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Laboratory of Systematic and Evolutionary Zoology, Institute of Biology "Tr. Savulescu", Roumanian Academy of Sciences, Bucureşti

A CORRECTION ON MEGAGOBIO NASUTUS KESSLER AND ON THE GENUS MICROPHYSOGOBIO MORI (PISCES, CYPRINIDAE)

PETRU BANARESCU

Received November 13, 1967

Abstract: The author gives a correct figure and description of the right type-specimen of *Megagobio nasutus*, which is specifically distinct from *Rhinogobio cylindricus*. The Taiwan specimens considered by Banarescu & Nalbant (1966) as identic with *Microphysogobio obtusirostris* proved to belong to *M. brevirostris*, *obtusirostris* itself being a subspecies of *brevirostris*. The five Chinese and Korean forms considered by Banarescu & Nalbant as subspecies of *brevirostris* represent a distinct species, *M. kachekensis*.

MEGAGOBIO NASUTUS KESSLER

In a recent revision of the Chinese Cyprinid genus *Rhinogobio* Bleeker published in this journal (Banarescu, 1966), I gave a photograph of a type-specimen of *Megagobio nasutus* Kessler, kindly presented to me by Prof. A. N. Svetovidov. I remarked that the eye of this specimen seems, according to the photograph, to be much larger than indicated by Kessler (1874) in the original description of the species and I considered *M. nasutus* to be conspecific with *Rhinogobio cylindricus* Günther from the Yangtze.

During a recent visit to the Institute of Zoology of the Academy of Sciences in Leningrad, I had the opportunity to examine the collection of Gobioinae and I realized that there occured a confusion of the labels of two specimens: the specimen whose photograph I published as type of *Megagobio nasutus* (Banarescu, 1966, Pl. I., Fig. 4 and 5) being actually a *Saurogobio dabryi* and the true type-specimen of *Megagobio nasutus* being labelled as *Armatogobio lini* (a manuscript name by Taranetz). By comparing the two specimens with Kessler's description, Prof. A. N. Svetovidov fully agreed that there had been an exchange of labels and the true type specimen of *M. nasutus* received its own label and original Catalogue number (Z.I.A.N. 2481). I am very obliged to Prof. Svetovidov for having made the facility for me to study the rich collections of the Zoological Institute in Leningrad.

The type specimen of *Megagobio nasutus* (Fig. 1) has following characters:

D 3/7; L. lat. 45—52; standard length 207.0 mm; in % of standard length: depth 18.7%; caudal peduncle length 24.6%; least depth of caudal peduncle 9.2%; predorsal distance 38.7%; distance from pectoral to pelvic origin 23.2%; distance from pelvic to anal origin 22.7%; length of pectoral 20.0%;

length of head 21.7%; of snout 9.9%; diameter of eye 2.4%; diameter of eye 11.1% of head and 35.7% of interorbital width; anus nearer anal origin than pelvic axil. Air bladder reduced, its anterior chamber enclosed in an inner fibrous and an outer osseous capsule; posterior chamber free, short and slender.

These characters show that *M. nasutus* is a distinct species of the genus *Rhinogobio*, closer to *R. ventralis* and *R. cylindricus* than to *R. typus*. In spite of the fact that the pectoral does not reach the pelvic origin, a character which *nasutus* bears in common with *cylindricus*, both species differ sharply in general habitus, size of eye, shape of snout, etc and cannot ne considered as subspecies of a single species as I (1966) suggested. *R. cylindricus* is undoubdtedly closer to *R. ventralis* (with which it occurs together in the Yangtze) than to *R. nasutus*. The genus *Rhinogobio* consists thus of four and not of three species and none of these seems to be polytypic.

The specimen from Tsinan, lower Hwang-ho, recorded by Mori (1929) as *R. nasutus* and which I suggested (1966) to be a *R. ventralis* is, quite probably, a *R. nasutus*, its eye being as small as in the type specimen (11.8% of head, 37.8% of interorbital width); it differs from the type only in its longer pectorals, reaching to pelvic axil.

I publish also a photograph of the type specimen of *Gobio longipinnis* Nichols (A.M.N.H. 8419; Fig. 2), kindly presented me by the Department of Fishes, American Museum of Natural History, New York. This photograph confirms that *G. longipinnis* is a synonym of *Rhinogobio ventralis* as I suggested.

GENUS MICROPHYSOGOBIO MORI

In a recent revision of the East Asian genus *Microphysogobio* published in this journal (Banarescu & Nalbant, 1966), nine species were recognized, four of them polytypic; 5 Chinese and one Korean forms, hitherto considered as distinct species, were lumped as subspecies of *M. brevirostris* (Günther), whose nominal subspecies lives in Taiwan, while a series of specimens from Taichung, NE Taiwan, were identified with *M. obtusirostris* (Wu & Wang), a species originally described from the Upper Yangtze.

The examination of recent samples from the Taiwan island in the collections of the United States National Museum convinced me that the status of some forms of *Microphysogobio* is somewhat different from that indicated in the above-mentioned paper.

Two specimens from Chu-Tung, U.S.N.M. 191286, 78.0—82.0 mm st. standard length, belong undoubtedly to the typical form of *M. brevirostris*; they have 38—40 scales, depth 19.3—23.0% of st. length, eye diameter 5.5—6.2% of st. length and 78.0—87.5% of interorbital width; they have no lateral spots, but a longitudinal dark stripe and a more intensive dark spot on caudal base and another spot above pectoral; in colour pattern, these specimens agree with those from Taichung, NE Taiwan, identified by Banarescu & Nalbant (1966) with *M. obtusirostris*. But the same colour, especially the longitudinal stripe and the spot on caudal base can be recognize, with some difficulty, also in the rather badly preserved paratype of *brevirostris* (Z.M.B. 6305) recorded and figured by Banarescu & Nalbant (1966, Pl. I, Fig. 1); this colour pattern was surely present in the even more badly preserved lectotype (B.M.N.H. 1865. 5. 2.). The mental pads are broader than long.

A series of 67 specimens from Chia-I-Hsien, western coastal plain, U.S.N.M. 19296, agree with *M. brevirostris brevirostris* in colour pattern, but have a deeper body (depth 21.7—28.0% of st. length), fewer scales (35—37) and their mental pads are usually confluent on most of their length and longer than broad; these specimens represent a distinct subspecies, *M. brevirostris alticorpus*, which will be describe in another paper, while the 11 specimens from Taichung, Taiwan, I.B.T.S. 1333, identified by Banarescu & Nalbant (1966) with *M. obtusirostris*, can be considered as intergrades between *brevirostris* and *alticorpus*; the have 37—39, rarely 40 scales and their depth is 21.6—24.1% of standard length.

The upper Yangtze *Pseudogobio obtusirostris* Wu & Wang has, according to Wu & Wang (1931) and to Chang (1944) 35—37 scales, depth 20.4—22.2% of standard length and apparently the same colour pattern as *brevirostris*; it seems to represent a third subspecies of *M. brevirostris*.

The four representative Chinese gudgeons — *fukiensis, bicolor, kiatingensis* and *kachekensis* — approach *Microphysogobio brevirostris* in most characters, but differ from it in number of scales, body proportions and especially in having distinct laterals spots and not an unique stripe, neither caudal spot; their mental pads are longer than broad. Because of the sympatrical occurence of *kiatingensis* and *obtusirostris* in the upper Yangtze, I canot consider these four gudgeons as subspecies of *brevirostris* (as suggested by Banarescu & Nalbant), but as subspecies of a distinct species, whose right name is *Microphysogobio kachekensis* (Oshima); it is unfortunate that this name, based on a poorly described form, has priority over *fukiensis*. It is rather difficult to decide if *M. koreensis* Mori belongs to *M. brevirostris* or to *M. kachekensis*; it seems closer to the last named.

The genus *Microphysogobio* Mori contains thus 9 species: *kachekensis* (with 5 subspecies), *brevirostris* (with 3 subspecies and intergrades), then *exiguus, yaluensis, chinssuensis* (with three subspecies), *chenhsienensis, tungtingensis* (with 3 subspecies), *labeoides, tafangensis* (with two subspecies); the status of the 7 last-named species is that indicated by Banarescu & Nalbant (1966).

SUMMARY

The specimen figured by Banarescu (1966) as holotype of *Megagobio nasutus* proved to be a mislabeled *Saurogobio dabryi*; the true type of *M. nasutus* is figured. *Rhinogobio cylindricus* is specifically distinct from *R. nasutus*. The specimens from Taichung, North Taiwan identified by Banarescu & Nalbant (1966) with the upper Yangtze *M. obtusirostris* proved to be conspecific with *M. brevirostris* and intermediate between the East Taiwan nominal subspecies and a West Taiwan subspecies. *M. obtusirostris* from upper Yangtze too is a subspecies of *M. brevirostris*, while five other representative gudgeons *(M. koreensis, kiatingensis, bicolor, fukiensis* and. *kachekensis)* considered by Banarescu & Nalbant (1966) as subspecies of *M. brevirostris*, belong to an other species, *M. kachekensis*.

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

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Hydrobiologisches Laboratorium der Akademie der Wissenschaften, Prag

ÜBER HÖHLENHARPACTICIDEN AUS DEM RUMÄNISCHEN BANAT

VLASTIMIL KULHAVÝ

Eingegangen am 22. Dezember 1967

Vor einiger Zeit hat mir Herr L. Botosaneanu vom Speologischen Institut in Bukarest ein Copepodenmaterial aus folgenden Höhlen des rumänischen Banats zur Determination übergegeben:

Lokalität Nr.*	Datum der Probenentnahme
1. Pestera de la Valee	22. VI. 1960
2. Pestera Hoţilor (Herculane)	30. VI. 1961
3. Pestera Comarnic	2. VII. 1961
4. Pestera Comarnic	2. VII. 1961
5. Pestera Bohui (Intrarea Certes) „cascada izvorului"	5. VII. 1961
6. Pestera Ponor-Uscata (Steierdorf)	7. VII. 1961
7. Pestera Gaura Haiducească	13. VII. 1961
8. Pestera Ponor-Plopa	26. IX. 1961
8. Dieselbe Höhle	26. IX. 1961
9. Pestera Gaura Porcarului	9. X. 1961
10. Pestera Marghitas	14. X. 1961
11. Pestera de dupa Cîrsie	19. X. 1961
12. Pestera din Valea Čeuca	9. VI. 1962
13. Pestera Gaura cu Musca	14. VI. 1962
14. Pestera Zamonitza	17. VI. 1962
15. Pestera de la Voinicovatz	19. VI. 1962
16. Pestera Gaura Coknii	21. VI. 1962
16. Dieselbe Höhle	21. VI. 1962
17. Pestera Soroniste	27. VI. 1962
18. Pestera „Gaurile lui Miloi II"	17. VIII. 1962
19. Pestera de la Valee	19. VIII. 1962
20. Pestera de sub Padina Popii	21. X. 1962
21. Galeria de mina de la Firdea (Poiana Ruscai Gebirge)	24. V. 1963
22. Pestera Gaura Ponicovei („Donau-Defilé")	27. VII. 1963
23. Pestera de dupá Cîrsa (Caras-Tal)	6. X. 1963

*) Genauere Auskünfte über die erwähnten Höhlen sind in „Recherches sur les grottes du Banat et d'Olténie — Roumaine" (Editions du C. N. R. S., Paris 1967) zu finden.

In dem untersuchten Material von den oben angeführten Lokalitäten habe ich folgende 9 Harpacticiden-Arten festgestellt:

Harpacticoida

Canthocamptus staphylinus (Juriné)	Lok.: 743
Bryocamptus spinulosus occidentalis Štěrba	Lok.: 612, 1086, 1104, 1149
Bryocamptus pygmaeus (G. O. Sars)	Lok.: 1135
Bryocampus unisaetosus Kiefer	Lok.: 1172
Echinocamptus (Limocamptus) echinatus (Mrázek)	Lok.: 742
Maraenobiotus brucei carpathicus Chappuis	Lok.: 597, 640, 864
Elaphoidella phreatica pseudophreatica (Chappuis)	Lok.: 620, 889, 1132
Elaphoidella romanica n. sp.	Lok.: 612, 795
Moraria poppei (Mrázek)	Lok.: 620

Juvenile Harpacticiden wurden in Pestera Comarnic (Nr. 3, 4) gefunden. In den Proben Nr. 1, 15, 16 und 20 wurden keine Copepoden festgestellt.

BEMERKUNGEN ZU EINIGEN DER GEFUNDENEN ARTEN

Elaphoidella phreatica var. pseudophreatica (Chappuis, 1928)

Die wichtigsten morphologischen Merkmale der gefundenen Tiere sind aus den beigefügten Abbildungen beider Geschlechter (Abb. 1a, b) ersichtlich. Es ist hinzuzufügen, dass die inneren Ränder der ersten Glieder Enp. P_2—P_3 ♀♀ mit einem Dörnchen versehen sind, im Gegensatz zum Innenrand des ersten Gliedes Enp. P_4 ♀, der frei bleibt. Dieses Merkmal ist, nach Chappuis Angabe (1928, 1953) typisch für *Elaphoidella pseudophreatica.*

Am Benp. P_5 ♀ variiert die Borstenanzahl von 2—4, am Exp. P_5 ♀ von 3 bis 5.

Tabelle 1. Bewehrung der Endopoditen verschiedener Formen von *Elaphoidella phreatica.*

♀♀	*E. phreatica* var. *pseudophreatica* aus Rumänien	*E. phreatica* var. *pseudophreatica* aus der Slowakei (Štěrba, 1956)	*E. phreatica* var. *pseudophreatica* aus Italien (Chappuis, 1928, 1953)	*E. phreatica* typ.
P_1	1, 0/1, 0/1, 1, 1	1, 0/1, 0/1, 2, 0	1, 0/1, 1/1, 2, 0	
P_2	1, 0/2, 2, 1	1, 0/2, 2, 1	1, 0/2, 2, 1	0, 0/2, 2, 1
P_3	1, 0/3, 2, 1	1, 0/3, 2, 1	1, 0/3, 2, 1	0, 0/3, 2, 1
P_4	0, 0/2, 1, 1	0, 0/1, 2, 1	0, 0/1, 2, 1	0, 0/1, 2, 1
P_5	2—4	3—4	4	4
♂♂				
P_1	1, 0/1, 0/1, 2, 0	1, 0/1, 0/1, 2, 0	1, 0/1, 0/1, 2, 0	1, 0/1, 0/1, 2, 0
P_2	0, 0/2, 2, 0	1, 0/2, 2, 0	1, 0/2, 2, 0	0, 0/2, 2, 0
P_3	0, 0/1, 0/1, 1, 0	0, 0/1, 0/0, 2, 0	1, 0/1, 0/0, 2, 0	0, 0/1, 0/0, 2, 0
P_4	0, 0/1, 2, 0	0, 0/0, 3, 0	1, 0/1, 2, 0	0, 0/1, 2, 0
P_5	unentwickelt	unentwickelt	unentwickelt	unentwickelt

Gemeinsam mit den Weibchen wurden in denselben Proben auch Männchen gefunden, deren morphologische Merkmale, d. h. die Form und die Bewehrung der Furcaläste und der Körperglieder sich jenen der gefundenen Weibchen näherten; die Bewehrung ihrer Schwimmbeine entsprach jedoch der von *Elaphoidella phreatica*. Eine sehr ähnliche Situation fand auch Štěrba (1956) bei dem aus der Slowakei stammenden Material dieser Art. (Siehe Tabelle 1.).

