artbestimmung ungenügend sind, haben fast alle seine Arten und Gattungen ihren Status behalten. Durch Absolon wurde die Liste der Collembolen aus den Hohlen des Mährischen Karstes von etwa 10 auf 15 Arten erhöht.

Ausser den oben angeführten Verfassern hat sich viele Jahre hindurch niemand intensiv der Collembolenerforschung des Mahrischen Karstes gewidmet. In seiner Monographie fuhrt Wolf (1934—1937) nur zwei weitere Arten (*Onychiurus armatus* (Tullb.) und *Onychiurus fimetarius* Denis) aus der Ochozská Hohle auf. Weitere Angaben uber die Hohlencollembolen des Mahrischen Karstes stammen erst aus der letzten Zeit (Rusek, 1961b, 1964, 1965, 1966, 1971, Rusek in Absolon 1970, Rusek, Raušer et Vašátko, 1969). Es handelt sich grosstenteils um taxonomische und faunistische Arbeiten, in denen auch einige Arten aus den Hohlen angeführt und beschrieben sind.

METHODIK

Beim Sammeln der Hohlencollembolen habe ich mehrere Methoden angewandt. Einesteils wurde zum individuellen Fang ein spezieler Exhaustor (Rusek, 1969), der auf kleinen Glaschen mit 70% Alkohol direkt befestigt war, verwendet. Mittels Exhaustor wurde auf den Wänden, Tropfsteinen und morschem Holz gesammelt. Andernteils wurden die Collembolen von der Wasseroberfläche der Tümpel mittels kleiner Drahtschlaufen gesammelt. Die Tumpel stellen in den Hohlen natürliche Boden- (Barber) fallen dar, und die Collembolen kann man von hier mittels dieser Methode sehr leicht aufsammeln. Am effektivsten ist aber beim Sammeln der Höhlencollembolen das Aufsammeln von Proben aus morschem Holz, Fledermausguano, Moosen aus der Umgebung der Reflektoren, etc. Diese Proben wurden in PVC-Säckchen ins Labor gebracht und mittels Tullgren-Apparaten ausgelesen. Das Material wurde nach Gisin (1960) fixiert und in 70% Alkohol konserviert.

STANDORTVERZEICHNISS

Das Gebiet des Mährischen Karstes kann in drei Teile gegliedert werden: 1. der Südteil mit den Höhlen in dem Říčka Tal, 2. der Mittelteil mit den Höhlen in den Křtinské und Josefské Tälern und in dem Halbblindtal Rudické údolí und 3. der Nordteil im Stromgebiet des Punkva Flusses. Dieser Gliederung nach sind auch die Standorte in dem folgenden Verzeichnis angeordnet. Die Nummer in Klammern, die nach der No. der Lokalität folgt, entspricht der No. des Arbeitsprotokolles, unter der auch die Tiere in der Sammlung eingereiht sind.

Südteil des Mährischen Karstes

Lok. No. 1 (14): Ochozská Höhle, Hauptdom, in morschem Holz, 25. V. 1957.
Lok. No. 2 (15): Dtto., auf feuchten Brettern eines Tisches, 25. V. 1957.
Lok. No. 3 (42): Ochozská Höhle, hintere Kapelle, im morschen Holz, 26. X. 1957.

Lok. No. 4 (50): Ochozská Hohle, Hauptdom, eine Bodenprobe mit morschem Holz, 26. X. 1957.
Lok. No. 5 (51). Dtto., 1. XII. 1957
Lok. No. 6 (52). Ochozská Hohle, Hauptdom, auf feuchtem, morschem Holz, 1. XII. 1957.
Lok. No. 7 (84): Ochozská Hohle, in dem Gang zwischen Hauptdom und Labyrinth, eine Probe von stark morschem, zerfallenem Holz, 8. V. 1958.
Lok. No. 8 (85): Ochozská Hohle, Hauptdom, auf feuchtem Holz, 8. V. 1958
Lok. No. 9 (134). Ochozská Hohle, im Gang zwischen Smuteční vrba und Německý sifon, auf morschem, feuchtem Holz. 21. IX. 1958
Lok. No. 10 (135): Dtto., eine Probe von morschem Holz, 21. IX. 1958
Lok. No. 11 (284): Dtto., 10. IV. 1960.

Mittelteil des Mährischen Karstes

Lok. No. 12 (172): Hohle Býčí skála, auf der Wasseroberfläche eines Tümpels beim hinteren Sifon im neuen Teil der Hohle, 7. II. 1959
Lok. No. 13 (173): Hohle Býčí skála, eine Probe von morschem Holz aus dem neuen Teil der Hohle, 7. II. 1959.
Lok. No. 14 (174): Hohle Býčí skála, etwa 30 m vor dem grossen See, eine Probe von wattenartigem, weissem Pilzmycelium, 7. II. 1959.
Lok. No. 15. (175): Dtto., eine Probe von morschem Holz, 7. II. 1959.
Lok. No. 16 (166): Hohle Nová Drátenická beim Dorf Křtiny, im unteren Stock, eine Probe von morschem Holz, 27. I. 1959.
Lok. No. 17 (167): Hohle Nová Drátenická, etwa 20 m von dem Eingang im oberen Stock, auf morschem Holz, 27. I. 1959.

Nordteil des Mährischen Karstes

Lok. No. 18 (154): Hohle Smrtní beim Dorf Vilémovice, in dem linken Gang auf der Wasseroberfläche kleiner Tümpel, 22. XI. 1958.
Lok. No. 19 (155): Dtto., eine Probe von morschem Stroh und Fledermausguano, 18. X. 1959.
Lok. No. 20 (272): Hohle Balcarka, im Dóm zkázy, eine Bodenprobe mit Fledermausguano, 18. X. 1959
Lok. No. 21 (273): Hohle Balcarka, hinterer Teil, auf Stalagmiten, Stalaktiten und Wänden, 18. X. 1959.
Lok. No. 22 (276): Hohle Balcarka, auf Stalagmiten, 14. II. 1960.
Lok. No. 23 (156): Sloupsko-Šošůvské Hohlen, im Gang „U stříbrné skály", eine Probe von Fledermausguano, 23. XI. 1958.
Lok. No. 24 (157): Sloupsko-Šošůvské Hohlen, in einem engen, künstlichen Gang der Šošůvka Hohle, auf der Wasseroberfläche eines künstlichen Tümpels, 23. XI. 1958.
Lok. No. 25 (158): Sloupsko-Šošůvské Hohlen, im Haupt-, Parallel- und Ostrover Gang der Šošůvka Hohle, auf Stalagmiten, 23. XI. 1958.
Lok. No. 26 (159): Sloupsko-Šošůvské Hohlen, in der Eliščina Hohle, auf Stalagmiten, 23. XI. 1958.
Lok. No. 27 (147): Punkevní Hohlen, im Masarykův Dom, auf Wasseroberfläche grosser Sinterseen, 22. XI. 1958.
Lok. No. 28 (148): Punkevní Hohlen, im Masarykův Dom, auf grossen Stalagmiten, 22. XI. 1958.
Lok. No. 29 (149): Punkevní Hohlen, im Masarykův Dom, eine Probe von nassem, morschem Holz, 22. XI. 1958.
Lok. No. 30 (150): Punkevní Hohlen, im Masarykův Dom, eine Probe von Moosen (*Leptobryum pyriforme* und *Scleropodium purum*) aus der Nähe der Reflektoren, 22. XI. 1958.
Lok. No. 31 (152): Punkevní Hohlen, im Reichenbachův Dom, auf Stalagmiten bei den Reflektoren, 22. XI. 1958.
Lok. No. 32 (153): Punkevní Hohlen, im vorderen Dom, auf der Wasseroberfläche der Sintertümpel, 22. XI. 1958.
Lok. No. 33 (176): Punkevní Hohlen, im Reichenbachův Dom, auf Stalagmiten, 25. II. 1959.
Lok. No. 34 (177): Punkevní Hohlen, im Reichenbachův Dom, eine Moosprobe aus der Nähe der Reflektoren, 25. II. 1959.
Lok. No. 35 (178): Punkevní Hohlen, im Eingangsdom, auf der Wasseroberfläche der Sintertümpel, 25. II. 1959.
Lok. No. 36 (179): Dtto., auf Stalagmiten, 25. II. 1959
Lok. No. 37 (180): Dtto., eine Probe von morschem Holz, 25. II. 1959
Lok. No. 38 (275): Dtto., 18. X. 1959.

Lok. No. 39 (168): Kateřinská Hohle, im hinteren Dom, eine Probe von morschem Holz m Pilzmycelium, 7. II. 1959.
Lok No. 40 (169): Dtto, trockenes, morsches Holz, 7. II. 1959.
Lok. No. 41 (170): Dtto , auf Stalagmiten, 7. II. 1959.
Lok. No. 42 (171): Kateřinská Hohle, auf der Wasseroberflache der Sintertumpel, 7. II. 1959
Lok. No. 43 (290): Kateřinská Hohle im Bambusový lesík auf Stalagmiten, 14. V. 1960.
Lok. No. 44 (291). Kateřinská Hohle, hinterer Dom, auf der Wasseroberfläche der Sintertümpel 14. V. 1960
Lok. No. 45 (369): Dtto., Probe von morschem Holz, 3. X. 1960.

VERZEICHNIS DER FESTGESTELLTEN COLLEMBOLEN-ARTEN

1. *Podura aquatica* Linnaeus, 1758

Aus den Hohlen des Mährischen Karstes hat sie Absolon (1900e) angefuhrt. Trogloxen
Verbreitung: Holarktis.

2. *Hypogastrura socialis* (Uzel, 1891)

Winterart, die haufig auf Schnee vorkommt. Aus der Hohle Staré skály bekannt (Absolon, 1900e). Trogloxen.
Verbreitung: Europa.

3. *Hypogastrura similis* (Absolon, 1901)

Nach einem einzigen Exemplar ungenügend beschriebene Art. Troglophil ?
Verbreitung: Mahrischer Karst - Hohle Staré skály.