Die Bewehrung Enp. P_1—P_5 bei rumänischen Weibchen entspricht jener von *Elaphoidella phreatica pseudophreatica* nach der Beschreibeung von Chappuis (1928) und Štěrba (1956). Dasselbe gilt auch für die Form und Bewehrung der Körperglieder und der Furca.

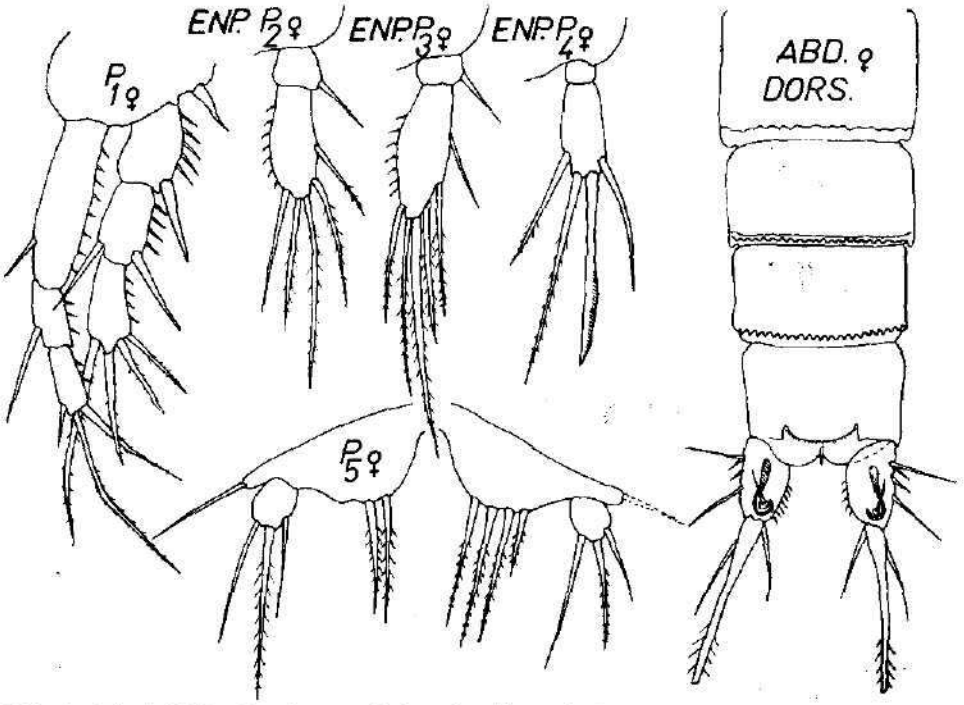

Abb. 1a: *Elaphoidella phreatica pseudophreatica* Chappuis, ♀

Zugleich ist also der Unterschied zwischen den rumänischen Exemplaren und *Elaphoidella phreatica* typ. hinsichtlich der Bewehrung der ersten Endopoditenglieder P_3—P_4 deutlich.

Die Endopoditenbewehrung der Männchen aus Rumänien entspricht dagegen völlig jener von *Elaphoidella phreatica* typ., unterscheidet sich aber von Štěrbas Beschreibung der *Elaphoidella phreatica pseudophreatica* durch die Abwesenheit des Dornes am ersten Glied Enp. P_2. Einen wichtigen Unterschied jedoch finden wir zwischen den Angaben von Chappuis (1953) und von Štěrba (1956) einerseits, und der hier festgestellten Bewehrung der rumänischen Männchen anderseits, was Exp. P_5 und die Form der Furca betrifft:

Nach Chappuis soll der Exp. P_5 ♂ nur 2 Borsten tragen, wogegen die slowakischen und rumänischen Exemplare 4 Borsten aufweisen.

Die Furca soll nach Chappuis Angabe kurz, breit und quadratförmig sein, mit mächtig entwickelten äusseren und inneren Furcalborsten. Die von Štěrba beschriebenen Männchen, sowie die aus Rumänien, sind mit einer längeren, schlankeren Furca sowie mit kurzen äusseren und inneren Furcalborsten versehen.

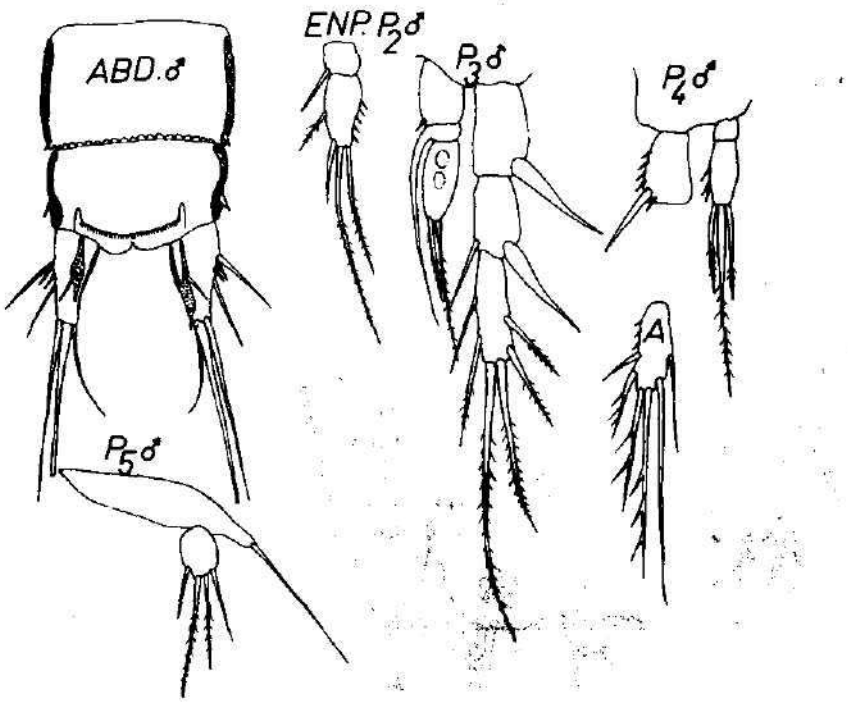

Abb. 1b: *Elaphoidella phreatica pseudophreatica* Chappuis, ♂ A — das letzte Glied Exp. P_4 ♂

Daraus muss man schliessen, dass das von Chappuis angeführte Männchen entweder ein atypisches Exemplar ist, oder zu einer anderen Art der Gattung *Elaphoidella* gehört.

Bei allen hier untersuchten Männchen findet man an den letzten Exopoditengliedern die äussere II.—IV. Borste grob und spärlich gefiedert, wogegen das Männchen nach Chappuis ganz normal gebaute Borsten zu haben scheint.

In Anbetracht der oben erwähnten Tatsachen kann man Štěrbas Auffassung von *Elaphoidella pseudophreatica* (Chappuis, 1928) als blosse Varietät der Art *Elaphoidella phreatica* (Chappuis, 1925) völlig berechtigt ansehen.

Elaphoidella romanica sp. n.

Holotypus: 1 ♀ aus der Höhle Pestera Bohui (intrarea certes, cascada izvorului), legit L. Botosaneanu 5. VII. 1961, Rumänien.

Paratypus: 1 ♀ aus der Höhle Pestera Gaura Porcariului, legit L. Botosaneanu 9. X. 1961, Rumänien.

Beide Exemplare werden im Hydrobiologischen Laboratorium der Tschechoslowakischen Akademie der Wissenschaften in Prag aufbewahrt.

Weibchen

Körperlange unbekannt.

A_1 achtgliedrig; A_2 zweigliedrig, mit eingliedrigem Exp., der 3 Borsten trägt.

Palpus mandibularis: Zweigliedrig, mit einer Lateralborste und mit 2 Borsten am Ende des zweiten Gliedes.

Bewehrung der Abdominalsegmente siehe Abb. 2.

Receptaculum seminis siehe Abb. 2.

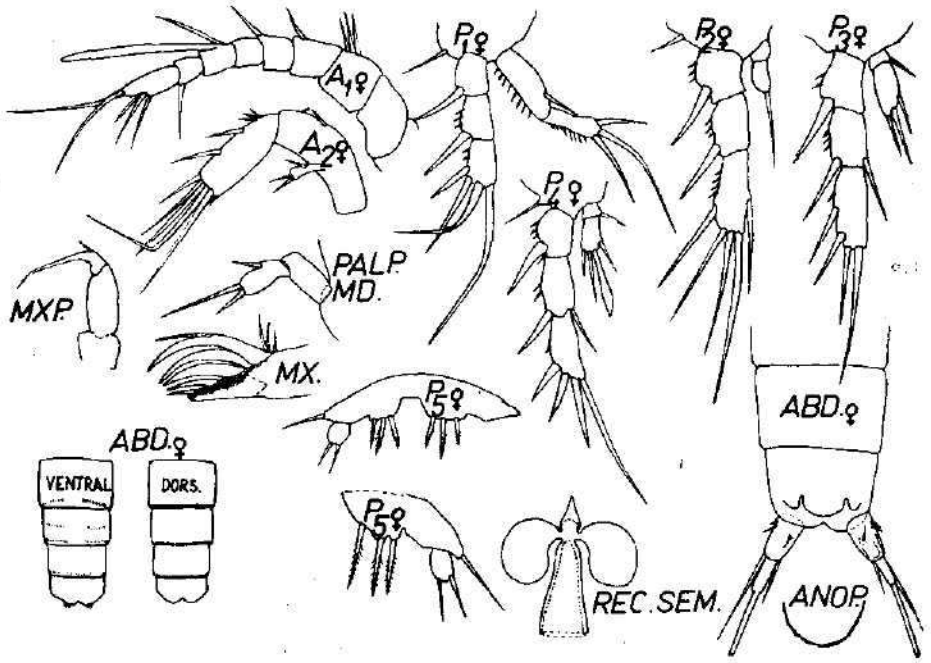

Abb. 2: *Elaphoidella romanica* n. sp., ♀

Analoperculum ist abgerundet, am Rand mit sehr dichten und feinen (hyalinen) Börstchen versehen. Der Rand des Analoperculums ragt nicht über den Hinterrand des letzten Abdominalsegments hervor.

Furca: Verhältnis der Länge zur Breite (in der Mitte der Länge gemessen) wie 2 : 1. In der Form ist sie konisch, etwas kürzer als das letzte Abdominalsegment (Länge des letzten Abdominalsegm. zur Länge der Furca 1,06 : 1).

Die mittlere Furcalendborste ist kräftig und lang, die äussere 1,5× länger als der Furcalast, die innere halb so lang.

Die Bewehrung der Schwimmbeine variiert bedeutend (siehe Tab. 2).

Enp. P_1 ist zweigliederig, das Ende des ersten Gliedes reicht bis zum Ende des zweiten Exopoditengliedes.

Benp. P_5 ♀ trägt 3 gefiederte Borsten und ist charakteristisch gestaltet:

sein Distalrand läuft nämlich schräg nach hinten aus und bildet einen Ansatz, auf dem ein kleiner Exopodit sitzt.

Eine ähnliche Gestaltung des Benp. P_5 findet man sonst nur bei *Elaphoidella brevipes* Chappuis, 1937 aus Jugoslawien, von der sich unsere neue Art aber durch die Bewehrung sowohl der P_1-P_4 als auch des P_5 unterscheidet (siehe Tab. 2).

Während man bei anderen Angehörigen der Gattung *Elaphoidella* die Bewehrung der letzten Exopoditenglieder P_1-P_4 nach folgendem Schema findet (siehe Lang, 1948):

P_1	P_2	P_3	P_4
1,2,2	1,2,2	2,2,2	2,2,2
oder 0,2,2	oder 2,1,2	oder 1,2,2	oder 1,2,2

ist bei unserer neuen Art diese Bewehrung stärker reduziert, und zwar hauptsächlich am Aussenrand der Glieder. (Siehe Tab. 2.)

Auch die Bewehrung des zweiten Gliedes Enp. P_2 ist ziemlich reduziert, mehr als bei *Elaphoidella javaensis* (Chappuis, 1928), d. h. man findet hier nur eine Borste.

Am zweiten Glied Enp. P_3 ist die Bewehrung auf 3 Borsten reduziert.

An den ersten Gliedern Enp. P_3 der beiden einzigen vorliegenden Weibchen wurde eine unterschiedliche Bewehrung festgestellt: entweder mit einem Dörnchen am Innenrand oder dieses Dörnchen fehlt.

Bryocamptus spinulosus occidentalis Štěrba, 1961

W e i b c h e n : A_1 achtgliedrig. Die Bewehrung der Abdominalsegmente entspricht bei den hier untersuchten Exemplaren vollständig Š t ě r b a s Beschreibung und man kann sagen, dass sie fast mit der Bewehrung des *Bryocamptus zschokkei* typ. (Schmeil, 1893) identisch ist.

Es fehlt hier lediglich auf der Ventralseite des III. Abdominalsegmentes eine Gruppe grösserer Dörnchen, die sich bei dem typischen *B. zschokkei* in der Mitte einer Reihe feinerer Dörnchen befindet.

Die Bewehrung der Schwimmbeine von den hier beschriebenen Exemplaren und anderen nächstverwandten Formen ist in der Tabelle 3 zusammengestellt.

Wie aus der Tabelle 3 zu ersehen ist, besteht in der Bewehrung der Schwimmbeine zwischen den ♀♀ von *B. zschokkei* typ. und *B. spinulosus occidentalis* Štěrba kein Unterschied, wogegen bei den ♂♂ von *B. spinulosus occidentalis* die Bewehrung der Enp. P_4 und Exp. P_5 spärlicher als beim typischen *B. zschokkei* ist.

Das Analoperculum trägt 3—5 grosse Zähne.

Die für die ♀♀ dieser Art so typische innere Furcalendborste, die sichelförmig gebogen ist und ventral von der mittleren Furcalenborste inseriert, ist an der Basis bulbenförmig verdickt.

Bei den ♂♂ findet man diese Borste ebenfalls sichelförmig gebogen, aber ohne den erwähnten Bulbus an der Basis.

Tabelle 2. Vergleich der Beinenbewehrungen zwischen *E. brevipes* und *E. romanica*.

	P_1		P_2		P_3		P_4		P_5	
	Exp.	Enp.	Exp.	Enp.	Exp.	Enp.	Exp.	Enp.	Exp.	Enp.
E. brevipes	0,1/0,1/0,2,2	1,0/1,1,1	?/?1,2,2	1,0/2,2,1	?/?2,2,2	1,0/3,2,1	?/?2,2,2	1,0/2,1,1	4	4
E. romanica	0,1/0,1/0,2,2	1,0/1,1,1	0,1/1,1/1,2,2 (0,2,2)	0,0/0,1,0	0,1/1,1/0,2,2	0,0/1,2,0 (1,0/2,1,0)	0,1/1,1/0,2,2	1,0/2,2,0	2	3

Tabelle 3. Vergleich der Schwimmbeinenbewehrung bei *Bryocamptus zschokkei* typ. und *Bryocamptus spinulosus occidentalis* Štěrba.

♀♀	P_1		P_2		P_3		P_4		P_5	
	Exp.	Enp.	Exp.	Enp.	Exp.	Enp.	Exp.	Enp.	Exp.	Enp.
B. zschokkei typ.	0,1/1,1/0,2,2	1,0/2,1,1 (1)	0,1/1,1/1,2,3	1,0/2,2,1	0,1/1,1/2,2,3	1,0/3,2,1 (2)	0,1/1,1/2,2,3	1,0/2,2,1	4—5	4—6
B. spinulosus occidentalis, nach Štěrba	0,1/1,1/0,2,2	1,0/1,1,1	0,1/1,1/1,2,3	1,0/2,2,1	0,1/1,1/2,2,3	1,0/3,2,1	0,1/1,1/2,2,3	1,0/2,2,1	5	6
B. spinulosus occidentalis, aus Rumänien	0,1/0,1/0,2,2/	1,0/1,1,1	0,1/1,1/1,2,3	1,0/2,2,1	0,1/1,1/2,2,3	1,0/3,2,1	0,1/1,1/2,2,3	1,0/2,2,1	5	6
♂♂										
B. zschokkei typ.	?	?	0,1/1,1/1,2,3	1,0/2,2,0	?	1,0/A/0,2,0	?	0,0/1,2,1	6	2
B. spinulosus occidentalis, nach Štěrba	0,1/1,1/0,2,2	1,0/1,1,1	0,1/1,1/1,2,3	1,0/2,2,0	0,1/1,1/2,2,3	1,0/A/0,2,0	0,1/1,1/2,2,3	0,0/0,2,1	5	2
B. spinulosus occidentalis aus Rumänien	0,1/1,1/0,2,2		0,1/1,1/1,2,3	1,0/2,2,0	0,1/1,1/2,2,3	1,0/A/0,2,0	0,1/1,1/2,2,3	0,0/0,2,1	5	2

Es handelt sich um den ersten Fund dieser Form in Rumänien. Die typische Form wurde bereits früher aus diesem Land gemeldet.

Bryocamptus unisaetosus Kiefer, 1930

In dem hier untersuchten Material habe ich insgesamt 2 ♀♀ gefunden; der vordere Körperteil des einen ging jedoch verloren.

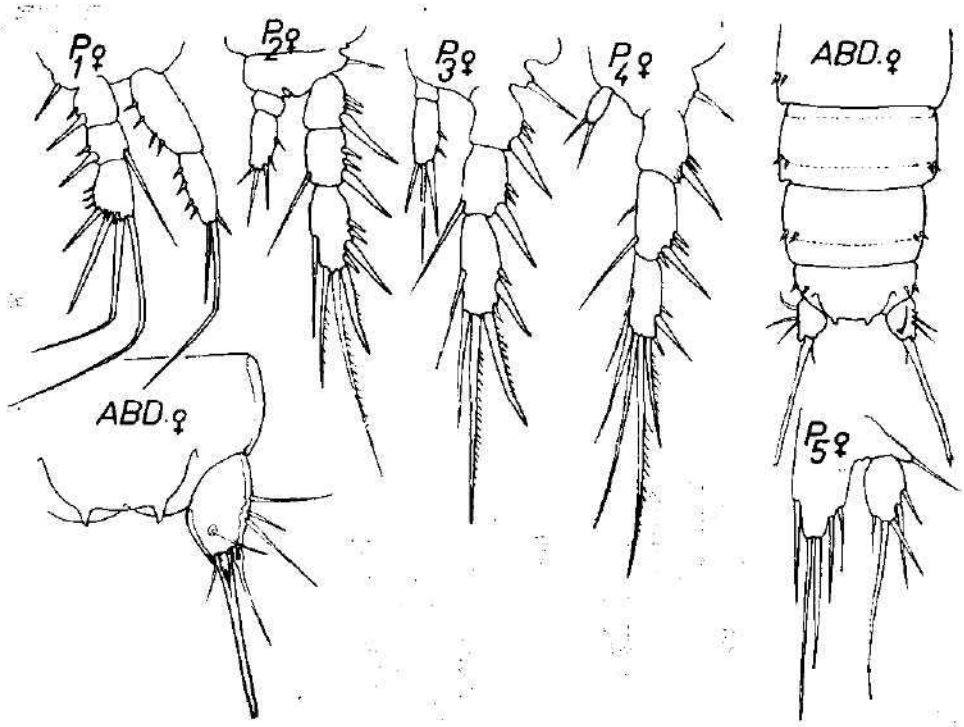

Abb. 3: *Bryocamptus unisaetosus* Kiefer, ♀

Weibchen: A_1 achtgliedrig. Die Bewehrung der Abdominalsegmente entspricht den Angaben Kiefers; bezüglich der Schwimmbeine wurde eine grosse Ähnlichkeit mit dem Typus gefunden, mit der einzigen Ausnahme der Bewehrung des P_5, wie aus der Abb. 3 und der folgenden Tabelle 4 ersichtlich ist:

Tabelle 4. Die Schwimmbeinebewehrung

	P_1		P_2	
	Exp.	Enp.	Exp.	Enp.
B. unisaetosus nach Kiefer	?	?	0,1/1,1/1,2,2	0,0/1,1,1
B. unisaetosus aus Rumänien	0,1/1,1/0,2,2	0,0/1,2,0	0,1/1,1/1,2,2	0,0/1,1,1

Ausser diesem Unterschied wurden noch folgende Abweichungen von Kiefers Beschreibung festgestellt: Beide ♀♀ tragen nur zwei Zähne am Analoperculum (nach Kiefer 3 Zähne), und bei einem Exemplar sind beide äusseren Furcalendborsten voll entwickelt und nicht auf 2 Knorren reduziert, wie es eigentlich für diese Art typisch sein sollte. Diese Art ist bis heute nur aus rumänischen, ungarischen und italienischen Höhlen bekannt.

Maraenobiotus brucei carpathicus Chappuis, 1928

Weibchen: Die gefundenen Exemplare waren höchst variabel, so dass nur ein Tier in seiner Morphologie der Beschreibung dieser Form voll entsprach.

So kann z. B. am I. Glied Enp. P_1 zuweilen eine kurze Borste am inneren Rand stehen. Am II. Glied desselben Enp. findet man gewöhnlich 3, also nicht 4 Borsten. III. Glied Exp. P_1 mit 5 Borsten.

Am ersten Glied Enp. P_2 ist die Bewehrung ebenfalls variabel, der innere Rand entweder mit einer Borste oder borstenlos. II. Glied mit 3—4—5 Borsten. III. Glied Exp. P_2 mit 4—5 Borsten.

Das I. Glied Enp. P_3 trägt gewöhnlich eine Innenrandborste, es war aber in einem Fall borstenlos. Schliesslich wurde einmal ein dreigliedriger Enp. gefunden! Das II. Glied Enp. P_3 trägt 5 Borsten. III. Glied Exp. P_3 mit 5 Borsten.

Das I. Glied Enp. P_4 gewöhnlich mit einer Innenrandborste, in einem Fall aber borstenlos, obgleich am Paarling das erste Glied mit Borste versehen war. Das II. Glied Enp. P_4 trägt 4—5 Borsten. III. Glied Exp. P_4 mit 5 Borsten.

Der Benp. P_5 mit 4 Borsten, Exp. gewöhnlich mit drei Borsten versehen.

Die dorsale Bewehrung der Abdominalsegmente: Die Segmente I—III tragen über dem Hinterrand je eine kurze laterale Dörnchenreihe. Das IV. Segment mit einigen Dörnchen an beiden Lateralseiten, oberhalb der Insertion der Furca.

Die ventrale Bewehrung der Abdominalsegmente: I—III Segment über dem Hinterrand auch mit je einer lateralen Dörnchenreihe. Ausserdem trägt das II. Segment in der Hälfte seiner Länge noch eine median unterbrochene Dörnchenreihe. Das IV. Segment mit einer Reihe Dörnchen oberhalb des Hinterrandes gegenüber der Furcainsertion.

Analoperculum mit zahlreichen Zähnchen in einer Reihe am Rande.

bei *Bryocamptus unisaetosus*.

P_3		P_4		P_5	
Exp.	Enp.	Exp.	Enp.	Exp.	Enp.
0,1/1,1/1,2,2	0,0/1,1,1	0,1/1,1/2,2,2	0,2,0	4	5
0,1/1,1/1,2,2	0,0/0,2,1	0,1/1,1/2,2,2	0,2,0	5	5

Furca: Auf der Dorsalseite eine proximal inserierte Borste; der Aussenrand im ersten Drittel mit 1 Borste, die in der Mitte einer Gruppe feinerer Dörnchen sitzt. Etwas hinter dem zweiten Drittel ihrer Länge befinden sich noch eine Borste und ein kurzer Dorn. Die äussere und mittlere Furcalendborste sind nebeneinander inseriert, mit verdickter Basis. Die innere Furcalendborste ist dagegen ventral von der mittleren Endborste inseriert.

Auf der Ventralseite ist die Furca mit einer latero-distalen Dörnchenreihe versehen, die ungefähr in der Hälfte der Innenrandlänge beginnt und zur Basis der mittleren Furcalendborste reicht.

ZUSAMMENFASSUNG

In einem Copepodenmaterial aus 22 Höhlen des rumänischen Banats wurden insgesamt 9 Harpacticiden-Arten festgestellt. Als die am häufigsten vorkommende Art wurde *Bryocamptus spinulosus occidentalis* Štěrba, 1961, eine ursprünglich aus der Tschechoslowakei beschriebene Form, gefunden. Weitere häufige Arten sind: *Maraenobiotus brucei carpathicus* Chappuis, 1928, charakterisiert durch hohe individuelle Variabilität, und *Elaphoidella phreatica pseudophreatica* (Chappuis, 1928), bislang nur in Italien und in der Tschechoslowakei gefunden.

An zwei Lokalitäten wurden zwei Weibchen der neuen Art *Elaphoidella romanica* sp. n. gefunden, die die stärkste Reduktion der Schwimmfussbewehrung aller bislang bekannten Arten dieser Gattung aufweist.

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OBSERVATIONS ON THE DEVELOPMENT OF CAMALLANUS LACUSTRIS (ZOEGA, 1776) (NEMATODA: CAMALLANIDAE)

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Abstract: The life history of *Camallanus lacustris*, parasitic in various freshwater fishes, was experimentally studied. The individual developmental stages and the morphological changes occurring during its development, are described in detail. The free, first stage larvae remained viable for 12 days at a temperature of 22° C, for 80 days at a temperature of 7° C. It was proved in experiments that the only intermediate hosts of this nematode species are representatives of the superfamily *Cyclopoidea: Megacyclops viridis, Macrocyclops albidus, Acanthocyclops vernalis, Mesocyclops leuckarti, Eucyclops serrulatus* and *Cyclops strenuus*. In these, the development of *C. lacustris* lasts 11—12 days at room temperature. A special feature of the third stage larvae (invasive larvae) is the *Paracamallanus* type of their mouth capsule. In the definitive host, the larva undergoes two more moultings; the mouth capsule of the fourth stage larva is of the *Camallanus* type. The complete development in the intestinal tract of perches lasts three months.

Although the development of the nematode *C. lacustris*, a common parasite of the intestinal tract of freshwater fishes, had been studied by various authors (Leuckart, 1876; Kuprjanova, 1954; Campana-Rouget, 1961), information on the development of this nematode species is still rather scarce, some of the observations are inaccurate and the various views somewhat antagonistic. For these reasons we started to study the life cycle of this nematode species in great detail and are here presenting the results of our work.

MATERIAL AND METHOD

The feeding of cyclops with the larvae and also experiments with feeding larvae to other possible first intermediate hosts were performed on larger petri dishes (⌀ 11—15 cm) at a temperature of approximately 20—25° C. Adequate number of various cyclops species or other invertebrates were transferred with a pipitte or a fine strainer to each petri dish, adding 2—4 females of C. *lacustris*, containing motile larvae; the worms were torn up with preparation needles. At first, the cyclops were examined at intervals of several hours, later once a day to obtain evidence on all developmental stages. The larvae obtained from the cyclops were fixed in 4% hot formalin and studied in native preparations, some of them were mounted in a method by Malmberg (1956). The experimental fishes, caught at localities, which were not found infested by the species *C. lacustris*, were fed with infected cyclops (the cyclops were transported directly into the stomach of the fishes with a long pipette). After several days, the fishes were examined in autopsy by complete helminthological dissection.

EXPERIMENTAL INFECTION OF INVERTEBRATES

In experiments conducted for the elucidation of the question of first intermediate hosts of the nematode *C. lacustris*, these were observed to be various cyclop species of the superfamily

Cyclopoidea, the species: *Megacyclops viridis* (Jurine), *Macrocyclops albidus* (Jurine), *Acanthocyclops vernalis* (Fischer), *Mesocyclops leuckarti* (Claus), *Eucyclops serrulatus* (Fischer) and *Cyclops strenuus* Fischer. Of the class *Copepoda*, we tried to infect several species of the family *Harpacticidae* and numerous specimens of the species *Diaptomus castor* (Jurine) (fam. *Diaptomidae*), but obtained only negative results.

The cyclops readily swallowed the motile larvae of *C. lacustris*, but higher doses of larvae caused a high incidence and often resulted in the death of the cyclops. The lethal dose of larvae is individual and depends largely on the size of the cyclop's body. In larger cyclops (e.g. *Megacyclops viridis*, *Macrocyclops albidus*), 13—17 larvae can develop to the invasive stage without becoming lethal for their host. In smaller cyclops (*Acanthocyclops vernalis*, *Cyclops strenuus*) the maximum number of larvae attaining the invasive stage was found to be 2—3, while specimens of the same species died of high larval incidence (up to 10 first stage larvae). In massive invasions, the critical days are the 2nd and 3rd day p.i., death is caused by the perforation of the intestine and by damage to the other organs during the migration of the larvae from the intestine of the cyclop to its body cavity. More heavily attacked cyclops are swimming with evident difficulties and keeping mainly to the bottom of the dish. Invasions were never found in younger forms of cyclops, perhaps in view of the fact that these juvenile forms cannot swallow food of the size of a first stage larva of *C. lacustris*.