4. *Hypogastrura purpurescens* (Lubbock, 1867)

Lok. No.: 12 (1 Ex.), 13 (2 Ex.), 27 (4 Ex.), 29 (4 Ex.), 30 (13 Ex.), 35 (9 Ex.), 37 (33 Ex.), 38 (1 Ex.).
Eine häufige troglophile Art, die schon Absolon (1900e) aus den mährischen Hohlen angefuhrt hat.
Verbreitung: Europa

5. *Ceratophysella bengtssoni* (Ågren, 1904)

Syn. nov.: *Achorutes sigillatus* var. *stygius* Absolon, 1900

Lok. No: 23 (756 Ex).
Troglophiler Guanobiont. Nach der Typusuntersuchung und den gültigen Nomenklaturregeln ist *Achorutes sigillatus* var. *stygius* Absolon, 1900 ein neues Synonymum zu *Ceratophysella bengtssoni* (Ågren, 1904). Das Synonymum wurde mehr als 50 Jahre nicht verwendet und hat so seinen Artstatus (contra *C. bengtssoni*) verloren. Sie kommt in den Hohlen im Fledermausguano massenhaft vor.
Verbreitung: Von Island und Lappland bis Frankreich und Österreich.

6. *Ceratophysella sigillata* (Uzel, 1891)

Lok. No: 19 (8 Ex.).
Trogloxen, Edaphobiont, besonders im Winter vorkommend.
Verbreitung: Sudeten, Karpathen, Alpen.

? *Ceratophysella armata* (Nicolet, 1841)

Trogloxen Die von Absolon (1900e) angeführte *C. armata* kann heutigen taxonomischen Kenntnissen nach mehreren Arten zugehohren. Ich habe sie in den Hohlen des Mahrischen Karstes nicht gefunden.

7. *Schaefferia emucronata* Absolon, 1900

Lok. No.: 1 (4 Ex.), 2 (13 Ex.), 3 (38 Ex.), 7 (14 Ex.), 8 (16 Ex.), 9 (31 Ex.), 10 (9 Ex.), 11 (180 Ex.), 13 (5 Ex.), 27 (2 Ex.), 35 (26 Ex.).

Troglobiont. Diese Art und Gattung hat im Mährischen Karst ihre Terra typica. Sie kommt hier nur in den Höhlen (manchmal sehr häufig) vor. In den Höhlen stellt sie ein dealpines Element (Glazialrelikt) dar. Ausserhalb der Hohlen lebt sie im Moos und Boden in der alpinen und subalpinen Stufe des Schweizer Jura und der Pyrenäen.

Verbreitung: Höhlen in O-Sudeten, Mährischem Karst, Jura, Burgund, N-Italien. Ausserhalb der Höhlen im Schweizer Jura und in den Pyrenäen.

8. *Mesachorutes quadriocellatus* Absolon, 1900

Diese troglobionte Art wurde aus den Hohlen des Mährischen Karsts beschrieben. Sie lebt in dem Fledermausguano und wurde bisher nur in den Höhlen gefunden, wird aber sehr wahrscheinlich auch hochalpin in den Nestern von *Microtus* und anderen Säugetieren (wie die verwandte *Mesogastrura ojcoviensis*) leben.

Verbreitung: Höhlen im Mährischen Karst, in Ariège und auf Korsika.

9. *Willemia anophthalma* Börner, 1901

Lok. No.: 30 (16 Ex.), 16 (2 Ex.), 19 (1 Ex.), 45 (38 Ex.).

Euedaphische Art, die im Mahrischen Karst auch troglophil vorkommt.

Verbreitung: Deutschland, Polen, Finnland, Tschechoslowakei.

10. *Brachystomella parvula* (Schäffer, 1896)

Von Absolon (1900e) aus der Höhle Staré skály angeführt. Trogloxen.

Verbreitung: kosmopolitisch.

11. *Neanura tenebrarum* (Absolon, 1901)

Troglobiont. Ungenügend beschriebene Art, die bisher nur aus der Výpustek Höhle (Locus typicus) bekannt ist.

Verbreitung: Mährischer Karst.

12. *Neanura muscorum* (Templeton, 1835)

Lok. No.: 4 (2 Ex.), 7 (14 Ex.), 8 (1 Ex.), 29 (68 Ex.), 38 (1 Ex.). Trogloxen.

Verbreitung: Europa.

Neanura sp.

Lok. No. 10 (1 Ex.).

13. *Tetrodontophora bielanensis* (Waga, 1842)

Trogloxen. Aus einigen kleineren Höhlen des Mährischen Karstes bekannt (Absolon, 1900e).

Verbreitung: Sudeten, Karpathen, Gebirge in N-Jugoslavien.

14. *Onychiurus serratotuberculatus* Stach, 1933

Lok. No.: 19 (1 Ex.).

Troglophil, im Mährischen Karst demontanes Element.

Verbreitung: O-Alpen, Karpathen, Höhle bei Domaszkow in Sudeten.

15. *Onychiurus sibiricus* (Tullberg, 1876)

Lok. No.: 12 (9 Ex.), 29 (28 Ex.).

Troglophile, euedaphische Art. Aus der Höhle Staré skály angeführt (Absolon, 1900e).

Verbreitung: Europa.

16. *Onychiurus pseudosibiricus* Stach, 1954

Lok. No.: 37 (10 Ex.).
Bisher nur aus der Aggtelek-Höhle in Ungarn und von der angeführten [redacted]hrischen Karst bekannt (Rusek, 1966). Troglobiont.
Verbreitung: Ungarn, Tschechoslowakei.

17. *Onychiurus armatus* (Tullberg, 1869) s. Stach, 1954

Lok. No.: 1 (6 Ex.), 3 (4 Ex.), 4 (12 Ex.), 5 (21 Ex.), 7 (6 Ex.), 8 (1 Ex.), 9 (1 Ex.), 10 (12 Ex.) 19 (2 Ex.), 27 (2 Ex.), 30 (2 Ex.), 37 (3 Ex.), 39 (5 Ex.), 42 (1 Ex.), 45 (9 Ex.).
Troglophile, euedaphische Art. Ein kleinerer Teil des Materiales wurde bis zu den Gisin'schen „Kleinarten" (Gisin, 1960) bestimmt, über deren Status man z. Z. viel diskutiert. Sie werden hier nur als Formen von *Onychiurus armatus* bezeichnet: f. *pulvinatus* (Lok. No. 37), f. *tricampatus* (Lok. No. 10, 30).
Verbreitung: kosmopolitisch.

Onychiurus stillicidii (Schiödte, 1849)

Absolon (1900e) führt diese Art aus den Sloupsko-Šošůvské Höhlen an. Es dürfte sich aber um eine falsche Bestimmung handeln! Ich konnte diese Art im Mährischen Karst nicht feststellen.

18. *Onychiurus rectospinatus* Stach, 1922

Lok. No.: 16 (1 Ex.).
Troglophile euedaphische Art.
Verbreitung: Polen, Tschechoslowakei, Spanien, Britische Inseln.

19. *Onychiurus fimetarius* Denis, 1838

Lok. No.: 1 (5 Ex.), 3 (20 Ex.), 4 (16 Ex.), 7 (16 Ex.), 8 (29 Ex.), 9 (5 Ex.), 10 (31 Ex.), 11 (10 Ex.), 12 (3 Ex.), 13 (11 Ex.), 20 (29 Ex.), 23 (5 Ex.), 24 (6 Ex.), 25 (2 Ex.).
Troglophile, euedaphische Art.
Verbreitung: Europa.

20. *Onychiurus silvarius* Gisin, 1952

Lok. No.: 21 (4 Ex.).
Troglophile, euedaphische Art. Neu für die Tschechoslowakei.
Verbreitung: Schweiz, Frankreich, Österreich, Rumänien, Tschechoslowakei, Deutschland (unveröffentlicht — briefliche Mitteilung von Dr. W. Hüther).

Ungenügend beschriebene Formen

Onychiurus spelcus Absolon, 1900, *Onychiurus inermis* Tullberg: Absolon, 1900, *Onychiurus gracilis* (Müller, 1958) und *Onychiurus armatus* f. *multipunctatus* Absolon, 1900.

Onychiurus sp.

Lok. No.: 29 (9 Ex.), 35 (1 Ex.).

21. *Tullbergia sylvatica* Rusek, 1971

Lok. No.: 9 (2 Ex.), 10 (225 Ex.), 13 (9 Ex.), 29 (15 Ex.), 34 (2 Ex.), 37 (37 Ex.), 38 (3 Ex.) 45 (1 Ex.).
Troglophile, euedaphische Art.
Verbreitung: Karpathen, Rila Gebirge in Bulgarien, N-Italien.

22. *Tullbergia krausbaueri* Börner, 1901 s. Rusek, 1971

Lok. No.: 7 (4 Ex.), 23 (16 Ex.), 29 (15 Ex.).
Euedaphische, troglophile Art.
Verbreitung: Europa.

23. *Tullbergia japygiformis* Absolon, 1900

Aus der Elišččina Hohle durch Absolon (1900e) beschrieben.
Euedaphische, troglophile (?) Art.
Verbreitung: Mährischer Karst, S—Slowakei.

24. *Uzelia setifera* Absolon, 1901

Diese Art wurde aus der Hohle Michalova díra im Mährischen Karst beschrieben (Absolon, 1901). Sie lebt in Wäldern im Gebirge. Im Mährischen Karst stellt sie ein demontanes Element dar. Trogloxen.

Verbreitung: Sudeten, Karpathen. Alpen, Pyrenäen.

25. *Anurophorus laricis* Nicolet, 1842

Höhle Staré skály (Absolon, 1900e). Trogloxene, europäische Art.

26. *Folsomia quadrioculata* (Tullberg, 1871)

Höhle Stare skály (Absolon, 1900e), troglophil.
Verbreitung: Holarktis.

27. *Folsomia multiseta* Stach, 1947

Lok. No.: 12 (1 Ex.), 29 (318 Ex.), 30 (1 Ex.).

Euedaphische Art. Die in den Hohlen des Mahrischen Karstes gefundenen Tiere waren sehr wenig pigmentiert und bei den meisten Exemplaren fehlten die Augen. Die Beborstung des Manubriums entsprach der *Folsomia multiseta* Stach, 1947. Troglophil.

Verbreitung. Mittel-Europa, Italien, Kaukasus.

28. *Folsomia litsteri* Bagnall, 1939

Lok. No. 9 (12 Ex.), 10 (333 Ex.), 11 (240 Ex.), 15 (124 Ex.), 17 (4 Ex.). 23 (14 Ex.), 34 (1 Ex.) 39 (462 Ex.), 40 (85 Ex.), 45 (56 Ex.).

Im Mährischen Karst kommt diese Art als Troglophil vor. Ausserhlab der Höhlen lebt sie in Torfböden und im Moos der Birkenwälder (auch in Mittel-Europa).

Verbreitung: Britische Inseln, Schweiz, Deutschland, Tschechoslowakei, Polen, Schweden, Färöerinseln.

29. *Folsomia candida* (Willem, 1902)

Lok. No.: 1 (18 Ex.), 2 (18 Ex.), 3 (16 Ex.), 4 (17 Ex.), 5 (28 Ex.), 6 (52 Ex.), 7 (839 Ex.), 8 (6 Ex.), 13 (209 Ex.), 15 (13 Ex.), 20 (17 Ex.), 21 (10 Ex.), 22 (93 Ex.), 25 (2 Ex.), 27 (3 Ex.), 37 (225 Ex.).

Troglophil.

Verbreitung: Kosmopolitisch.

Folsomia fimetaria (L., 1758)

Diese Art hat Absolon (1900e) aus den Hohlen des Mahrischen Karstes angefuhrt. Ich konnte hier diese Art nicht feststellen. Bei den Angaben von Absolon wird es sich um die beiden oben angeführten Arten handeln.

Isotomodes diplophthalmus Absolon, 1907

Spec. inquirenda.

30. *Proisotoma minima* (Absolon, 1900)

Sloupsko-Šošůvské Höhlen (Absolon, 1900e), demontane, troglophile **Art**.
Verbreitung: N- und Mittel-Europa.

31. *Isotomiella minor* (Schäffer, 1896)

Lok. No. 23 (2 Ex.).
Euedaphische, troglophile Art.
Verbreitung. Palaarktis.

32. *Isotoma notabilis* Schäffer, 1896

Lok. No.: 10 (6 Ex.), 16 (21 Ex.), 19 (4 Ex.), 25 (1 Ex.), 27 (1 Ex.), 30 (27 Ex.), 33 (6 Ex.), 34 (46 Ex.), 37 (22 Ex.), 38 (3 Ex.).
Euedaphische, troglophile Art.
Verbreitung: kosmopolitisch.

33. *Isotoma viridis* Bourlet, 1838

Absolon führt diese hemiedaphische, trogloxene Art aus mehreren Höhlen an (Absolon, 1900e).
Verbreitung: Europa.

Isotoma maritima Tullberg, 1871

Staré skály Höhle (Absolon, 1900e). Die Bestimmung ist unsicher!

34. *Isotoma olivacea* Tullberg, 1871

Lok. No.: 15 (7 Ex.).
Hemiedaphische Art, trogloxen.
Verbreitung: N- und Mittel-Europa.

35. *Isotoma violacea* Tullberg, 1876

Lok. No.: 28 (42 Ex.), 31 (16 Ex.), 33 (31 Ex.), 36 (1 Ex.).
Hemiedaphische, troglophile Art.
Verbreitung. Europa.

Isotoma formaneki Absolon, 1900

Höhle Staré skály (Absolon, 1900e). Ungenügend beschriebene Art.

36. *Pseudisotoma sensibilis* (Tullberg, 1876)

Höhle Staré skály (Absolon, 1900e), trogloxen.
Verbreitung: Europa.

37. *Isotomurus palustris* (Müller, 1776)

Höhle Staré skály (Absolon, 1900e), trogloxen.
Verbreitung: Kosmopolitisch.

38. *Sinella coeca* (Schött, 1896)

Höhlen Staré skály und Nicová (Absolon, 1900e). Trogloxen.
Verbreitung: Paläarktis.

Entomobrya sp. juv.

Lok. No.: 25 (1 Ex.).

39. *Lepidocyrtus lanuginosus* (Gmelin, 1788)

Absolon (1900e): bei den Eingängen in die Nicová und Staré skály Höhle. Den neuen taxonomischen Kenntnissen nach, kann diese Art mehreren heute bekannten Arten zugeordnet werden.

40. *Pseudosinella alba* (Packard, 1873)

Lok. No.: 10 (1 Ex.), 19 (1 Ex.), 23 (1 Ex.), 26 (1 Ex.).
Troglophile, edaphische Art.
Verbreitung: Holarktis.

41. *Heteromurus nitidus* (Templeton, 1835)

Syn: *Heteromurus margaritarius* Wankel, 1860,
Heteromurus hirsutus Absolon, 1900

Lok. No.: 3 (10 Ex.), 8 (1 Ex.), 12 (7 Ex.), 13 (65 Ex.), 15 (1 Ex.), 18 (2 Ex.), 20 (1 Ex.), 21 (6 Ex.), 22 (3 Ex.), 24 (32 Ex.), 25 (10 Ex.), 26 (4 Ex.), 27 (14 Ex.), 29 (1 Ex.), 31 (1 Ex.), 33 (3 Ex.), 35 (1 Ex.), 41 (3 Ex.), 42 (18 Ex.), 43 (5 Ex.), 44 (5 Ex.).
Troglophile Art.
Verbreitung: Europa.

42. *Pogonognathellus flavescens* (Tullberg, 1871)

Lok. No.: 35 (5 Ex.).
Trogloxene, hemiedaphische Art.
Verbreitung: Europa.

43. *Pogonognathellus longicornis* (Müller, 1776)

Absolon (1900e): Höhle Staré skály. Trogloxen.
Verbreitung: Europa, Madeira, Azoren.

44. *Tomocerus vulgaris* (Tullberg, 1871)

Absolon (1900e): Sloupsko-Šošůvské Höhlen. Trogloxen.
Verbreitung: Europa, N-Amerika.

Tomocerus sp. juv.

Lok. No.: 36 (1 Ex.).

Species dubiae

Tomocerus viridescens Wankel, 1860 und *Tritomurus macrocephalus* Kolenati, 1858

45. *Cyphoderus albinus* Nicolet, 1842

Absolon (1900e): Sloupsko-Šošůvské Höhlen. Myrmecophil, trogloxen.
Verbreitung: Europa.

46. *Megalothorax minimus* Willem, 1900

Lok. No.: 9 (1 Ex.), 10 (8 Ex.), 16 (1 Ex.), 19 (12 Ex.), 25 (3 Ex.), 29 (9 Ex.), 34 ([illegible] Ex.) 38 (27 Ex.), 42 (1 Ex.).
Euedaphische, troglophile Art.
Verbreitung: Holarktis.

47. *Neelus murinus* Folsom, 1896

Lok. No.. 13 (4 Ex.), 32 (30 Ex.), 33 (15 Ex.), 34 (15 Ex.), 35 (8 Ex.), 37 (9 Ex.), 39 (14 Ex.), 45 (4 Ex.).
Troglophil. Die Tiere, die in den Höhlen leben, erreichen grössere Körperausmasse als Tiere ausserhalb der Höhlen.
Verbreitung: Holarktis.

48. *Arrhopalites caecus* (Tullberg, 1871)

Lok. No.: 10 (3 Ex.).
Troglophile, euedaphische Art.
Verbreitung: Europa.

49. *Arrhopalites bifidus* Stach, 1945

Lok. No.: 22 (1 Ex.), 24 (26 Ex.).
Troglobiont. Diese Art wurde bisher niemals ausserhalb der Höhlen gefunden.
Verbreitung: Deutschland, Polen, Ungarn, Tschechoslowakei.

50. *Arrhopalites pygmaeus* (Wankel, 1860)

Lok. No.: 4 (5 Ex.), 5 (1 Ex.), 23 (1 Ex.), 25 (1 Ex.), 27 (2 Ex.), 29 (4 Ex.).
Troglophile, demontane bis dealpine Art.
Verbreitung: Europa.

Arrhopalites sp. juv. et ♂♂

Lok. No.: 16 (1 Ex.), 17 (1 Ex.), 43 (2 Ex.).

51. *Sminthurus fuscus* (L., 1758)

Absolon (1900e): Žlebové. Kůlna und Staré skály Höhlen. Trogloxen.
Verbreitung: Europa.

52. *Dicyrtoma fusca* (Lucas, 1849)

Absolon (1900e): Staré skály Höhle. Trogloxen.
Verbreitung: Europa.

53. *Dicyrtomina minuta* (Fabricius, 1783)

Absolon (1900e): Staré skály Höhle. Trogloxen.
Verbreitung: Europa.

VERZEICHNIS DER IN DEN EINZELNEN HÖHLEN GEFUNDENEN COLLEMBOLEN

Das Collembolen-Material wurde in insgesamt 8 Höhlen des Mährischen Karstes gesammelt. Es sind die Ochozská, Býčí skála, Drátenická, Balcarka, Smrtní, Kateřinská, Punkevní und die Sloupsko-Šošůvské Höhlen. Das reichhaltigste Material wurde in den Punkevní und Ochozská Höhlen

Tab. 1.

Colembolenart / Höhle / Lok. No./Ex.	Ochozská											Býčí skála				Dráte-nická		Smrt-ní	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Folsomia candida	18	18	16	17	28	29	839	6	—	—	—	—	209	—	—	—	—	—	—
Schaefferia emucronata	4	13	38	—	—	—	14	16	31	9	180	—	5	—	—	—	—	—	—
Onychiurus armatus	6	—	4	12	21	—	6	1	1	12	—	—	—	—	—	—	—	—	2
Onychiurus fimetarius	5	—	20	16	—	—	16	29	5	31	10	3	11	—	—	—	—	—	—
Heteromurus nitidus	—	—	10	—	—	—	—	1	—	—	—	7	65	—	1	—	—	2	—
Arrhopalites pygmaeus	—	—	—	5	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Neanura muscorum	—	—	—	2	—	—	14	1	—	—	—	—	—	—	—	—	—	—	—
Tullbergia krausbaueri	—	—	—	—	—	—	4	—	—	—	—	—	—	—	—	—	—	—	—
Tullbergia sylvatica	—	—	—	—	—	—	—	—	2	225	—	—	9	—	—	—	—	—	—
Folsomia litsteri	—	—	—	—	—	—	—	—	12	333	240	—	—	—	124	—	4	—	—
Megalothorax minimus	—	—	—	—	—	—	—	—	1	8	—	—	—	—	—	1	—	—	12
Isotoma notabilis	—	—	—	—	—	—	—	—	—	6	—	—	—	—	—	21	—	—	4
Pseudosinella alba	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	1
Arrhopalites caecus	—	—	—	—	—	—	—	—	—	3	—	—	—	—	—	—	—	—	—
Neanura sp.	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—
Onychiurus sibiricus	—	—	—	—	—	—	—	—	—	—	—	9	—	—	—	—	—	—	—
Folsomia multiseta	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—
Hypogastrura purpurescens	—	—	—	—	—	—	—	—	—	—	—	1	2	—	—	—	—	—	—
Neelus murinus	—	—	—	—	—	—	—	—	—	—	—	—	4	—	—	—	—	—	—
Isotoma olivacea	—	—	—	—	—	—	—	—	—	—	—	—	—	—	7	—	—	—	—
Willemia anophthalma	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2	—	—	1
Onychiurus rectospinatus	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—
Arrhopalites juv.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—
Ceratophysella sigillata	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	8
Onychiurus serratotuberculatus	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
Onychiurus silvarius	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Arrhopalites bifidus	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Ceratophysella bengtssoni	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Isotomiella minor	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Isotoma violacea	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Onychiurus pseudosibiricus	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

erbeutet, wo 13 und 11 Proben entnommen wurden. Hier war auch die Zahl der Collembolen-Arten (21) am höchsten. Die in den einzelnen Höhlen gefundenen Collembolen sind in der Tabelle No. 1 aufgeführt. Es folgt eine kurze Charakteristik der durchforschten Höhlen mit ihrer Collembolenfauna.