The larvae penetrate after a very short time (approximately one hr after the feeding) the intestinal wall of the cyclop and enter its body cavity. Here they locate mainly in the dorsal part of the cephalothorax, generally closely above the intestine, developing there into the invasive stage. If larval incidence is higher, they can be found in various other parts of the body, in some cases even in the antenulles, the feet or the furca.

Moorthy (1938), studying the development of the larvae of *Paracamallanus sweeti* and *Dracunculus medinensis* in cyclops observed disturbances in the sexual organs, caused by the infection. We found the same symptoms in cyclops infected with *C. lacustris* larvae. In young female cyclops, experimentally infected with *C. lacustris* larvae, the ovarial sacs did not develop. On the other hand no infection has been observed in adult female cyclops with developed ovarial sacs. While young immature females (without sacs) and males were found to be relatively highly infected, in the same experiment almost all females with developed ovarial sacs remained negative. Only in one of these adult females did we find a single larva. This may be explained by the fact that the uptake of food is very low in females with already developed ovarial sacs, so that the possibility of infection is minimal.

The percentage of infected cyclops depends not only on the larval dose, but also on the space and amount of water, in which the experiment is performed. The highest incidence was observed in the least possible amount of water, e.g. in petri dishes, while in the same experiment the incidence was much lower, if performed in larger glass vessels.

The larvae of *C. lacustris* very often leave the body of the cyclops, which have died during the experiment. This phenomenon occurs mainly in first stage larvae, but sometimes even second and third stage larvae were found to leave the dead body of their host. In our experiments we tried to infect cyclops with larvae at various developmental stages, obtained from dead cyclops. Only young forms of the first stage larvae were found capable of reinvading a new cyclop host, while second and third stage larvae were found incapable of infecting the cyclops.

In addition to the representatives of the class *Copepoda*, infection experiments with *C. lacustris* larvae were also tried with other water invertebrates in view of some information obtained from the older literature, in which the species *Asellus aquaticus* and *Agrion sp.* larvae are recorded to be intermediate hosts of this nematode species (Leuckart, 1876; Linstow, 1909). We tried to infect the following water arthropodes with *C. lacustris* larvae: *Gammarus pulex fossarum* Koch (*Amphipoda*); *Asellus aquaticus* Linné (*Isopoda*); *Daphnia pulex* (de Geer), *D. magna* Straus, *Simocephalus vetulus* (O. F. Müller), *Leptodora kindti* (Focke) (*Cladocera*); the various species of insect larvae of the orders *Ephemeroptera* (*Baëtis* sp., *Ecdyonurus* sp.), *Odonata* (*Agrion* sp.), *Trichoptera* and *Diptera* (larvae of the fam. *Chironomidae*). All experiments were conducted in the same way as with the cyclops. 3—5 days p.i. all invertebrates were examined, but none of them was found infected.

To make sure, that the recording of *C. lacustris* larvae in *Asellus aquaticus* and *Agrion* sp. is not a case of reservoir parasitism, cyclops harbouring invasive stage larvae of *C. lacustris* were fed to *Asellus aquaticus*, *Agrion* sp. larvae and also to snails *Lymnaea stagnalis* and *Bithynia tentaculata* and examined three days later. No larvae of *C. lacustris* were found in any of them.

It seems evident that the only intermediate hosts of *C. lacustris* are various cyclop species and that the findings of these larvae in *Asellus aquaticus* and *Agrion* sp. were, in fact, larvae of another nematode species.

In our experiments, the time needed for the larvae to complete their development in the cyclops (third stage larva) lasted 10—11 days at laboratory temperature. This is in accordance with the data by Leuckart (1876), Kuprjanova (1954) and Campana-Rouget (1961). However, the rate of development in the cyclops is greatly dependent on the temperature; in lower temperatures reduced to 8—10° C, the last moulting occurred after three weeks. The same rapid development has also been observed in other representatives of the family *Camallanidae*. Moorthy (1938) in his study of the life history of *Paracamallanus sweeti* found at a temperature of 32—38° C third stage larvae in the cyclops after 5—7 days, but at a temperature of 13—21° C, after 8—12 days. Also Li (1935) recorded a period of 8—9 days as the time needed by the larvae of *Spirocamallanus fulvidraconis* to develop in the cyclops at room temperature.

EXPERIMENTAL INFECTION OF FISHES

In our experiments conducted to the purpose of tracing the development of *C. lacustris* in the definitive host, we used 45 fishes belonging to 12 species; these were fed with cyclops containing invasive larvae. Of the fishes in our experiment 26 specimens were perches, known to be the typical hosts of *C. lacustris* and in these we traced the complete life history of this nematode. The remaining fishes were used only for obtaining information about the further development of the larvae in these hosts. The infected cyclops were also fed to a grass-snake (*Natrix natrix* L.), but the result was negative.

A) Experimental infection of the typical hosts — the perches

The life cycle of *C. lacustris* in the perches was observed to last 91 days (from the invasive larvae to the development of larvae in the uteri of the female worms). After the digestion of the cyclops, the invasive larvae attach themselves with their buccal capsule to the intestinal mucosa of the host — in the perches they become located mainly in the pyloric appendages, less often they are found in the anterior portion of the intestine. 13—15 days later, the third moulting of the larvae sets in, whereby their buccal capsule changes from the *Paracamallanus* to the *Camallanus* type.

The last moulting starts at different times and depends on the fact, whether male or female specimens originate from the larvae. The last moulting of larvae, from which male worms originate starts at a time, when these larvae attain a length of about 1.6—1.7 mm, i.e. approximately on the 35th day p.i.; if females originate, these larvae moult considerably later, i.e. on the 67th to 69th day, when the larvae are longer than 2 mm. At this time, the male worms have reached sexual maturity and copulation of both sexes starts very soon. The female worms still continue in their growth while the males change only little in size. The first motile larvae in the uteri of the females were found 91 days p.i.

Leuckart (1876), the first to study in detail the life history of *C. lacustris* recorded that the larvae undergo only one more moulting in the perches. This occurs at the time, when these larvae measure approximately 1 mm. According to this author, these larvae become mature immediately after this moulting (the third), and are capable to copulate after 10—14 days. Contrary to that observation, the larvae in our experiments did not attain maturity after the third moulting, but represented only the fourth larval stage. Maturity sets in after the fourth moulting, occurring at a considerably later period (after about 35 days in the males, 67—69 days in the females). Also the data by Kuprjanova (1954) that the larvae mature in the perches

25—32 days p.i. may apply only to the males. Our results prove unanimously that the whole life cycle of *C. lacustris* in the perches (finishing with findings of developed larvae in the uteri of the females) lasts minimally three months, but often even longer. Evience of this relatively long lasting development is supported by the fact that in naturally infected fishes we have often found in addition to the adult *C. lacustris* specimens numerous larvae mainly at their fourth larval stage. Similar observations have been made by Li (1935) on the species *Spirocamallanus fulvidraconis*; its development in the fishes, according to this author, lasts four months.

B) Cross infection

During our studies of the life cycle of *C. lacustris*, we infected experimentally various fish species with this parasite. The larvae from the females of *C. lacustris*, originally taken from the three definitive hosts, *Perca fluviatilis*, *Esox lucius* and *Anguilla anguilla*, were used for feeding the cyclops and for obtaining invasive larvae. Our experiments showed that the invasive larvae, originating from one host species and obtained from the copepods could also infect various other fish-host species, (see Tab. 1), thus confirming that the species *C. lacustris* is, in fact, a single species with a wide range of fish hosts. Our experiments with perches showed that this fish species is very susceptible to infection with *C. lacustris* regardless to the fact, whether the invasive larvae came from perches, pikes or eels.

Table 1: Survey of experimental cross infection

Original host	Experimentally infected hosts
Perca fluviatilis	*Perca fluviatilis* *Lota lota* *Parasalmo gairdneri* *Leuciscus cephalus* *Scardinius erythrophthalmus* *Noemacheilus barbatulus*
Esox lucius	*Perca fluviatilis* *Parasalmo gairdneri*
Anguilla anguilla	*Perca fluviatilis* *Scardinius erythrophthalmus* *Tinca tinca*

GROWTH AND DEVELOPMENT OF THE LARVAE

A) First stage larva (Fig. 1)

Nematodes of the species *C. lacustris* are viviparous, the larvae exsheath in the uterus of the female. After leaving the uterus and reaching the intestine, the larvae are transported with the feces into the water, where they can live for some length of time. According to Kuprjanova (1954), free larvae

can live in the water at a temperature of 9—10° C for 11—12 days. Our experiments, however, showed that free larvae can live in water of a suitable temperature for a long time, e.g. in the laboratory in water kept at 22° C during day time the larvae lived 12 days, while in water of a constant temperature of 7° C, they lived 80 days.

Table 2. Comparison of sizes of free first-stage larvae after the various authors.

	Leuckart, 1876	Kuprjanova, 1954	Campana-Rouget, 1961	Own material
Body length	0.4	0.442—0.443	0.470—0.580	0.468—0.505
Body width		0.013—0.014	0.020—0.030	0.015—0.018
Esoph. length			0.097	0.084—0.111
Tail length			0.170	0.174—0.180

Larvae liberated from the uteri of the females are almost colourless, their body is slender and very elongated, their tail is sharply pointed. The cuticle is solid, with a relatively dense transverse striation starting close behind the cephalic end. On the dorsal side of the cephalic end the cuticle forms a relatively large dentate process, which also occurs in the first-stage larvae of other genera of the suborder *Camallanata* (e.g. genus *Paracamallanus*, *Dracunculus*). This process is used by the larvae for boring through the digestive tube of the cyclops while penetrating into their body cavity. Neither mouth papillae nor lips are developed. The mouth is formed by a very fine, short tube, attached to the anterior portion of the esophagus. This tube is practically the anlage of the buccal capsule. The esophagus is not yet divided into a muscular and glandular part, but is muscular throughout, cylindrical, slightly extended in its posterior part. This widened part of the esophagus is formed by three very elongated cells with large nuclei. The nerve ring and excretory pore are not visible. The intestine is straight, rectal glandular cells are present.

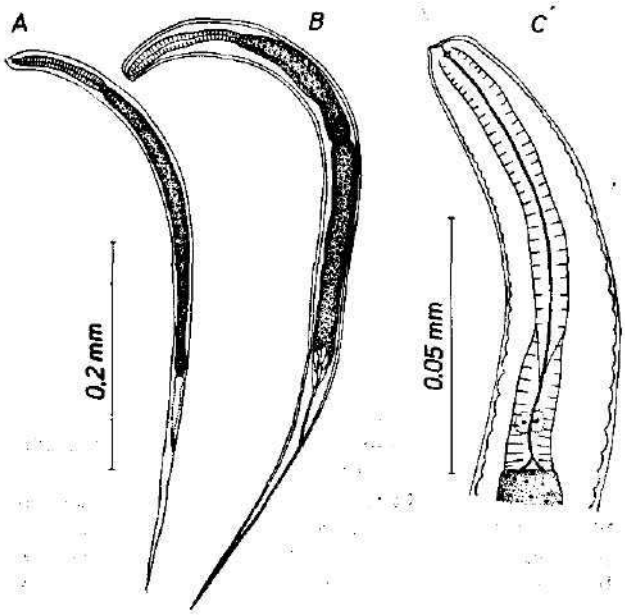

Fig. 1. *C. lacustris* — first-stage larva from cyclops. A — 17 hrs after invasion; B — 3 days after invasion; C — cephalic end of younger first-stage larva.

Even in their intermediate hosts the larvae retain most of their mobility and often change sites. There are little morphological changes from the time the larvae penetrate the body cavity of the intermediate host to the moulting except in their size. 17 hours after entering the intermediate host the larvae were almost identical with those obtained from the uteri of the females, only their intestine contained a greater number of dark granules.

Three days after the invasion, the cuticle of the larvae becomes thickened, the larvae extend moderately in width and their tail becomes shorter in relation to the length of the body. The intestine becomes slightly constricted at about a distance, equalling the length of the muscular esophagus, which is the first sign of differentiation of the so-called glandular esophagus, later originating from this constricted part of the intestine in the larvae of the second stage. This confirms also the endodermal origin of this organ. The dentate cuticular process on the dorsal side of the cephalic end is smaller and more rounded. In some larvae the detached old cuticle could be clearly viewed on the cephalic end, indicating the onset of moulting. Moulting did not occur simultaneously in all larvae; five days after entering the cyclops, first-stage larvae just at the verge of moulting could be found together with second-stage larvae.

Table 3. Growth of first-stage larvae in cyclops.

	Free larvae	Larvae 17 hrs after infection	Larvae 3 days after infection
Body length	0.468—0.505	0.510—0.558	0.585
Body width	0.015—0.018	0.018	0.027
Esoph. length	0.084—0.111	0.084—0.090	0.090
Tail length	0.174—0.180		0.150

B) Second stage larva (Fig. 2, 3, 4a, b, c, d, e, f)

Larvae obtained shortly after their first moulting, (four days after entering the cyclops,) are very similar to first stage larvae just before moulting. The cuticle is thin with indistinct transverse striation. The body is relatively very slender with a fairly long, pointed tail. The length of the larvae compared with the first-stage larvae close before moulting is slightly shorted, the width is probably the same. The cephalic end is rounded, without lips and papillae. The mouth is formed by a fine, very slightly pseudochitinized buccal tube, which is more distinct in its distal part; this tube is attached to the anterior margin of the esophagus on the slightly wider and more pseudochitinized ring round the anterior edge of the esophagus. The anterior end of the esophagus is formed by several big, glandular cells with distinct nuclei. Similarly, the anterior end of the body, principally round the buccal tube, is filled with big glandular cells, evidently producing the pseudochitin. At this time the glandular esophagus is developed, but not yet separated completely from the intestine. Numerous rectal glands are present round the rectum.

On the 5th day after entering the intermediate host the larval body has not only become bigger, but the tail has shortened and changes have occurred

in the structure of the mouth. The buccal tube, until now very fine, is becoming more strongly pseudochitinized and thickened in its anterior portion. The pseudochitinized ring on the anterior end of the esophagus is still visible. The glandular esophagus, although visibly separated from the intestine, is not yet very distinct. Neither nerve ring nor excretory pore could be viewed at this stage. Six days after penetration the larvae are morphologically almost identical, only the colour of the intestine is turning more orange. Also the larvae are slightly bigger.

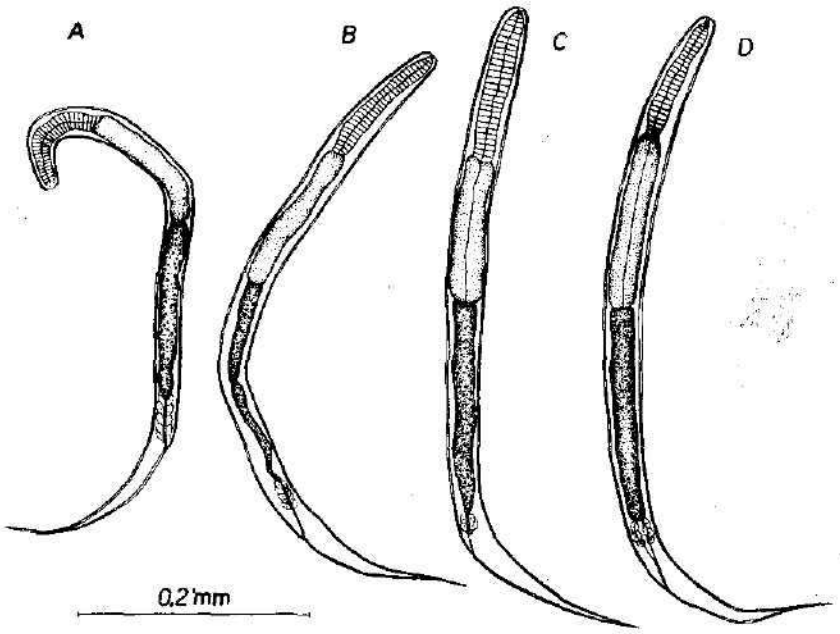

Fig. 2. *C. lacustris* — second-stage larvae. A — shortly after moulting (4 days p.i.); B — 5 days p.i.; C, D — 6 days p. i.

On the 8th day after invasion the larvae become less motile and more rounded in shape. The cephalic end widens, the original buccal tube dilates greatly exerting pressure on the surrounding tissue. Simultaneously this former buccal tube, becoming fixed to the anterior end of the esophagus, fuses into a copula-shaped pseudochitinized formation. In consequence of further pseudochitinization the formation becomes bell-shaped, the anterior part is narrower with a thicker wall, the posterior part wider with a thinner wall. At the same time the esophagus recedes leaving a spacious lumen inside this bell-shaped formation. The length of this capsule is 0.014 mm, its width 0.0308 mm. Large, elongated cells of a glandular nature open into the base of this capsule. The old cuticle tearing away at both sides of the cephalic end from the newly formed cuticle at the level of the capsule, forms some kind of "handles" at the dorsal and ventral side. At this period both parts of the esophagus, the muscular and the glandular part, can be distinguished. The wall of the intestine is thick, pressing the surrounding tissue to the

walls of the muscular sac and filling almost the entire lumen of the body. Now, the colour of the intestine is a rich orange; it passes into a colourless anus, which opens onto the surface through a long, straight and very thin tube; this is surrounded by numerous rectal glands consisting of big cells. At approximately half the length of the intestine a small primordium can be viewed on the ventral side of the larva.

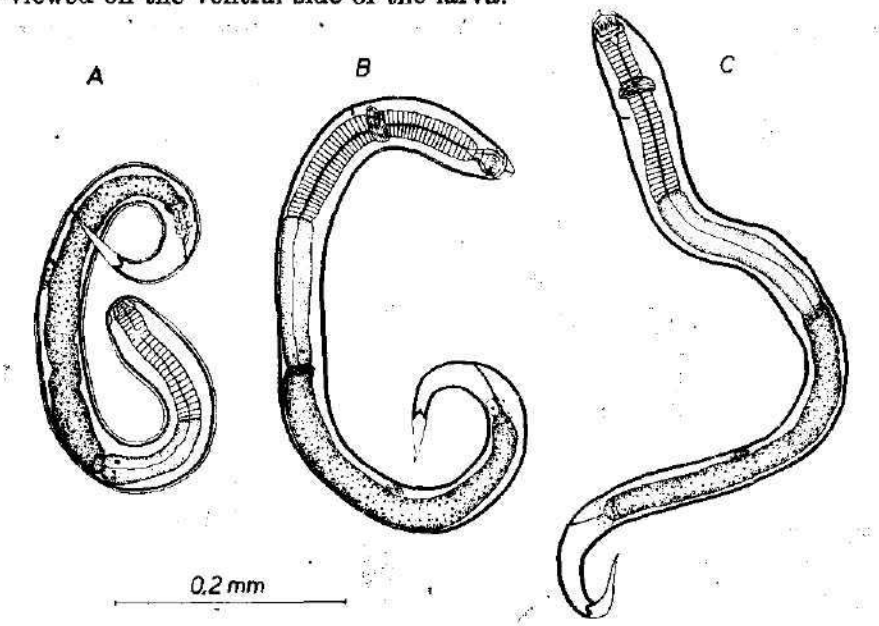

Fig. 3. *C. lacustris* — larvae of the intermediate stage closely before their second moulting. A — 8 days p.i.; B — 10 days p.i.; C — 11 days p.i.

The larvae reach the second moulting stage on the 10th to 11th day after invasion. At this time they are much plumper, being widest at the cephalic end. Their length is 0.750—0.776 mm, maximum width 0.054—0.057 mm. The sticking out cuticle is clearly visible at both ends of body. Larvae just entering their third stage have a distinctly developed buccal capsule with strong walls; at first, this capsule is laterally much wider than long, later both dimensions are about the same. While previously the length of the mouth capsule was 0.0168 mm, the width 0.028 mm, now the length of the mouth capsule is 0.024 mm, the width 0.027 mm. The buccal capsule is still colourless. Laterally, short, irregular, oblique ribs can be seen on the capsule, numbering approximately 9. The posterior end of the buccal capsule lies on a small pseudochitinized cup, forming the anterior end of the esophagus and originating from the former pseudochitinized ring on the anterior margin of the esophagus, present in older larvae of the first stage. Large, elongated, glandular cells lead to the base of the buccal capsule and to the pseudochitinous esophageal cup. The two parts of the esophagus are very distinct. At the end of the glandular esophagus three big cellular nuclei can be seen. The intestine is of a rich orange colour and of a similar structure as in larvae 8 days after the invasion. The nerve ring is very distinct, encircling the

muscular esophagus at a distance of 0.742 mm from the anterior end of the larva. The excretory pore following the nerve ring at a short distance, is situated 0.091—0.105 mm from the anterior end of the larva. Inside the cuticle of the old tail the new tail can be seen; it is different in shape, much shorter and terminating in three cone-shaped processes.

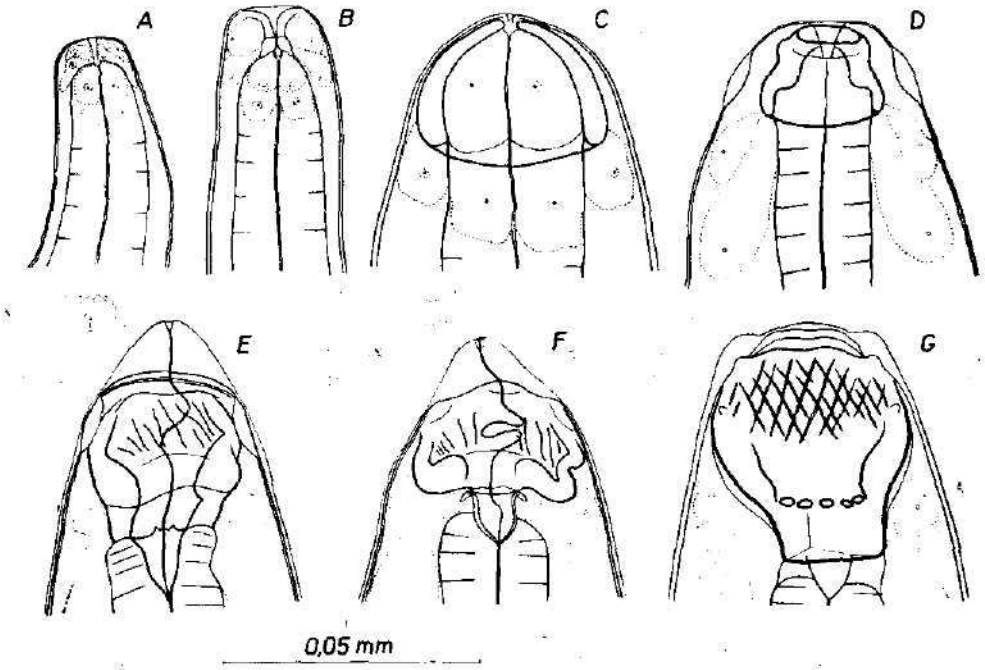

Fig. 4. *C. lacustris* — development of buccal capsule during the intermediate period between the second and third stage. A, B, C, D, E, F — larvae before moulting; G — young third-stage larva.

In most of the larvae the second moulting occurred 11 to 12 days after invasion, but at this time we found together with the larvae undergoing their second moulting larvae preparing for their first moult.

Table 4. Larval growth in the second stage.

	4 days p.i.	5 days p.i.	6 days p.i.	8 days p.i.	10 days p.i.	11 days p.i.
Body length	0.500	0.558—0.600	0.612	0.612	0.750	0.776
Body width	0.027	0.027	0.036	0.036	0.057	0.054
Length of musc. esoph.	0.072		0.120		0.210	0.161
Length of gland. esoph.			0.120		0.120	0.120
Tail length	0.136	0.129—0.135	0.156	0.135		0.133

C) Third stage larva – invasive larva (Fig. 4g, 5, 6, 7a, b)

The first larvae of the third stage were obtained 12 days after the invasion of the cyclops. These larvae can be distinguished by their rich orange colour and observed in living cyclops under the binocular microscope.

The body is fairly plump, widest close behind the buccal capsule. The tail is short, thick, terminating in three equally long, pointed, cone-shaped processes of 0.0098 mm in length; there are still present in the adult female, but there they are slightly changed in shape and smaller in size. The cuticle is thick, the buccal capsule is of the *Paracamallanus* type, yellowish brown in colour, 0.035–0.039 mm long, 0.033–0.036 mm wide, forming two cavities. The first is 0.027 mm deep, formed by two wide, lateral, valve-like structures with ribs at the inner side. This ribbing is oblique and extends only to half the length of the valves, thus distinguishing it from the buccal capsule of fourth-stage larvae and adults. Of the four mouth papillae one pair is placed dorsolaterally, the other ventrolaterally on the anterior end of the buccal capsule. The anterior margins of the valves are strongly pseudochitinized. The second cavity of the buccal capsule resembles that found in adult nematodes of the genus *Paracamallanus*, being almost cylindrical in shape and separated from the anterior cavity of the buccal capsule by a zone consisting of pseudochitinized plates. This second part of the buccal capsule is more narrow, its depth being 0.009 mm, its width 0.015 mm measured from the lateral side. Tridents are not yet present. The posterior part of the buccal capsule touches the esophageal pseudochitinized cup. The tissue round the buccal capsule is still formed by big glandular cells. The digestive tract is very prominent. The esophagus consists of two approximately equally long parts, the muscular and glandular portion. The muscular esophagus is generally slightly longer and is lined with a cuticular

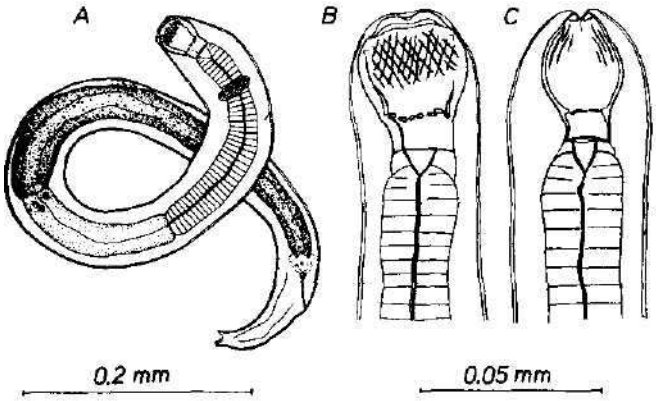

Fig. 5. *C. lacustris* – third-stage larva from cyclops. A – a general view; B – cephalic end (lateral view); C – cephalic end (dorsal view).

lining. At the termination of the glandular esophagus three very large cellular nuclei can be viewed even when unstained. The nerve ring surrounds the muscular esophagus at a distance of 0.109–0.126 mm from the anterior end of body. The excretory pore is situated slightly below the level of the nerve ring at a distance of 0.117–0.140 mm from the anterior end. The intestine is densely granulated; its wall is thick. Its colour is a rich orange to brown. The intestine terminates in a colourless rectum, which opens

through a straight thin tube onto the body surface. The anus is surrounded by numerous, big, glandular, rectal cells.

No further growth or morphological changes were observed in the third-stage larvae in the cyclops even when examining the invaded cyclops after a longer time (the last cyclop 27 days after the appearance of third-stage larvae). Neither Kuprjanova (1954), observing the larvae up to 32 days after the second moulting, could find further changes. This confirms the fact that these larvae have reached the invasive stage.

Table 5. Comparison of sizes of third-stage larvae from cyclops after various authors.

	Leuckart, 1876	Kuprjanova, 1954	Campana-Rouget, 1961	Own material
Body length	0.89	0.496—0.520	0.880	0.660—0.829
Body width		0.017	0.049	0.054
Length of musc. esophagus			0.165	0.159—0.217
Length of gland. esophagus			0.125	0.105—0.204
Distance of nerve ring from anter. end			0.095	0.109—0.126
Length of tail			0.075	0.051—0.084

Table 6. Measurements of third-stage larvae from cyclops.

	12 days p.i.	18 days p.i.	20 days p.i.
Body length	0.762	0.829	0.660—0.702
Body width	0.054	0.054	0.054
Length of buccal capsule	0.035	0.039	0.036
Width of buccal capsule	0.035	0.033	0.036
Length of musc. esophagus	0.195	0.217	0.159—0.180
Length of gland. esophagus	0.135	0.204	0.105—0.135
Distance of n. ring from anterior end	0.126	0.109	
Distance of ex. pore from anterior end	0.140		0.117
Length of tail	0.084	0.081	0.051

Third-stage larvae have a tendency to coil up and remain in this position for some time, a phenomenon observed as recently as 1961 by Campana-Rouget. This seems to be connected with the fact that larvae of this type are invasive larvae, infecting passively their definitive host. This trend becomes evident even when fixing such larvae.

Third-stage larvae obtained from the pyloric appendages and from the intestine of perches four and five days after feeding them with invaded cyclops, are morphologically almost indistinguishable from invasive larvae obtained from cyclops. The only exception are the slightly wider buccal capsule and body.