Die Ochozská Höhle

stellt die grösste Höhle im Süd-Teil des Mährischen Karstes dar. Ihre Gesamtlänge beträgt etwa 1,5 km. Alle Proben wurden in den grossen Domen und schmäleren Gängen weit entfernt vom Eingang entnommen. Es wurden hier 15 Collembolen-Arten festgestellt. Am häufigsten kommen hier *Folsomia candida* und *Folsomia litsteri* vor. Es sind vikariante Arten, die auch in anderen Höhlen des Mährischen Karstes niemals zusammen in derselben Probe gefunden werden. Weiter sind in dieser Höhle *Schaefferia emucronata,*

Balcarka			Sloupské				Punkevní												Kateřinská						
20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
17	10	93	—	—	2	—	3	—	—	—	—	—	—	—	—	—	225	13	—	—	—	—	—	—	
—	—	—	—	—	—	—	2	—	—	—	—	—	—	—	26	—	—	—	—	—	—	—	—	—	
—	—	—	—	—	—	—	2	—	—	2	—	—	—	—	—	—	3	—	5	—	—	—	—	—	
29	—	—	5	6	2	—	20	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
1	—	3	—	32	10	4	14	—	1	—	1	—	3	—	1	—	—	—	—	—	3	18	5	5	
—	—	—	1	—	1	—	2	4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
—	—	—	—	—	—	—	—	—	68	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	
—	—	—	16	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
—	—	—	—	—	—	—	—	—	15	—	—	—	—	2	—	—	37	3	—	1	—	—	—	—	
—	—	—	14	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	462	85	—	—	—	—	
—	—	—	—	—	3	—	—	—	9	—	—	—	—	2	—	—	—	27	—	—	—	1	—	—	
—	—	—	—	—	1	—	1	—	—	27	—	—	6	46	—	—	22	3	—	—	—	—	—	—	
—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
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—	—	—	—	—	—	—	—	—	28	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
—	—	—	—	—	—	—	—	—	318	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
—	—	—	—	—	—	—	4	—	4	13	—	—	—	—	9	—	33	1	—	—	—	—	—	—	
—	—	—	—	—	—	—	—	—	—	—	—	30	15	15	8	—	9	—	14	—	—	—	—	—	
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
—	—	—	—	—	—	—	—	—	—	16	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
—	4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
—	—	1	—	26	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
—	—	—	775	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
—	—	—	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
—	—	—	—	—	—	—	—	42	—	—	16	—	31	—	—	1	—	—	—	—	—	—	—	—	
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	10	—							

Tullbergia sylvatica, *Onychiurus fimetarius* und *Onychiurus armatus* dominant. Von den troglobionten und troglophilen Arten kommen *Heteromorus nitidus*, *Arrhopalites pygmaeus*, *Arrhopalites caecus* und *Megalothorax minimus* hier nur vereinzelt vor. Die verbleibenden Arten sind trogloxen und wurden in die Höhle durch den Hostěnický Bach bei Hochwasser hineingeschwemmt.

Die Býčí skála Höhle

stellt den bekannten Endteil eines riesigen Höhlensystems des Rudický Baches dar. Die Proben wurden einige Hundert Meter von dem Eingang entfernt entnommen. In 4 Proben wurden 11 Collembolenarten festgestellt. In der Probe No. 14 (wattenartiges, weisses Pilzmycelium) war kein Tier vorhanden. Auch in dieser Höhle waren die beiden Vikarianten *Folsomia candida* und *Folsomia litsteri* dominant. Weitere Dominanten sind noch

Heteromurus nitidus und *Onychiurus fimetarius*. Die troglophilen *Hypogastrura purpurescens*, *Neelus murinus* und die troglobionte *Schaefferia emucronata* kommen nur einzeln vor. Es wäre notwendig, diese Höhle in Zukunft gründlicher zu durchforschen.

Drátenická Höhle

Kleine, etwa 60m tiefe und einige 100m lange Höhle im Křtinské Tale. Hier wurden nur gelegentlich zwei Proben entnommen. Interessant ist hier das Vorkommen von *Onychiurus rectospinatus*.

Smrtní Höhle

Eine kleine, 130m lange und meist nur 30—50 cm hohe Höhle beim Dorfe Vilémovice. Von den troglophilen Arten wurden hier *Megalothorax minimus*, *Ceratophysella sigillata*, *Onychiurus armatus* und *Onychiurus serrototuberculatus* festgestellt.

Die Kateřinská Höhle

befindet sich am Ende des Suchý žleb Tales und gehört zu den grösseren Höhlen des Mährischen Karstes. Es wurden hier 6 Proben entnommen. Absolut dominant kommt hier *Folsomia litsteri* vor. Auf Stalagmiten und auf der Wasseroberfläche der kleinen Tümpel ist Heteromurus nitidus dominant. Im morschen Holz kommt *Neelus murinus* häufiger vor.

Die Punkevní Höhlen

gehören zusammen mit den Sloupsko-Šošůvské Höhlen zu den grössten und bekanntesten Höhlen des Mährischen Karstes. Es wurden hier 13 Proben entnommen, die 19 Arten enthielten. Dominant sind hier *Folsomia multiseta*, *Folsomia candida*, *Isotoma notabilis*, *Isotoma violacea*, *Neelus murinus*, *Neanura muscorum*, *Hypogastrura purpurescens*, *Tullbergia sylvatica*, *Megalothorax minimus*, *Schaefferia emucronata*, *Onychiurus sibiricus*, *Heteromurus nitidus* und *Onychiurus fimetarius*. Wir sehen, dass unter den dominanten Arten auch einige trogloxene sind. Sie verdanken ihr Vorkommen hier dem unterirdischen Punkva Fluss, der bei Hochwasser viel Holz und andere organische Bestandteile in die Höhlen bringt. Auffalend ist hier die fast völlige Absenz von *Folsomia litsteri* und das nur seltene Vorkommen von *Onychiurus armatus*. Auch die troglobionten Vertreter der Gattung *Arrhopalites* (*A. pygmaeus*) kommen in den Punkevní Höhlen nur einzeln vor. Interessant ist hier der zweite Fund von *Onychiurus pseudosibiricus*.

Die Sloupsko-Šošůvské Höhlen

gehöhren zum gleichen hydrographischen System wie die Punkevní Höhlen. Es wurden hier nur 4 Proben entnommen. Am reichsten war die Probe des Fledermausguanos (No. 23) mit Collembolen besiedelt. Hier war auch die absolut dominante Art *Ceratophysella bengtssoni* vorhanden. Weitere dominante Arten sind hier *Heteromurus nitidus*, *Arrhopalites bifidus* (zahlreich !), *Tullbergia krausbaueri*, *Folsomia litsteri* und *Onychiurus fimetarius*.

Von den troglobionten und troglophilen Arten kommen im Mährischen Karst *Heteromurus nitidus, Folsomia litsteri, Megalothorax minimus, Folsomia candida, Onychiurus fimetarius* und *Onychiurus armatus* in den meisten Höhlen vor. Die Arten *Schaefferia emucronata, Arrhopalites pygmaeus, Arrhopalites caecus, Hypogastrura purpurescens, Neelus murinus, Onychiurus rectospinatus, Onychiurus silvarius, Arrhopalites bifidus, Onychiurus serratotuberculatus, Onychiurus pseudosibiricus* und *Ceratophysella bengtssoni* wurden nur in 1—3 von den durchforschten Höhlen festgestellt.

Es ist interessant, dass wir nur 12 trogloxene Arten in den Höhlen (weit von dem Eingang entfernt) des Mährischen Karstes feststellen konnten. Ausserhalb der Höhlen leben edaphisch in der Waldstreu, den Moosen und korticikol viele Collembolen-Arten (etwa 200 Arten—cf. Rusek, 1961b), die hygrophil sind und bei denen man eine Praedisposition für das Leben in der Höhle erwarten könnte. Man muss voraussetzen, dass der grösste Teil dieser Arten beim Hochwasser mit dem Holz, Moos, Waldstreu, etc. in die Höhlen eingeschleppt wird, aber hier nicht leben kann. Wir wissen bisher sehr wenig über die Nahrungspezialisation, Ökologie und Biologie der Collembolen! Hier werden vielleicht auch die Antworten auf die Frage, warum sich einige Arten dem Leben in der Höhle anpassen können und andere gleich absterben, liegen.

COLLEMBOLEN UND DIE MIKROSTANDORTEN IN DEN HÖHLEN

Wie schon gesagt wurde, sind die Collembolen (und auch die anderen Tiergruppen) in der Höhle nicht gleichmässig verteilt. Ihre Verteilung wird hier von verschiedenen Faktoren beeinflusst. Wenn wir nicht die Eingangsräume, wo sich die Lebensbedingungen den Bedingungen in den Böden ausserhalb der Höhle sehr nähern und wo auch viele trogloxene muscicole, hemi- und euedaphische Arten leben, in die Betrachtung nehmen, bleibt uns der klimatisch stark ausgeglichene Innenraum der Höhle zur Analyse. Die Temperatur schwankt während des Tages und während des Jahres nur sehr gering, die relative Luftfeuchtigkeit sinkt fast niemals unter 99—98%. Dieser Faktor kann daher nur in sehr trockenen Sommern die Population der troglophilen und troglobionten Tiere, die gegen Austrocknen nicht geschützt sind (Mais, 1969), negativ beeinflussen. Die fast konstanten klimatischen Faktoren spielen im Leben der Troglobionten und Troglophilen also nur eine sehr kleine Rolle; die Höhlentiere sind an die herrschende niedrige Temperatur und hohe relative Luftfeuchtigkeit angepasst. Wir müssen die Ursache für die unregelmässige Verteilung der Tiere in den Höhlen in anderen Faktoren suchen.