The third moulting in the perches occurred 13—15 days after infection. At first, the larvae shed the original buccal capsule and the cuticular lining

of the muscular esophagus and then the old cuticle from the surface of the body. In one perch examined 14 days p.i. we found fourth-stage larvae together with third-stage larvae preparing for moulting. In the latter larvae the newly forming buccal capsule could be seen under the old, strongly pseudochitinized buccal capsule.

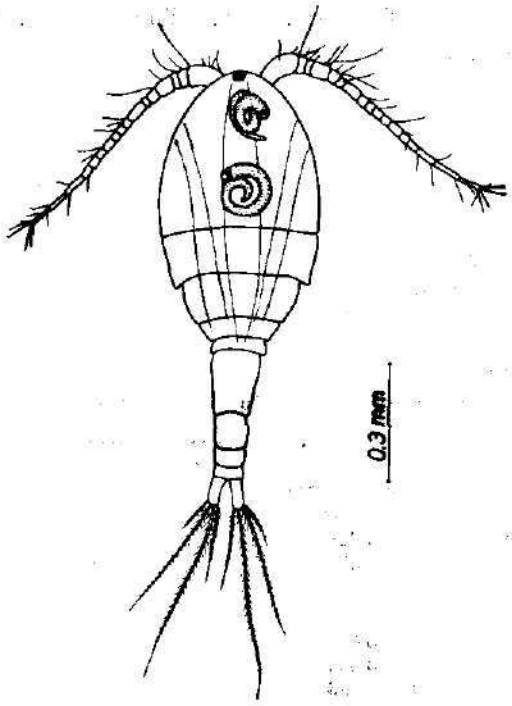

Fig. 6. *Macrocyclops albidus* with two third-stage larvae of *C. lacustris* in its body cavity.

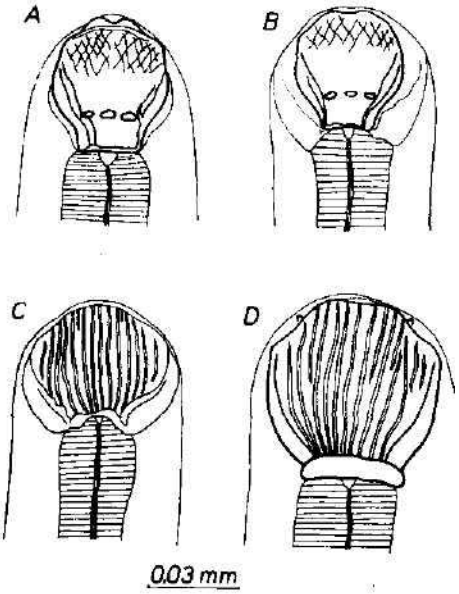

Fig. 7. *C. lacustris* — change of buccal capsule from the *Paracamallanus* to the *Camallanus* type during the period of transition from the third to the fourth larval stage. A, B — larvae prior to moulting; C — larva shortly after moulting; D — older fourth-stage larva.

D) Fourth — stage larva (Fig. 7c, d, 8, 9, 10)

These larvae are very similar to the third-stage larvae in the structure of their internal organs. Differences are found only in the structure of the buccal capsule. During moulting the larva measures approximately 1 mm. After the old buccal capsule has been shed, the new buccal capsule occupies almost the entire width of the anterior end of the nematode and is of a typical *Camallanus* type. Contrary to the foregoing capsule type, this capsule has only one cavity, its internal surface is ribbed longitudinally as in the adults.

The buccal capsule of the larvae shortly after moulting is light, translucent, but the longitudinal ribs (10—12 on each valve of the buccal capsule) are very distinct at this stage. A large pseudochitinized ring, later developing in the posterior margin of the buccal capsule in the fourth- and fifth-stage larvae and in adults, is not yet developed, only its anlage — a slightly pseudochitinized layer — is present on the surface of the proximal end of the esophagus. The length of this new buccal capsule is about the same as

in older larvae of the preceding stage, but it is much wider and the buccal capsule occupies the entire width of the anterior end of the larval body. Four subterminally situated papillae, two dorsolateral and two ventrolateral, are distinguishable on the cephalic end of the larvae. The body is widest at the cephalic end, containing in this part very large glandular cells, which presumably are producing pseudochitin. The esophagus consists of two portions, the anterior muscular and the posterior glandular portion. Contrary to the foregoing larval type, the glandular esophagus is slightly longer than the muscular esophagus. The anterior portion of the esophagus is very muscular, internally it is lined with a thick cuticular layer. The muscular esophagus passes into the glandular part through the valvular apparatus. The glandular esophagus is of about equal width throughout and also opens through a valvular apparatus into the intestine. At the posterior end of the glandular esophagus there are developed three large cells of a glandular character, containing prominent cellular nuclei. The intestine is straight, wide, with thick walls, ending in a rectum; this is formed by a fine, straight tube and surrounded by a mass of unicellular rectal glands. The tail is conical, relatively short, ending in three large conical appendages (similar as the tail of the third-stage larva). The nerve ring surrounds the muscular esophagus near its anterior end. The excretory pore is very distinct, situated slightly below the nerve ring.

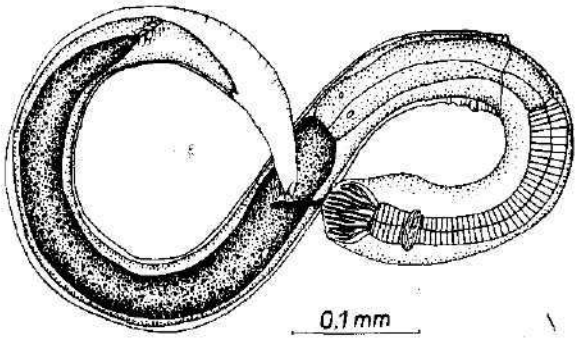

Fig. 8. *C. lacustris* — larva during third moulting.

Table 7. Measurements of third-stage larvae from perches.

	4 days p.i.	14 days p.i.
Body length	0.720—0.856	1.115—1.197
Body width	0.048—0.057	0.075—0.081
Length of buccal capsule	0.042—0.051	0.041
Width of buccal capsule	0.035—0.036	0.041
Length of musc. esophagus	0.180—0.192	0.217—0.231
Length of gland. esophagus	0.150—0.174	0.204—0.217
Distance of n. ring from anterior end	0.093—0.096	0.109—0.122
Distance of ex. pore from anterior end	0.114	0.231
Length of tail	0.051—0.060	0.081—0.095

Some days later the buccal capsule starts to grow, extending principally in length. Its colour, influenced by a strong pseudochitinization, turns to

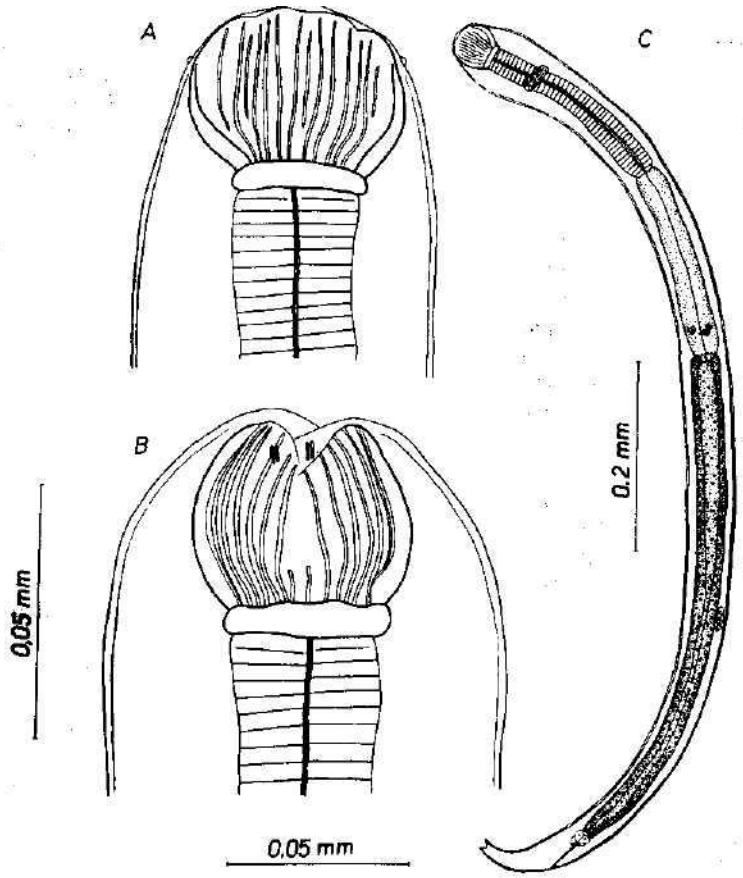

Fig. 9. *C. lacustris* — fourth-stage larva. A — cephalic end (lateral view); B — cephalic end (dorsal view); C — general view.

Table 8. Growth of fourth-stage

	12 days p.i.	14 days p.i.	26 days p.i.
Body length	0.960	1.210—1.346	1.278
Body width	0.069	0.075—0.081	0.081
Length of buccal capsule	0.039	0.054	0.063
Width of buccal capsule	0.045	0.054—0.061	0.060
Length of musc. esophagus	0.195	0.217—0.231	0.210
Length of gland. esophagus	0.216	0.217—0.224	0.255
Distance of n. ring from anterior end	0.075	0.109	0.120
Distance of ex. pore from anterior end			0.150
Number of ribs on valve of buccal capsule	10—12		11—12
Length of tail	0.078	0.081	0.087

orange or, sometimes brown, Simultaneously with the onset of growth of the capsule the number of ribs on its valves increases to 12—15 and the ribs are becoming more distinct in appearance. A strongly pseudochitinized ring similar to the one in adult worms, becomes distinctly visible at the posterior margin of the buccal capsule. After complete pseudochitinization, the size of the buccal capsule remains unchanged.

At the same time, a general growth of the larva sets in. About 30 days after infection the "male" larvae are preparing to moult; their length is approximately 1.6—1.7 mm. Their cephalic end becomes very enlarged, a new, more voluminous buccal capsule starts to develop under the old capsule, which shows slight signs of longitudinal ribbing. On the dorsal and the ventral side, there are the anlage of the tridents, which are still very indistinct. At the posterior end of these larvae the tail wings, characteristic for the male and the postanal pedunculate papillae can be seen under the old cuticle. Shortly before moulting also the spicules become visible. Moulting occurs approximately 35 days after the invasion. At first the old cuticles separates from the anterior part of the body, the larva sheds the old buccal capsule and the membranous cuticular lining of the esophagus and then sheds the old cuticle.

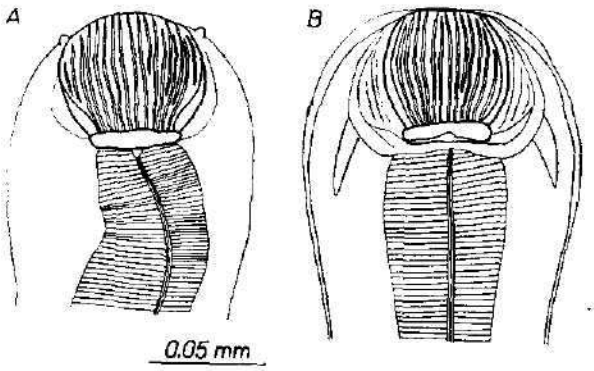

Fig. 10. *C. lacustris* — development of buccal capsule of the final type in larvae of the fourth stage shortly before the last moulting.

The larvae, which develop into future female worms, start to moult at a later period, approximately 65—69 days after invasion. However, as

larvae in perches.

34 days p.i.	50 days p.i.	53 days p.i.	56 days p.i.	69 days p.i.
1.215—1.340	1.224	1.940	1.700—1.995	1.713—2.067
0.069—0.075	0.102	0.090	0.122—0.136	0.095—0.136
0.060—0.066	0.063	0.069	0.069—0.075	0.066—0.078
0.060—0.066	0.060	0.066	0.069—0.075	0.060—0.078
0.240—0.261	0.210	0.313	0.313—0.367	0.258—0.340
0.195—0.225	0.300	0.313	0.326—0.367	0.272—0.353
0.114—0.126	0.135	0.180	0.141—0.150	0.129—0.163
	0.156		0.204—0.225	
	12—13	15	12—14	14—15
0.063—0.081	0.096	0.111	0.108—0.144	0.108—0.136

recently as 56 days p.i. it was possible to observe the anlage of the vagina, appearing as a short, very slender tube turned backwards, surrounded by numerous cells. The sexual glands were still represented only by the genital primordium. At this time the length of the larva during the last moulting exceeded 2 mm.

E) Adults

Male: The "male" larvae undergo their last moulting 35 days p.i. at the earliest, but even as late as 69 days after p.i. judging from our observation of juvenile male worms. Shortly after the moulting, the morphology of the juvenile males*) is almost in complete keeping with that of fully mature specimens; different is only the colour of the buccal capsule, which is light in the juvenile worms and supported only by 16 ribs. Also their tail is not yet coiled ventrally. The lips of the anal pore are elevated, appearing from the lateral view as two small adanal papillae. Fully developed are the spicules, the alae of the tail and the tridents of the buccal capsule.

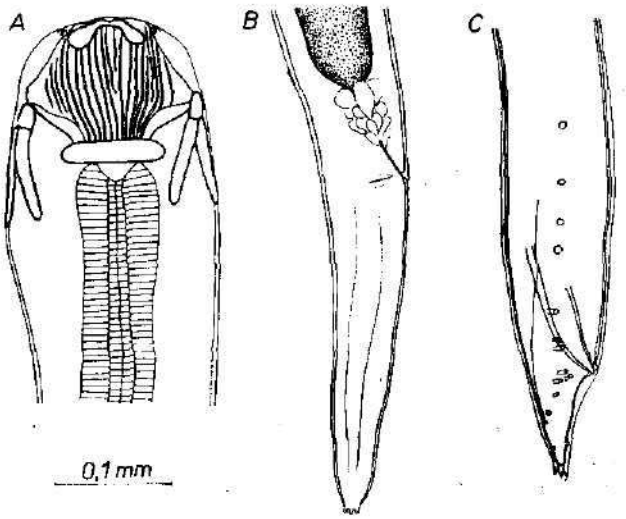

Fig. 11. *C. lacustris*. A — cephalic end of juvenile female; B — tail of juvenile female; C — tail of "male" larva closely before the last moulting.

In their later development the number of ribs on the buccal capsule increases to 20 and the tail curves ventrally. The batten-like elevating anal lips are no longer visible. At the same time the males increase in size until the length of the fully mature males attains generally 3 mm.