Die Collembolen wurden in den Höhlen auf verschiedenen Substraten gesammelt. Es wurden Proben von morschem Holz, Fledermausguano, Pilzmycelium und Moosen aus der Nähe der Reflektoren genommen und die Tiere individuel an den Stalagmiten, Stalagtiten, Wänden, Sintertümpeln und angeschwemmten Böden gesammelt. Am reichsten war die Fauna in den feuchten Proben von morschem Holz und Fledermausguano. Im morschen Holz kommen *Folsomia candida* und *Folsomia litsteri* massenhaft vor. Mit diesen Arten leben hier noch häufig *Schaefferia emucronata, Onychiurus fimetarius, Heteromurus nitidus, Neelus murinus, Hypogastrura purpurescens, Megalothorax minimus, Onychiurus pseudosibiricus* und einige trogloxene Arten zusammen. Auf und im morschen Holz finden sie eine reiche Futterquelle — Pilzmycelium, Bakterien, abgestorbene organische Reste, viele Protozoa, etc.

Im Fledermausguano ist *Ceratophysella bengtssoni* die häufigste Collembolenart. Mit ihr leben hier noch *Folsolia litsteri, Tullbergia sylvatica* und *Onychiurus fimetarius* zusammen. Hier kommen auch *Folsomia candida, Heteromurus nitidus* und *Arrhopalites pygmaeus* (vereinzelt) vor.

Interessant ist die Probe No. 14 — weisses, wattenartiges Pilzmycelium. Hier konnte keine tierische Besiedlung festgestellt werden. Diese Tatsache weisst darauf hin, dass nicht alle Pilze für die Tiere geeignet sind, manche können sie sogar abstossen.

Auf den Stalagmiten, Stalagtiten und Tropfsteinwänden kommen die Collembolen nur vereinzelt vor. Sie bevorzugen die nassen Tropfsteine, wo sie in der dünnen Wasserschicht die Nahrung (Bakterien, kleine Wassertiere und mit dem Wasser angeschwemmte kleine organische Reste) finden. Von den Collembolen leben hier *Folsomia candida, Heteromurus nitidus, Folsomia litsteri, Onychiurus silvarius, Onychiurus fimetarius, Arrhopalites bifidus, Isotoma violacea, Arrhopalites pygmaeus* und *Megalothorax minimus*. Die Fauna ist hier meist individuenarm.

Manchmal sehr zahlreich kommen die Collembolen auf der Wasseroberfläche kleiner Wassertümpel vor. Die meisten Arten sind hier wie in einer Bodenfalle "gefangen", wir können hier viele tote Tiere finden, aber einigen ist die Wasseroberfläche ein natürliches Milieu. Sie finden hier tote Tiere und verhältnismässig reiches Neuston (Bakterien, Pilzhyphen, Protozoa, etc.) die ihnen als Nahrung dienen. Es lebt hier sehr häufig *Neelus murinus* und *Heteromurus nitidus*, manchmal auch *Onychiurus fimetarius* und *Schaefferia emucronata*. Vereinzelt findet man hier auch die *Arrhopalites*-Vertreter.

Die Moose bei den Reflektoren sind in der Höhle ein fremdes Element. Im Moos wurden die Troglobionten nicht gefunden, die Troglophile sind hier nur durch bestimmte Arten vertreten. Dagegen leben hier häufig die trogloxenen Arten, die auch ausserhalb der Höhle im Moos oder im Boden zu finden sind. Dominant sind hier *Isotoma notabilis, Willemia anophthalma, Hypogastrura purpurescens* und *Neelus murinus*, vereinzelt *Onychiurus armatus, Folsomia multiseta, Tullbergia krausbaueri, Megalothorax minimus* und *Pogonognathellus flavescens*.

Auf freiem, angeschwemmten Boden wurden keine Collembolen gefunden.

ZOOGEOGRAPHISCHE NOTIZEN UND URSPRUNG DER HÖHLENFAUNA DES MÄHRISCHEN KARSTES

Unsere Kenntnisse der europäischen Collembolenfauna sind verhältnismässig gut. In weiten Gebieten Europas wurde schon früher den Collembolen grosse Aufmerksamkeit gewidmet, und in den letzten Jahrzehnten wurde diese, boodenzoologisch sehr wichtige Tiergruppe auch synökologisch bearbeitet. Wir können z. Z. zu zoogeographischen Zwecken Angaben aus so wichtigen Gebieten wie Iberische-, Apenninische- und Balkanhalbinsel, Pyrenäen, Alpen, Karpathen, Sudeten, Hügellandschaft und Ebene Mittel-, West- und Nordeuropas benützen. Grosse Fortschritte hat auch die Taxonomie der Collembolen in der letzten Zeit gemacht. Diese Kenntnisse erlauben in immer grösserem Mass die Collembolen zu wichtigen zoogeographischen Analysen und zur Lösung des Faunaursprunges bestimmter Gebiete heran zuziehen. Sie sind für zoogeographische Analysen besonders geeignet, denn als Vertreter der Bodenfauna widerspiegeln sie die historische Faunaentwicklung besser als die fliegenden Insekten oder andere sich schneller ausbreitende Tiergruppen.

Über den Ursprung der mährischen Höhlenfauna wurde lange Zeit gestritten, ohne dass dabei eine eindeutige Lösung des Problems gefunden wurde. Heute können wir auf Grund der Collembolenfauna diese Frage genauer und eindeutiger beantworten.

Von den Troglophilen leben in den Höhlen des Mährischen Karstes grösstenteils solche Arten, die hier (oder in der weiteren Umgebung) auch ausserhalb der Höhlen vorkommen. Sie sind meistens über ganz Europa oder noch weiter verbreitet. Ausser diesen leben hier in den Höhlen noch troglophile Arten mit beschränkterer Verbreitung in den Hochgebirgen Europas (Pyrenäen, Alpen, Karpathen, Sudeten) oder mit dem Zentrum ihrer Verbreitung in den ursprünglich vereisten Gebieten Mittel- und Nordeuropas. Ihr Höhlenvorkommen im Mährischen Karst ist mehr oder weniger disjunkt hinsichtlich der heutigen Verbreitung ausserhalb der Höhlen. Diese Arten stellen im Mährischen Karst demontane (*Onychiurus serratotuberculatus*, *Onychiurus rectospinatus*, *Onychiurs silvarius*, *Uzelia setifera*) oder nordische (*Folsomia litsteri*) Elemente dar und gehören hir zu den Glazialrelikten.

Von den Troglobionten wurden im Mährischen Karst nur *Schaefferia emucronata*, *Mesachorutes quadriocellatus*, *Neanura tenebrarum*, *Onychiurus pseudosibiricus* und *Arrhopalites bifidus* festgestellt. Über Ursprung (und auch über den taxonomischen Wert) der Art *Neanura tenebrarum* können wir bisher nichts sagen. *Onychiurus pseudosibiricus* ist ausserhalb des Mährischen Karstes nur von dem Locus typicus — der Aggtelek-Höhle in N-Ungarn bekannt. Sie stellt sehr wahrscheinlich ein Praeglazialrelikt dar. Dasselbe Alter müssen wir auch der Art *Arrhopalites bifidus* zuerkennen. Ein sehr charakteristisches Element stellt *Schaefferia emucronata* dar. Ihre Verbreitung ist so gut bekannt und so charakteristisch, dass sie eindeutige Schlussfolgerungen über die glaziale, dealpine Herkunft dieser Collembolenart erlaubt. Dieselbe Herkunft wird vieleicht auch *Mesachorutes quadriocellatus* (eine Parallele mit *Mesachorutes ojcoviensis ?*) haben.

Wenn wir die Collembolenfauna der Höhlen des Mährischen Karstes mit der Höhlenfauna der Karpathen vergleichen (Tabelle No. 2), stellen wir fest, dass sie verhältnismässig arm ist. Beiden Faunen gemeinsam ist eine ganze Reihe troglophiler Arten, von den Troglobionten ist es nur *Onychiurus pseudosibiricus*. In den Höhlen der Karpathen kommen *Schaefferia emucronata*, *Mesachorutes quadriocellatus*, *Neanura tenebrarum* und *Arrhopalites bifidus* nicht vor. Diese Collembolenarten deuten auf einen unterschiedlichen Ursprung der Troglobionten im Mährischen Karst hin. Die im Mährischen Karst vorkommenden Troglobionten leben meistens auch in den Höhlen W-Europas und erreichen in Mähren die Ostgrenze ihrer Verbreitung. In den Karpathen kommen wieder einige endemische Troglobionten vor, die im Mährischen Karst und in W-Europa fehlen. In den Westkarpathen (Slowakei) sind solche Arten selten (westkarpathische Endemiten *Pseudosinella paclti*, *Hypogastrura crassegranulata dobsinensis*, *Hypogastrura crassegranulata carpatica* und *Onychiurus kratochvili*). In den rumänischen S-Karpathen sind dagegen die endemischen Troglobionten und Troglophilen nicht selten (Tabelle No. 2). Die polnischen Höhlen haben viele troglophile und troglo-

Tab. 2. Höhlencollembolen des Mährischen Karstes und benachbarter Gebiete

Collembolenart:	1	2	3	4	5
Hypogastrura similis	+	—	—	—	—
Hypogastrura purpurescens	+	+	—	+	—
Ceratophysella bengtssoni	+	—	—	—	—
Schaefferia emucronata	+	+	+	—	—
Mesachorutes quadriocellatus	+	—	—	—	—
Neanura tenebrarum	+	—	—	—	—
Onychiurus serratotuberculatus	+	—	+	—	—
Onychiurus sibiricus	+	+	—	—	+
Onychiurus pseudosibiricus	+	—	—	—	—
Onychiurus armatus	+	—	+	+	+
Onychiurus rectospinatus	+	—	—	—	+
Onychiurus fimetarius	+	+	—	+	+
Onychiurus silvarius	+	—	—	—	+
Tullbergia sylvatica	+	—	—	—	—
Tullbergia krausbaueri	+	—	—	—	—
Tullbergia japygiformis	+	—	—	+	—
Uzelia setifera	+	—	—	—	—
Folsomia quadrioculata	+	+	+	—	+
Folsomia multiseta	+	—	—	—	—
Folsomia litsteri	+	—	+	—	+
Folsomia candida	+	—	+	+	+
Proisotoma minima	+	+	—	—	—
Isotomiella minor	+	—	+	—	+
Isotoma violacea	+	—	—	—	—
Pseudosinella alba	+	—	+	—	—
Heteromurus nitidus	+	+	+	+	+
Megalothorax minimus	+	—	+	—	—
Neelus murinus	+	—	—	—	+
Arrhopalites caecus	+	—	—	—	—
Arrhopalites bifidus	+	—	+	—	—
Arrhopalites pygmaeus	+	—	+	+	+
Mesachorutes ojcoviensis	—	—	+	+	+
Onychiurus schoetti	—	—	+	—	—
Onychiurus paxi	—	—	+	—	—
Pseudosinella paclti	—	—	—	+	—
Onychiurus burmeisteri	—	—	—	+	—
Onychiurus kratochvili	—	—	—	+	—
Onychiurus ambulans	—	—	—	+	—
Hypogastrura crassegranulata dobsinensis	—	—	—	+	—
Hypog. crassegr. carpatica	—	—	—	+	—
Ceratophysella ionescui	—	—	—	—	+
Triacanthella perfecta	—	—	—	—	+
Acherontides tanasachie	—	—	—	—	+
Acherontides spelaea	—	—	—	—	+
Onychiurus tuberculatus	—	—	—	+	+
Onychiurus closianus	—	—	—	—	+
Onychiurus romanicus	—	—	—	—	+
Onychiurus ancae	—	—	—	—	+
Onychiurus hateganus	—	—	—	—	+
Onychiurus boldorii	—	—	—	—	+
Onychiurus orghidani	—	—	—	—	+
Onychiurus postumicus	—	—	—	—	+
Isotomurus alticola	—	—	—	—	+