The adult males are reddish to brownish in colour. The cuticle is solid, with a moderate transverse striation. The mouth is formed by a large, brownish buccal capsule, which is strongly pseudochitinized and consists of two lateral valves with longitudinal ribbing on their internal side. The number of ribs is 18—20. The anterior margin of the valves is strengthened by two strongly pseudochitinized, rounded plates. A strong, pseudochitinized ring is placed at the bottom of the capsule. The dorsal and ventral side of the buccal capsule is supported by a trident, distinctly shorter than the length of the buccal capsule. The mouth opening is slit-shaped, surrounded by four oral papillae, of which two are situated dorsolaterally, two ventro-

*) The larval stages, which have just finished their last moulting, but have still incompletely developed sexual organs, are often found designated as fifth-stage larvae in the literature.

laterally. Two small cervical papillae are placed close below the nerve ring. The esophagus resembles that of the third- and fourth-stage larvae, being divided into the anterior muscular and the posterior glandular portion. The anterior portion is slightly shorter, tripartite, bearing the nerve ring close to its anterior end. The intestine is straight, wide, of brownish colour. The tail of the males is conical, ventrally bent and bears narrow tail alae. There are two unequally long, slender, simple spicules. Length of the shorter spicule is 0.063—0.105 mm, length of the longer spicule is 0.111—0.150 mm. The proximal ends of both spicules are slightly extended. The ventral side of the tail bears 7 pairs of precloacal and 6 pairs of postcloacal pedunculated papillae. The last two pairs of the precloacal papillae are close together, whereby the last precloacal pair is shifted slightly to the median line. The first three pairs of postcloacal papillae are close together, the second pair being strongly shifted to the median line. The last pair of postcloacal papillae is not very distinct.

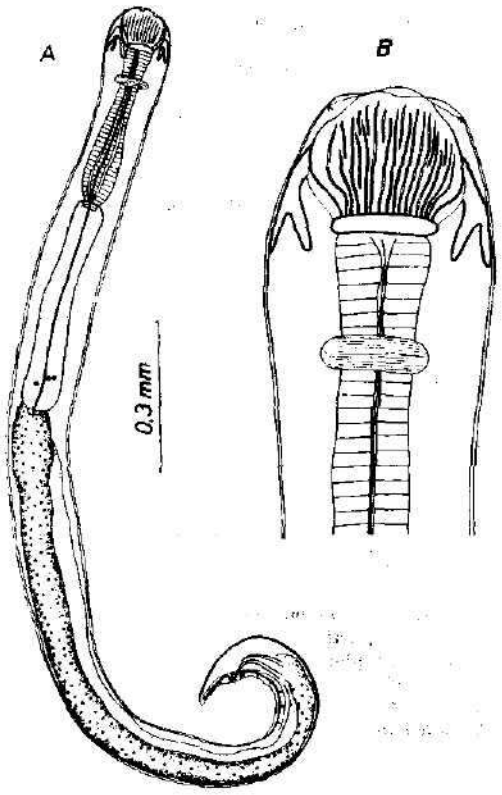

Fig. 12. *C. lacustris* — male. A — general view; B — cephalic end (lateral view).

F e m a l e : The "female" larvae undergo their last moulting 65 days and later after invasion. Both vulva and vagina are developed in these females at the ontset of the last moulting, but the vulval lips are not yet elevated. The tail of these females is long, conical, bearing three rudimentary tail appendages at its end. Several days after the last moulting of the females copulation of both sexes is started. The eggs developing in the females are oval, with thin walls, measuring 0.136—0.149 × 0.163 mm.

The next stage of development of the females is marked mainly by growth of their body; the female worm is much larger than the male. At the same time, the eggs in the uterus increase in number, start to cleave, the vulval lips arise above the surface. Three months after invasion viable, motile larvae are found in the uteri.

The colouring of the female is red, the buccal capsule is brown. The morphological structure of the buccal capsule, the digestive tract, the location of the nerve ring and of the cervical papillae is in keeping with that of the male. The tail is relatively long, conical, ending in three rudimentary processes. The uterus is opposed, occupying most of the body cavity at the time, when loaded with developed larvae. Anteriorly, the

Table 9. Growth of males of *C. lacustris* in perches.

	55 days p.i.	56 days p.i.	69 days p.i.	86 days p.i.	91 days p.i.
Body length	2.285	3.440	1.985	4.038	3.380
Body width	0.093	0.136	0.095	0.149	0.136
Length of buccal capsule	0.084	0.090	0.090	0.090—0.093	0.108
Width of buccal capsule	0.081	0.093	0.075	0.090	0.093
Length of tridents	0.075	0.075	0.051	0.072	0.090
Length of musc. esophagus	0.326	0.367	0.299	0.380—0.421	0.421
Length of gland. esophagus	0.408	0.408	0.299	0.557	0.530
Distance of n. ring from anterior end	0.150	0.156		0.176—0.180	0.204
Length of tail	0.087	0.099	0.095	0.099	0.108
Length of shorter spicule	0.081	0.099	0.081	0.105	0.063
Length of longer spicule	0.111	0.144	0.144	0.150	0.120
Distance of cervical papillae from anterior end				0.300	

uterus extents to the nerve ring, posteriorly almost to the termination of the tail. The vulva is situated in the centre of the body, forming two highly elevated vulval lips. The vagina is short, pointing backwards.

Table 10. Growth of females of *C. lacustris* in perches.

	67 days p.i.	71 days p.i.	86 days p.i.	91 days p.i.
Body length	3.617		5,632	7.080
Body width	0.163—0.176		0.217	0.285
Length of buccal capsule	0.117—0.120	0.126	0.141—0.150	0.165
Width of buccal capsule	0.126—0.129	0.126	0.144—0.147	0.138—0.156
Length of tridents	0.078—0.081	0.099	0.099	0.105—0.135
Length of musc. esophagus	0.421—0.503		0.544—0.625	0.571—0.612
Length of gland. esophagus	0.530		0.680—0.748	0.761
Distance of n. ring from anterior end	0.231	0.225	0.244	0.312
Length of tail	0.204—0.231		0.435	0.462
Distance of vulva from posterior end	1.523		2.545	
Distance of cervical papillae from anterior end			0.326	

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THE EYE MUSCLES IN COD, GADUS MORHUA CALLARIAS LINNAEUS AND BURBOT, LOTA LOTA (LINNAEUS)

OTA OLIVA & VLASTISLAV SKOŘEPA

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Abstract: The eye muscles of the cod *(Gadus)* and burbot *(Lota)* are not inserted in myodomes. In the cod the oblique eye muscles are longer then recti muscles, in the burbot, on the contrary, the obliqui muscles are shorter then the recti.

MATERIAL AND METHOD

Several heads of adult burbots and cods were used for dissections by use of technique described in former communications (see Oliva & Skořepa, 1967).

EXPLANATIONS TO ABBREVIATIONS

ASPH — alisphenoid
BO — basioccipital
EL — lateral ethmoid
EXO — exoccipital
EPO — epiotic
FR — frontal
ME — mesethmoid
no — optic nerve
OPS — opisthotic
oi — obliquus inferior muscle
os — obliquus superior muscle
PRO — prootic
PS — parasphenoid
re — rectus externus muscle
ri — rectus inferior muscle
rm — rectus medialis muscle
rs — rectus superior muscle
SO — supraoccipital
SPH — sphenotic
VO — vomer

RESULTS

In the cod *(Gadus)* there is no anterior myodome. Both obliqui muscles originate from ethmoidal cartilage and from the common point of origin on the dorsal part of cartilage ethmoidalis run the obliqui muscles to both eye bulbs. Musculus obliquus inferior is flattened dorsoventrally, the widest near the eye bulb, in the half of its course it is narowest, but again dilates near the origin from the ethmoidal cartilage. On the surface of the eye bulb this muscle covers the attachment of musculus rectus inferior. The superior oblique muscle is also flat, the widest on its attachment on the eye bulb, where it covers the begin of the superior rectus.

There is not posterior myodome, all recti arise from thick fascia and encircle the optic nerve, which does not possess a separate foramen in the orbit wall. The largest from all recti muscles is the rectus externus, its flat attachment on the caudal surface of the eye bulb is the widest one. The

muscle during its course towards the origin becomes twisted and therefore the shape is conical. The origin is bifurcated, the longer branch grows from the cited common fascia, which is inserted here to the parasphenoid and prootic suture, the shorter branch, closely connected with the longer one, inserts ventrally from the origin of the rectus superior. Musculus rectus medialis is flat, flattened lateromedially. It originates together with the rectus inferior, but the course of the muscle is somewhat ventral compared with the rectus inferior. Optic nerve adheres closely dorsally on the medial rectus and by this manner together with the course of the inferior rectus the optic nerve is roofed by help of both muscles. The rectus medialis is attached to the cranial part of the ventromedial surface of the eye bulb. Musculus rectus superior originates from the same point of insertion as the foregoing muscle. At the point of the origin of the rectus superior and the rectus inferior their tendons are firmly united. Similar connection can be seen in mm. obliqui superiores and inferiores.

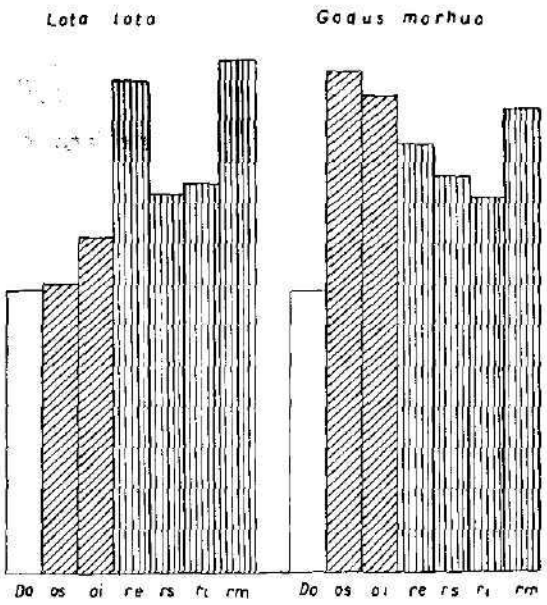

Fig. 1: Relative length of eye muscles in the burbot and the cod compared with longitudinal eye diameter (Do.).

Rectus superior muscle is flat, attaches on the dorsal surface of the eye bulb, its attachment is roofed by the attachement of the obliquus superior. Musculus rectus inferior is also a flat muscle, its attachment on the ventral surface of the eye bulb is covered by the attachement of the obliquus inferior. Both muscles are twisted closely at their origin. In the burbot *(Lota)* there is also no anterior myodome. Both obliqui are inserted to the ethmoidal cartilage. The tendineous (fibrous) tissue partially penetrates through the cartilage and grows into lateral ethmoid. Musculus obliquus inferior is flat and narrow, it covers the attachement of musculus rectus inferior on the eye bulb surface. In the last fourth part of its length its course is united with the course of the musculus obliquus superior, the muscle becomes conical in shape. The tendineous insertion (similarly as the same in musculus obliquus superior) is very long, nearly as the muscle's body length. Musculus obliquus superior is attached together with the musculus rectus superior on the upper surface of the eye bulb, the former muscle covers the atachment of the later one. Musculus obliquus superior is flat, narrow, its tendon is thin and it is in close connction with the tendon of origin of the oblique inferior muscle. In front of the eye bulb both obliqui become confluent

and are joined by their epimysia along their length. In the ethmoidal cartilage the tendons of the muscles of opposite eye communicate.

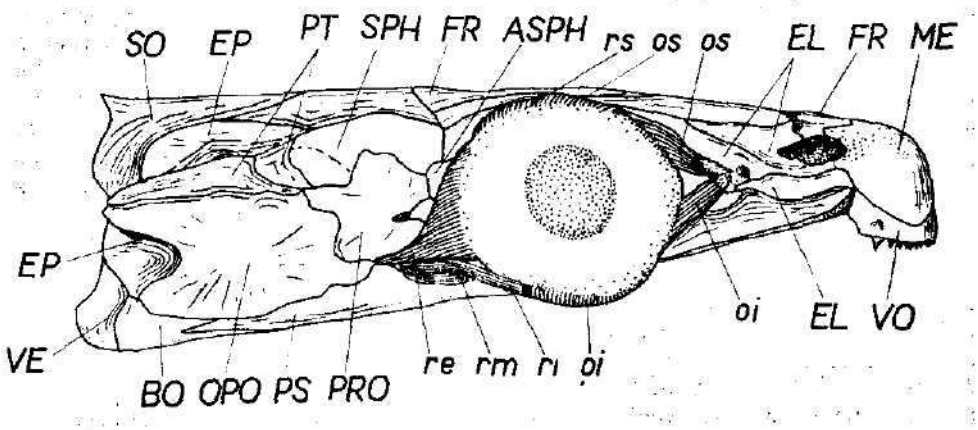

Fig. 2: *Gadus morhua callarias*. Lateral view.

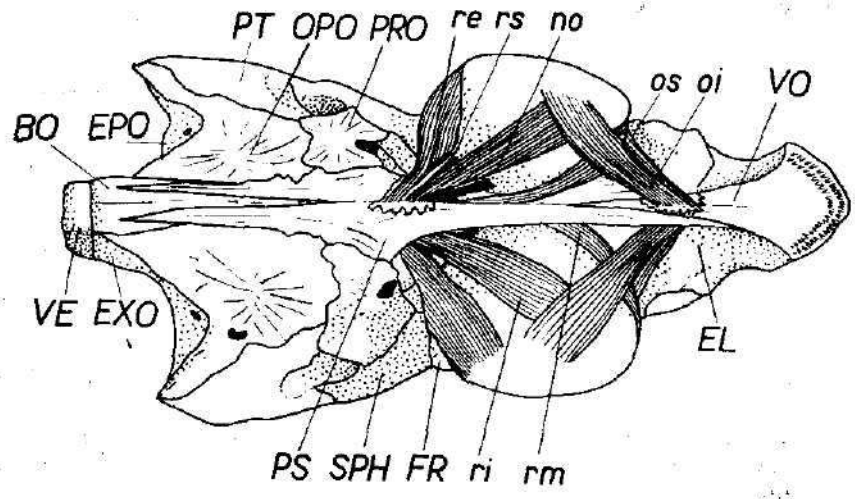

Fig. 3. *Gadus morhua callarias*. Ventral view.

There is no the posterior myodome, the recti muscles originate from broad fibrous tissue on the periost of the parasphenoid, prootic and alisphenoid. All recti (with the exception of the musculus rectus medialis) are flat, the rectus externus changes its shape to the conical one near of the insertion, the rectus superior possesses its width along its whole length, the shape of the rectus inferior is similar to the rectus externus, the rectus medialis is narrow and conical.