1 — Mährischer Karst, 2 — Mährische Höhlen (ausserhalb Mähr. Karst), 3 — Polnische Höhlen, 4 — Slowakische Höhlen, 5 — Rumänische Höhlen.

bionte Arten mit dem Mährischen Karst gemeinsam, die Zahl dieser Elemente ist in ihnen jedoch geringer.

Für die sprachliche Korektur des Manuscripts spreche ich meinen innigsten Dank Herrn Kollegen Dr. W. Hüther (Bochum) aus.

ZUSAMMENFASSUNG

In dieser Arbeit wird ein Collembolen-Material aus den Höhlen des Mährischen Karstes bearbeitet. Zusammen mit den früher veröffentlichten Angaben (die in dieser Arbeit kritisch bewertet werden) sind aus diesem Karstgebiet 53 höhlenbewohnende Collembolenatern bekannt (ohne Spec. dubiae und falsch determinierten Arten). Die grösste Zahl der Arten ist trogloxen und troglophil. Von den Troglophilen sind die demontanen und nordischen Arten, die im Mährischen Karst Glazialrelikte sind, interessant. Von den Troglobionten stellt *Schaefferia emucronata* (und vieleicht auch *Mesachorutes quadriocellatus*) ein dealpines Element dar und ist hier ein Glazialrelikt. Tertiärer Herkunft (Praeglazialrelikte) sind sehr wahrscheinlich die Troglobionten *Onychiurus pseudosibiricus*, *Arrhopalites bifidus* und *Neanura tenebrarum*.

Es wird auf Grund des Typusmaterials *Achorutes sigillatus* var. *stygius* Absolon, 1900 mit *Ceratophysella bengtssoni* (Ågren, 1904) neu synonymisiert.

LITERATUR

Absolon, K., 1899a: Über die Fauna der Höhlen des mährischen Devonkalkes. (Thysanura) *Zool. Anz.* **22** : 317—317, 321—322.

Absolon, K., 1899b: *Vorläufige Mittheilung über die Gattung* Dicyrtoma und Heteromurus hirsutus nov. sp. aus den mährischen Höhlen. *Zool. Anz.* **22** : 493—496.

Absolon, K., 1900a: *Einige Bemerkungen über die mährische Höhlenfauna. Zool. Anz.* **23** : : 1—6, 57—60, 189—195.

Absolon, K., 1900b: Vorläufige Mittheilung über einige neue Collembolen aus den Höhlen des mährischen Karstes. *Zool. Anz.* **23** : 265—269.

Absolon, K., 1900c: Vorläufige Mittheilung über die Aphoruriden aus den Höhlen des mährischen Karstes. *Zool. Anz.* **23** : 406—414.

Absolon, K., 1900d: Systematický přehled fauny jeskyň moravských. *Věst. Klubu přírodov. v Prostějově*, **2** : 60—68.

Absolon, K., 1900e: Studie o jeskynních šupinuškách. *Věst. Klubu přírodov. v Prostějově* **3** : : 83—117.

Absolon, K., 1901a: Zwei neue Collembolenformen aus den Höhlen des Mährischen Karstes. *Zool. Anz.* **24** : 32—33.

Absolon, K., 1901b: Über Uzelia setifera, eine neue Collembolen-Gattung aus den Höhlen des mährischen Karstes, nebst einer Übersicht der Anurophorus-Arten. *Zool. Anz.* **24** : 209—216.

Absolon, K., 1901c: Über Neanura tenebrarum n. sp. aus den Höhlen des mährischen Karstes; über die Gattung Tetrodontophora Reuter und einige Sinnesorgane der Collembolen. *Zool. Anz.* **24** : 575—585.

Absolon, K., 1901d: *Beiträge zur Kenntnis der mährischen Höhlenfauna. Verh. naturf. Ver. Brünn* **39** : 6—14.

Absolon, K., 1901e: *Kritické úvahy o moravské zvířeně jeskynní. Časopis Matice moravské* **25** : 33—45.

Absolon, K., 1902: Über die apterygoten Insecten der Höhlen Europas mit besonderer Berücksichtigung der Höhlenfauna Mährens. *Congr. int. Zool. V* (— 1902, Berlin) *Verh.*: 804—805.

Absolon, K., 1907: Zwei neue Collembolen-Gattungen. *Wien. ent. Z.* **26** : 335—343.

Dudich, E., 1932: Biologie der Aggteleker Tropfsteinhöhle „Baradla“ in Ungarn. *Speläol. Monogr.* **13**.

Gisin, H., 1960: Collembolenfauna Europas. Genève. 312 pp.

Gruia, M., 1969: Donneés sur la répartition des Collemboles dans les grottes de Roumanie. *Lucr. Inst. Speol. ‚Emil Racoviță“* **8** : 161—176.

Kolenati, F., 1858: Zwei neue österreichische Poduriden. *S.-B.math.-naturw. Cl. Akad. Wiss. Wien*, **29** : 241—246.
Mais, K., 1969: Zur Kenntnis der ökologischen Valenz von Onychiurus cavernicolus und O. vornatscheri (Collembola, Insecta apterygota). Über Temperatur-, Feuchtigkeits- und Lichtreaktionen. *Pedobiologia* **9** : 282—287.
Müller, J., 1859: Beitrag zur Hohlenfauna Mährens. (Apterygota.) *Lotos* **9** : 30—32.
Nosek, J., 1962: The Collembola form the cave Plavecké Podhradie in Small Carpathians. *Acta Soc. ent. Čechoslov.* **59** : 12—18.
Nosek, J., 1963: Zwei neue Collembolenarten aus den Karpathen. *Zool. Anz.* **170** : 76—80.
Paclt, J., 1957a: Über die Collembolen-Fauna der slowakischen Hohlen. (Collembola.) *Beitr. Ent.* **7** : 269—275.
Paclt, J., 1957b: Collembola z kvaplovej jaskyne „Dupna diera" v Strážovských vrchoch. *Acta rer. nat. mus. slov.*, **23** : 1—6.
Paclt, J., 1961: Die hohlenbewohnende Collembolen-Fauna des Nordmährischen Karstes. *Přírodov. čas. slezský* **22** : 375—378.
Rusek, J., 1961a: Eine neue Collembolenart aus den slowakischen Hohlen. *Beitr. Ent.* **11** : 21—23.
Rusek, J., 1961b: K poznání Apterygot Moravského krasu. Dipl. práce ze zool. ú. přír. fak. UJEP v Brně. 73 pp. + 24 Tab.
Rusek, J., 1964: Poznámky k zvířeně a ochraně přírody v Moravském krasu. *Ochrana přírody* **19** : 155—156.
Rusek, J., 1966: Einige Collembolen-Arten aus der Tschechoslowakei. *Acta soc. zool. bohemoslov.* **30** : 54—64.
Rusek, J., 1965: Soil and caves as the environment of animal life. *Problems of the speleological research* · 163—166.
Rusek, J., 1969: Chvostoskoci — Collembola. In: Novák K. et all: Metody sběru a preparace hmyzu. Academia, Praha, 108—111.
Rusek, J., 1970: Jeskynní zvířena Moravského krasu. In: Absolon K., Moravský kras 2, pp. 308 to 310. Academia, Praha.
Rusek, J., 1971: Zur Taxonomie der Tullbergia (Mesaphorura) krausbaueri (Börner) und ihrer Verwandten (Collembola). *Acta ent. bohemoslov.* **68** : 188—206.
Rusek, J., J. Raušer et J. Vašátko: Živočišstvo Moravského krasu. Bezobratlí. In Charakteristika chráněné krajinné oblasti Moravský kras. Krajské středisko pam. péče a ochrany přírody v Brně. Im Druck.
Thibaud, J.-M., 1970: Biologie et écologie des Collemboles Hypogastruridae édaphiques et cavernicoles. *Mém. Mus. nat. hist. nat.* (A) *Zool.* **61** : 83—201.
Wankel, H., 1857: Über die Fauna der mährischen Hohlen. *Verh. zool.-bot. Ver. Wien* **6** : 467 bis 470.
Wankel, H., 1858: Beiträge zur Fauna der mährischen Höhlen. *Lotos* **10** : 202—203.
Wolf, B., 1934—1937: Animalium cavernarum catalogus. Den Haag.

Anschrift des Verfassers: Dr. Josef Rusek, CSc., Entomologisches Institut der Tschechoslowakischen Akademie der Wissenschaften, Viničná 7, Praha 2, Tschechoslowakei.

VĚSTNÍK ČESKOSLOVENSKÉ SPOLEČNOSTI ZOOLOGICKÉ
Svazek XXXVI – Číslo 1 – 1972 – Str. 73–74

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Department of Water Technology, Institute of Chemical Technology, Praha

A NOTE ON THE CILIATE ASTYLOZOON FAUREI KAHL

VLADIMÍR SLÁDEČEK

Received June 4, 1971

Abstract: The Ciliate was found in winter plankton of the balancing Reservoir Želiv. The circumstances on the locality do not exclude the idea of some protozoologists that *Astylozoon* is not a valid genus but only a special form a of free-moving *Vorticella*, most probaly *Vorticella microstoma*.

Nusch (1970) observed that some specimens of *Vorticella microstoma* Ehr. were able to get free from their contractile stalks and to swim freely without forming a telotroch stage. There was thus no second ring of aboral cilia in the lower part near the former stalk, but there was observed a rudimentary stiff cilia as in the genus *Astylozoon*. Without seeing the whole development of that organism Nusch would determine it as *Astylozoon pyriforme* or *A. faurei*. A similar phenomenon was observed by Stiller (1954) at *Vorticella microstoma* f. *hians* and f. *turgescens* after a rapid change of the environmental conditions. Both these observations mean that a question dealing with the validity of the genus *Astylozoon* must be raised.

I found the free-moving peritrichous Ciliate *Astylozoon faurei* Kahl in the balancing reservoir Želiv below the main dam of the Sedlice Reservoir on the Želivka River in S. E. Bohemia February 11, 1971. A sample was collected by Dr. A. Sládečková and Ing. J. Semrád under the ice cover. About 5 ind./l were found in the net plankton catch, they moved quickly with the peristom forwards and were 55–60 μm in length (Fig. 1).

The very poor phytoplankton showed only about 2 org./ml and consisted of *Chrysococcus rufescens*, *Synura*, *Synedra*, *Melosira*, *Pinnularia*, naviculoid diatoms, *Gymnodinium*, *Chlamydomonas*, *Scenedesmus obliquus* and *Phormidium*, the zooplankton consisted of *Bodo*, *Monas*, *Anthophysa vegetans*, *Aspidisca lynceus*, *Carchesium polypinum*, *Cinetochilum margaritaceum*, *Codonella cratera*, *Cyclidium glaucoma*, *Lembadion lucens*, *Stentor coeruleus*, *Trachelius ovum*, *Vorticella* and cyclopids. Moreover, few filaments of the bacterium *Sphaerotilus natans* were present. A chemical analysis was performed by Ing. Jiří Semrád with the following results:

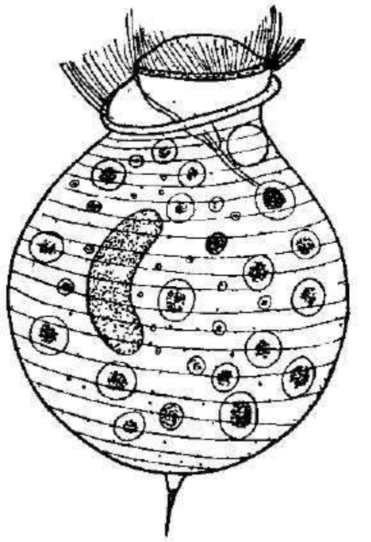

Fig. 1. *Astylozoon faurei* Kahl, 1935 (syn. *Astylozoon pyriforme* Schewiakoff, 1893, var., Fauré-Fremiet, 1924) from the balancing reservoir Želiv in S.E. Bohemia. Body length 55–60 μm.

BOD_5 = 3,2, oxygen consumed from potassium permanganate = 1,7, ammonium-ion = 2,1, nitrites = 0,15, nitrates = 13,5, total N = 6,8, inorganic phosphates = 0,16 and total phosphates = 0,6 mg/l. Both biological as well as chemical analyses gave evidence on an advanced process of selfpurification about at the α-mesosaprobic up to β-mesosaprobic level. The mixture of organisms was caused by the effects of clean tributaries to the main river system which was polluted in the area of the town of Pelhřimov.

In the samples from March and April *Astylozoon* was no more detected and the same was true in samples collected on other localities of the same river system.

Although my findings do not allow to confirm the observations of Nusch (1970) and Stiller (1954) in the full extent, I can state that the Czech record of *Astylozoon faurei* (the first in this country, see Šrámek — Hušek, 1952—53) is not in contradiction with the ecological findings of both authors. *Astylozoon* seems to be bacteriophagous like *Vorticella microstoma* (Stout, 1954).

A new fact is the tolerance of *Astylozoon faurei* to the very low water temperature, approximately 1—4°C. Previous records, e.g. Čorik, 1968, dealt only with the summer. Also the size of the body was a little bigger, Fauré-Fremiet (1924) and Kahl (1935): 40—50 µm, Čorik (1968): 50 µm, Želiv 55—60 µm, but such variations are common among Ciliates.

The saprobiological evaluation of this species can be indicated preliminarily as follows:

$$x = 0, \ o = 0, \ \beta = +, \ \alpha = 9, \ p = 1, \ G = 5, \ S = 3{,}1$$

REFERENCES

Čorik, F. P., 1968: Svobodnoživuščije infuzorii vodoemov Moldavii. — Akad. Nauk Moldavskoj SSR, Inst. Zool., Kišinev, p. 252.

Fauré-Fremiet, E., 1924: Contribution à la connaisance des Infusoires planctoniques. — *Bull. Biol. France Belgique, Suppl.* **6** : 1—171.

Kahl, A., 1930—35: Wimpertiere oder Ciliata. — In F. Dahl: *Die Tierwelt Deutschland,* Teil 18, 21, 25, 30, p. 1—886, Jena.

Nusch., E. A, 1970: Ökologische und systematische Untersuchungen der Peritricha (Protozoa, Ciliata) im Aufwuchs von Talsperren und Flußstauen mit verschiedenem Saprobitätsgrad (mit Modellversuchen). — *Arch. Hydrobiol. Suppl.* **37** : 243—386.

Stiller, J., 1954: *Vorticella microstoma* Ehrenberg (Peritricha, Ciliata) als Bioindikator ökologisch verschiedener Gewässer. — *Ann. Hist. Nat. Musei Nat. Hung. N.S.* **5** : 191—201.

Stout, J. D., 1954: The effect of enviromental factors on the life history of the Ciliate, *Vorticella microstoma*. — *Trans. Roy. Soc. N. Zealand* **82** : 705—711.

Šrámek-Hušek, R., 1952—53: Předběžný seznam nálevníků (Ciliata) z Čech, Moravy a Slezska do r. 1950. I. II., — *Čas. Nár. musea, odd. přír.* **121** : 140—148, **122** : 76—88. (Tschechisch mit dt. Zus.: Vorläufiges Verzeichnis der in Böhmen, Mähren und Schlesien bis zum Jahre 1950 gefundenen Ciliatenarten.)

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VĚSTNÍK ČESKOSLOVENSKÉ SPOLEČNOSTI ZOOLOGICKÉ
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CHANGES IN THE AMOUNT AND COMPOSITION OF PROTEINS AS INFLUENCED BY THE CALORIC CONTENT AND TIME DISTRIBUTION OF FOOD INTAKE

JAROSLAVA SOBKOVÁ & RICHARD PETRÁŠEK

Received May 14, 1971

Abstract: The authors investigated the effect of 1—8 weeks intermittent fasting (fre access to food on alternate days) on the dynamics of changes in the total protein content of serum liver, kidneys and carcass of female rats, so-called white laboratory rats, Wistar strain.

It was found that while in the liver and kidneys after 8 weeks the total protein is reduced, i serum it increases gradually from the 4th week and in the carcass after an increase during th 2nd—4th week, during the 8th week the values become gradually levelled with those in control

The authors discuss the probable interpretation of changes which involve a shift from enhance anabolic processes to an increase of catabolic ones.

A large food intake leads to a number of metabolic changes in particula in the carbohydrate and fat metabolism; some data suggest, however, tha also the metabolism of proteins, specially as regards their total amount i the body, is affected.

Cohn's experiments revealed that in rats fed by tube twice a day no only the ratio of body fat increases but at the same time the ratio of tota proteins declines (Cohn and Joseph, 1959; Cohn et al 1963, 1964). Similar changes in body composition were found in intermittently fed rats wit access to food limited to defined periods (Fábry et al., 1962, 1964).

The above authors, however, assessed changes in body proteins afte a single interval of cca 4—6 weeks. In our experiments we wanted to investigate the dynamics of these changes. We assessed therefore the protein in serum, in some organs and in the carcass after varying periods followin ingestion of a large meal.

MATERIAL AND METHODS

For the experiments female "albino rats", Wistar strain, were used, the albinotic form *Rattus norvegicus*, adapted to a temperature of 19—22° C, regular alternation of light and darkne (7 a.m. — 7 p.m. light, 7 p.m. — 7 a.m. darkness). The animals were fed standard Larsen mixtu (Fábry, 1959), containing 25 cal.% protein, 53 cal.% carbohydrates and 22 % fat. The ra fed daily ad libitum were compared with intermittently fasting rats (Fábry et al., 1962) fed o alternate days for a period of 1—8 weeks.

After 1, 2, 4 and 8 weeks of intermittent feeding the rats were killed by decapitation and som parameters of the protein metabolism were investigated.

The proteins in serum and organs were assessed by means of Folin's reagent (Lowry et al., 1951) and the proteins in carcass by means of Kjeldahl's method. The carcass was prepared, as described by Mickelsen and Anderson (1959).

EXPERIMENTAL

a) Serum proteins

The results are summarized in table 1. The intermittently fasting rats

Table 1. Total serum proteins

Group	No. of rats	Mean weight of rats g	Experimental period - weeks	g% protein
Fed daily ad lib.	6	183,7	1	8.00 ± 0.04
Intermittently fasting fed on alternate days ad lib.	6	167.7	1	7.83 ± 0.3
Fed daily ad lib.	6	181.7	2	8.50 ± 0.09
Intermittently fasting fed on alternate days ad lib.	6	158.5	2	8.58 ± 0.3
Fed daily ad lib.	6	210.0	4	8.54 ± 0.08
Intermittently fasting fed on alternate days ad lib.	6	166.0	4	9.79 ± 0.09
Fed daily ad lib.	6	223.0	8	8.70 ± 0.24
Intermittently fasting fed on alternate days ad lib.	6	182.5	8	11.00 ± 0.09[1]

Values give mean ± S.E.

[1]) Difference is as compared with control group statistically significant $P < 0.01$

have after two weeks adaptation practically the same serum protein levels. Only after more prolonged adaptation, after 4 weeks or longer the serum protein level rises in intermittently fasting animals.

b) Protein content of organs — liver — kidneys

From the presented results (table 2) ensues that the proteosynthetic activity of the liver of rats adapted to intermittent fasting and animals fed ad libitum does not differ during the first week of adaptation. After two weeks we observed, however, an enhanced deposition of protein in the liver in the intermittently fasting rats and the same effect was noted also after four weeks' adaptation. On the other hand, two months intermittent fasting apparantly promoted catabolic processes in hepatic tissue and protein synthesis in this tissue is reduced. The total amount of proteins in the kidneys is given in table 3. As far as the amount of protein in the kidneys is concerned, we did not find any marked changes in the protein content of ad libitum fed and intermittently fed animals. After the second week there is in the experimental animals a tendency towards a lower total protein content.

c) Protein content of carcass

The results of the experiments are presented in table 4. Periodically fasting rats have after the first week of adaptation a smaller amount of body proteins

Table 2. Total protein content of liver

Group	No. of rats	Means weight of rats g	Experimental period - weeks	g% protein
Fed daily ad lib.	6	182.7	1	12.57 ± 1.4
Intermittently fasting fed on alternate days ad lib.	6	188.2	1	13.50 ± 0.7
Fed daily ad lib.	6	174.2	2	15.69 ± 0.3
Intermittently fasting fed on alternate days ad lib.	6	144.2	2	16.87 ± 0.6
Fed daily ad lib.	6	216.2	4	19.45 ± 0.9
Intermittently fasting fed on alternate days ad lib.	6	170.5	4	23.79 ± 1.0
Fed daily ad lib.	6	219.0	8	20.95 ± 0.6
Intermittently fasting fed on alternate days ad lib.	6	164.0	8	15.53 ± 0.24[1])

Values give means ± S.E.
[1]) Difference is as compared with control group statistically significant $p < 0.05$

than controls. Intermittently fasting rats respond to the alternation o periods of free access to food and complete fasting in a different way durin different stages of adaptation. Already after the second week of adaptatio we can observe an increase in the amount of protein in intermittentl fasting rats which is even more marked after four weeks, as compared wit ad libitum fed animals. During the 8th week the protein levels in the tw groups are again more balanced though the adapted animals have stil

Table 3. Total protein content of kidneys

Group	No. of rats	Means weight of rats g	Experimental period - weeks	g% protein
Fed daily ad lib.	6	182.7	1	11.75 ± 0.7
Intermittently fasting fed on alternate days ad lib.	6	188.2	1	11.01 ± 1.38
Fed daily ad lib.	6	174.2	2	13.61 ± 1.23
Intermittently fasting fed on alternate days ad lib.	6	144.2	2	11.80 ± 0.2
Fed daily ad lib.	6	216.2	4	19.56 ± 0.2
Intermittently fasting fed on alternate days ad lib.	6	170.5	4	18.60 ± 1.9
Fed daily ad lib.	6	219.0	8	19.36 ± 0.62
Intermittently fasting fed on alternate days ad lib.	6	164.0	8	16.10 ± 1.7[1])

Values give mean ± S.E.
[1]) Difference is as compared with control group statistically significant $P = 0.02$

Table 4. Total protein content of carcas

Group	No. of rats	Mean weight of rats g	Experimental period - weeks	g% protein
Fed daily ad lib.	6	167.6	1	24.05 ± 2.0
Intermittently fasting fed on alternate days ad lib.	6	179.3	1	22.69 ± 1.28[1]
Fed daily ad lib.	6	177.6	2	26.87 ± 1.29
Intermittently fasting fed on alternate days ad lib.	6	147.6	2	29.12 ± 1.74
Fed daily ad lib.	6	192.3	4	21.38 ± 1.26
Intermittently fasting fed on alternate days ad lib.	6	151.6	4	23.62 ± 1.52[1]
Fed daily ad lib.	6	233.6	8	19.40 ± 0.48
Intermittently fasting fed on alternate days ad lib.	6	195.0	8	20.93 ± 0.56

Values give mean ± S.E.
[1]) Difference is as compared with control group statistically significant $P < 0.01$
[2]) $P = 0.05$

a higher protein content. The difference is, however, very small. Intermittent feeding on alternate days causes an increase of protein in rats accustomed to fasting until the animal becomes adapted to this feeding pattern (in our set-up 8 weeks) and after that the amount of protein in the two groups is on the whole equal.

DISCUSSION

Observation of parameters of the protein metabolism in the course of intermittent fasting enables us to follow up the adaptative capacity of experimental animals. Periodic changes and the sudden ingestion of a large amount of food in rats is manifested by a number of metabolic adaptations. Plasma proteins are an important protein reservoir of the organism which participates substantially in the total nitrogen metabolism of the organism. Intermittent fasting leads to an increase of plasma proteins. Obviously during the first week of intermittent fasting when the organism is not adapted to the altered feeding pattern the greatest changes in plasma proteins take place. By further adaptation subsequently mechanisms are created which no longer are so sensitive to caloric deficiency and regulated the plasma protein level. Normal plasma protein levels may be found also during fasting (Hořejší et al, 1963).

The greatest changes of protein content under the influence of various nutritional factors were found in the liver (Addis et al., 1936). In this organ the protein content declines after two days fasting much more than in the other organs but this protein is very rapidly replenished after ingestion of food. Therefore the majority of authors consider the liver as the site where so-called reserve protein is deposited which is released more readily than so-called structural proteins. Some experiments revealed that animals accustomed to fasting form from dietary proteins more liver proteins per unit of body-weight than ad libitum fed animals (Hrůza and Fábry, 1954). It is probable that adaptation to a reduced food supply was manifested by enhanced anabolic processes.

Our results are thus on the whole in keeping with the above findings as far as the influence of intermittent fasting on the whole body protein content is concerned.

CONCLUSION

1. In the course of 1—8 weeks' intermittent fasting (feeding ad libitum on alternate days) changes in the total protein content of serum, liver, kidneys and carcass were investigated.

2. The serum protein in intermittently fasting rats increases gradually after the 4th week of adaptation.

3. After 8 weeks intermittent fasting the total protein content of liver is reduced.

4. In the kidneys after 8 weeks the protein content is lower in the experimental group.

5. In intermittently fasting rats an increased amount of protein was found during the 4th week, during the 8th week the values gradually levelled with those of controls.

LITERATURE

Addis T., L. Poo, and W. Lew, 1936: Protein loss from liver during a two-day fast. *J. Biol. Chem.* **115** : 117—118.

Cohn, C., 1963: Feeding frequency and body composition. *Ann. N. Y. Acad. Sci.*, **110** : 395—409.

Cohn, C., 1964: Feeding patterns and some aspects of cholesterol metabolism — Fedn. Proc. *Fedn. Ann. Soc. exp. Biol.* **23** : 76—81.

Cohn, C. and Joseph, D., 1959: Changes in body composition attendant on force feeding. *Amer. J. Physiol.* **196** : 965—968.

Fábry, P., T. Braun, R. Petrásek, E. Horáková and E. Konopásek, 1964: The effect of the pattern of food intake on the carcass composition of rats receiving diets with varying fat content. *Physiol. Bohemoslov.* **13** : 333—340.

Fábry, P., R. Petrásek, T. Braud, M. Bednárek, E. Horáková and E. Konopásek, 1962: Lipogenesis in rats adapted to intermittent starvation or continuous undernutrition. *Experientia* **18** : 556—562.

Fábry, P., R. Petrásek, V. Kujalová and E. Holečková, 1962: Adaptace na změněný přívod potravy. SZdN, Praha.

Holečková, E. and P. Fábry, 1959: Hyperphagia and gastric hypertrophy in rats adapted to intermittent starvation. *Brit. J. Nutr.* **13** : 260—266.

Hořejší, J., K. Mašek and P. Pudlák, 1963: Krevní bílkoviny. SZdN, Praha.

Hrůza, Z. and P. Fábry, 1955: Studies on the adaptation of metabolism. II. Adaptation of protein metabolism under varying conditions of nutrition. *Physiol. Bohemoslov.* 4 : 152—154.

Hrůza, Z. and P. Fábry, 1955: Studie o adaptaci přeměny látek. II. Adaptace přeměny bílkovin za různých stavů výživy. *Čsl. Fysiologie* **3** : 283—290.

Hrůza, Z., 1956: O cyklických změnách přeměny bílkovin v játrech, *Čsl. Fysiologie* 5 : 40—45.

Lowry, O., N. J. Rosenhraegh, Fau L. and R. J. Randale, 1951: Protein measurement with the Phenol Reagent. *J. Biol. Chem.* **193** : 266—275.

Mickelsen, O. and A. A. Anderson, 1959: A method for preparing intact animals for carcass's analysis. *J. Lab. Clin. Med.* **53** : 282—290.

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Gesa Hartmann-Schröder, Annelida, Borstenwürmer, Polychaeta. Die Tierwelt Deutschland Díl 58, str. 597, obr. 191. VEB Gustav Fischer Verlag Jena, 1971. Cena brož. výtisku 128,50 marek

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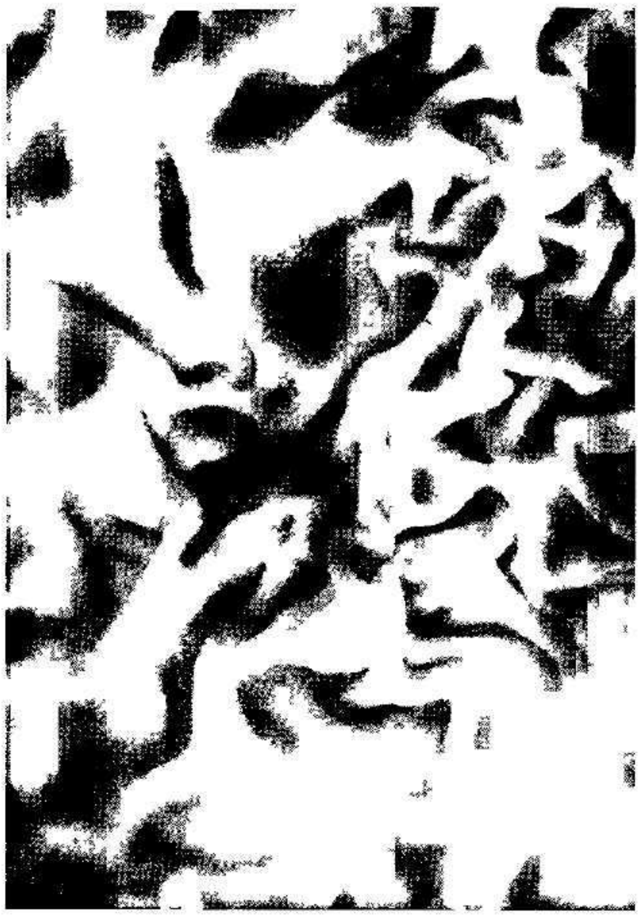

Fig 1 *E thaxteriana* cultu c on gulated yolk (enlarged 4 times)

Fig. 2. *E. coronata*-culture on coagulated yolk (enlarged 4 times).

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Changes in the amount and composition of proteins as influenced by the caloric content and time distribution of food intake.

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