There are no fundamental differences between the eye muscles' topography in the cod and in burbot. Both species are deprived of myodomes (anteriores and posteriores), the apparent difference is in the length of obliqui muscles,

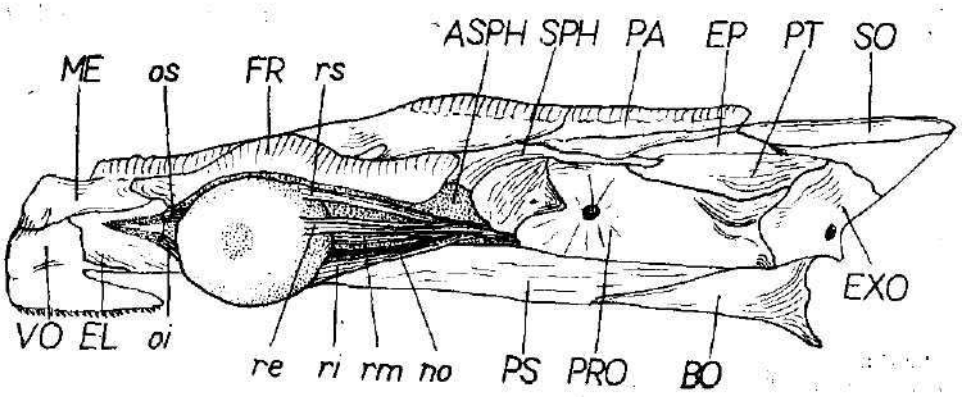

Fig. 4: *Lota lota lota*. Lateral view.

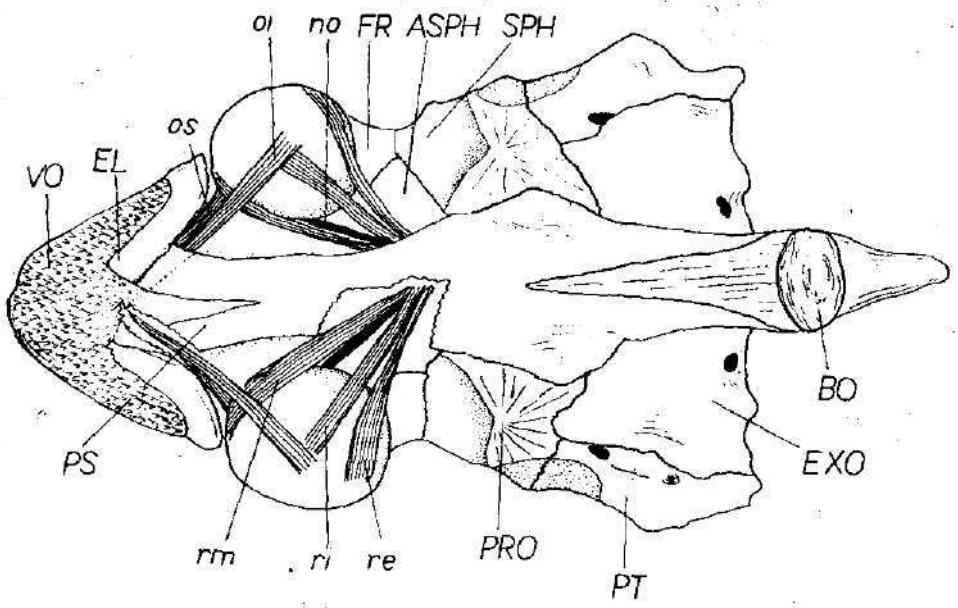

Fig. 5: *Lota lota lota*. Ventral view.

which are short (shorter then recti muscles) in the burbot, but relatively long in the cod, in this species are, however, the recti muscles shorter. The rectus medialis muscle is flat and wider in the cod, but narrow and conical in the burbot. When the shallow pits in the ethmidal cartilage of both species, engraved by the insertion of obliqui muscles will be evaluated

as the tendency to form the anterior myodome, we can speak about the type of "anterior pseudomyodome" in both species, but no true canal for penetrating of eye muscles can be seen here. Therefore it is not possible to speak here about the functional anterior myodome. Generally, the lacking of myodome in *Gadidae* is mentioned by several authors, e.g. Edgeworth, 1935; Berg, 1940, 1949, 1955; Devillers, 1958; Holmgren, 1943; Svetovidov, 1948. But there is a very curious fact, in *Gadus morhua* is the myodome lacking (see Devillers, 1958; Berg, 1955; Holmgren, 1943), but in the whiting, *Odontogadus merlangus* the posterior myodome of the "*Amia* typus", with rectus externus muscle only, is developed!! (De Beer, 1937, p. 168; Holmgren, 1943, p. 167; see also Berg, 1955, p. 212).

Therefore also the note of Grodziński (1947) about arteria encephalica "which pierces the hole between the parasphenoid and enter the myodome" in *Gadus* (according the data of Allis, 1912) evidently concerns another species of cod than *Gadus morhua*.

According to Gregory (1933) the absence of myodome (in sharks) speaks for a more primitive evolutionary status, but Devillers (1958) giving the description of three chief types of teleostean myodomes believes, the loss or various forms of myodomes are probably secondary and they do not show any regularities, e.g. in the same family there is a primitive myodome in *Odontogadus merlangus*, lack of this structure in *Gadus morhua*, in ostariophysous fishes the myodome occurs in cyprinoids, but lacks in siluroids (with exception in Corydoras-Holmgren, 1943).

It is also difficult to understand why the obliqui muscles in the burbot are short, in cod longer. The obliqui muscles turn the eye ball forwards (Rochon-Duvigneaud, 1954), therefore, it could be suspected, when it is known, the burbot lives on the bottom hidden between roots and stony holes (Svetovidov, 1948; Dyk, 1956), it will possess more developed obliqui muscles with eventual regard to its mode of life.

And this is not true, the longer obliqui were found in cod, which lives also demersally, but in open sea in depths from 10—100 fathoms (Travis-Jenkins, 1942). But is a very interesting fact with regard to the presence of myodome in whiting *(Odontogadus merlangus)*, this species opposite to the other members of cod family prefers shallow water, (Svetovidov, 1948) over 90% of British catch e.g. is taken from the depth between 10 and 20 fathoms (Travis-Jenkins, 1942), here the presence of myodome could be eventually connected with probably better posibilites to use the eyes during the mode of life in shallow water and near of the surface.

SUMMARY

In the cod *(Gadus morhua)* and burbot *(Lota lota)* no myodomes occur. In the burbot the obliqui muscles are shorter than the recti ones, in cod obliqui are longer than recti muscles. With regard to the mode of life this phenomenon is hardly understable, especially if we know that the burbot is living on the bottom of rivers and lakes mostly hidden in stony holes or between the roots. The cod is a species of the open sea; the better developed obliqui muscles could be theoretically more useful for the burbot because the obliqui turn the eye ball forwards.

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RECHERCHES SUR LA BIOLOGIE DE LA REPRODUCTION DU CARASSIN (CARASSIUS CARASSIUS (L.)) DANS LE BASSIN INFÉRIEUR DU DANUBE

MIHAIL PAPADOPOL

Recu le 10 janvier 1968

Content: Le carassin *(Carassius carassius)* abonde en Roumanie dans les secteurs des fleuves à courant lent ainsique dans les eaux stagnantes c. à d. les bras morts des fleuves et le étangs. On étudia la maturation sexuelle et la fécondité de 150 individus adultes. Le stade de maturation des gonades fut déterminé macro- et microscophiquement. Il fut constaté que la plupart des individus de deux sexes atteignent la maturité sexuelle dans la deuxième année de leur vie, leur taille étant de 11 à 13 cm et leur poids de 85 à 100 g. La fécondité absolue des femelles dont la taille est de 9 à 19 cm varia entre 5.600 à 84.700 ovules. La fécondité relative (chez les individus de taille de 10 à 20 cm, c. à d. âgés de 2 à 4 ans) représentait 15.000 à 24.000 ovules par 100 g de poids. On prouva que l'ovogenèse est asynchrone, de même que chez un grand nombre de poissons du famille *Cyprinidae*. L'évacuation se fait par portions (les ovules mûrs sont éliminés graduellement au cours de la période de reproduction en une ou plusieurs étapes) en rapport avec les conditions climatiques et surtout météorologiques et les changements de saisons dans la région en question. La reproduction des carassins en Roumanie a lieu principalement en juin et juillet. La reproduction est souvent commencée par les individus les plus développés et les plus âgés déjà dans la deuxième moitié du moi de mai et par contre chez les individus les plus petits elle peut se prolonger jusqu'en août.

INTRODUCTION

Le carassin est un cyprinidé typiquement lacustre, habitant la zone littorale des lacs, des étangs et des mares. On ne le trouve que rarement dans le lit des rivières et seulement dans les parties où le courant est faible. En Roumanie, le carassin est fréquent, dans la plupart des eaux stagnantes — les étangs de la zone inondable du Danube, dans les lacs du Delta, dans les marais du Sireth et du Pruth, dans le bassin de l'Olt, du Muresh, dans les lacs littoraux à eau douce et les étangs (Antipa, 1909; Busnitza, 1938, 1963; Carausu, 1952; Banarescu, 1964).

Espèce peu prétentieuse et très résistante, le carassin vit aussi dans les eaux fortement colmatées, envahies par la végétation, à déficit d'oxygène et même dans des caux acides à pH atteignant 4,5. Dans la plupart de nos eaux stagnantes le carassin est un objet de pêche industrielle, ce qui explique son importance économique assez grande.

La biologie du carassin n'est connue que dans ses grandes lignes à la suite des travaux de Busnitza (1938), et des ouvrages généraux consacrés à l'ichtyofaune et à l'ichtyologie (Antipa, 1909; Pojoga, 1944; Carausu, 1952; Vasiliu, 1959; Banarescu, 1964). Parmi les chercheurs étrangers qui se sont occupés de différents aspects concernant la biologie et l'écologie de la reproduction de cette espèce nous pouvons signaler Dréaguine, 1939, 1949; Lukin, 1949; Varfolomeev, 1954; Cerphas, 1956; Bekker, 1958; Jukov, 1958, 1965; Libosvárský, 1963.

Nos premiers résultats (1958) ont trait à la biologie de la croissance du carassin dans le lac de Braila. Le présent ouvrage se propose de compléter les données de notre littérature concernant la biologie et l'écologie de la reproduction de ce cyprinidé très commun dans le bassin inférieur du Danube.

MATERIEL ET METHODE

Dans le but de mieux connaître la biologie de la reproduction (maturation sexuelle, fécondité et type de ponte chez les carassins) nous avons procédé à une étude biométrique et à la dissection de 150 individus sexuellement mûrs, pêchés dans les lacs du Delta et dans l'étangs de Jijila, à l'époque préreproductive, à l'époque de la reproduction et après celle-ci.

Le stade de la maturité sexuelle des gonades a été apprécié macro- et microscopiquement d'après l'échelle (à VI stades) de Kulaev et Moien pour les *Cyprinidae* et les *Percidae*. La fécondité individuelle ou absolue a été établie par la méthode quantitative des poids de Fulton. A été aussi calculée la valeur de la fécondité relative, ainsi que le coefficient de fécondité d'après la formule de Benning (cité d'après Carausu, 1952). Pour connaître le mode de développement et de la maturation des ovocytes et, en fonction de ceux le type de la ponte nous avons procédé à une analyse numérique différentielle à l'époque préreproductive des éléments génitaux dans les ovaires — ovules et ovocytes — d'après leurs dimensions et leur coloration. Nous avons procédé en même temps au contrôle histologique général des ovaires et avons observé la variation du rapport gono-somatique dans la période préreproductive (avril) et la période de reproduction. Ce rapport a été établi aussi bien entre le poids des gonades et le poids total du corps, qu'entre le poids des gonades et le poids du corps moins celui des gonades. Nous avons également étudié la variation du nombre des ovules et des ovocytes contenus dans un gramme d'ovaire, ainsi que le poids moyen de ceux-ci par rapport aux dimensions linéaires des femelles de carassin. L'âge des individus a été déterminé d'après les écailles de la région latéro-dorsale de leurs corps.

RESULTATS

a) Maturation sexuelle et fécondité

Pour connaître les dimensions et l'âge quand cette espèce atteint la maturité sexuelle et pour établir sa fécondité absolue et relative, nous avons étudié des gonades chez 74 exemplaires pêchés au cours de la période précédant la reproduction (IV — 1959), dans le lac Rosu (Delta du Danube) et chez 85 autres exemplaires pêchés du Juin à Septembre 1961 dans l'étang de Jijila et le Delta.

Les données obtenues dans le premier cas chez 74 exemplaire étudiés avant l'époque de reproduction sont présentées dans le tableau 1; on y trouve

Tableau 1 — La composition selon l'age, les dimensions et le stade de maturation des gonades des individus de *Carassius carassius* du lac Rosu — Delta de Danube, disséquées avant leur reproduction.

Age en ans	Longueur sans caudale cm		Poids du corps g		Stade de maturation	n	n %
	moyenne	variation	moyenne	variation			
			femelles				
2	13,0	8,9—15,4	100	40—160	III	22	44,9
3	16,1	14,0—18,8	246	130—330	III—IV	22	44,9
4	18,4	17,8—19,3	299	260—330	III—IV	5	10,2
			mâles				
2	11,8	9,9—14,2	86	40—140	III—IV	16	64,0
3	14,8	13,0—18,1	157	100—270	IV	9	36,0
			Femelles et mâles				
2	12,4	8,9—15,4	92	40—160	III—IV	38	51,3
3	15,4	13,0—18,8	201	100—330	III—IV	31	42,0
4	18,4	17,8—19,3	299	260—330	IV	5	6,7

inscrits la composition, selon l'âge des individus, leur longueur, leur poids et le stade de maturation de leurs gonades.

D'après les données de ce tableau, tous le individus mâles et femelles de la période citée ont été sexuellement mûrs, présentant des gonades aux stades III et III—IV de maturation.

Le rapport des sexes dans le groupe étudié pêché le 7 Avril est d'environ 2 femelles pour 1 mâle; dans les trois catégories d'âge présentes dans le groupe, les femelles de deux et trois ans prédominaient et chez les mâles, ceux de deux ans.

Nous pouvons affirmer que le carassin atteint la maturité sexuelle en masse à l'âge de deux ans, car dans le groupe examiné, formé d'individus de 8,9—19,3 cm âgés de deux à quatre ans, il n'y avait aucun exemplaire immature sexuellement. À cet âge, les mâles ont une longueur moyenne de 11,8 cm sans caudale ou 14,6 cm avec caudale; les femelles ont 13,0, respectivement 16,1 cm et un poids moyen entre 85 et 100 gr.

Selon les données du tableau 1, les mâles et les femelles de carassin atteignent la maturité sexuelle même avant d'avoir 10 cm de longueur et un poids de 50 gr.

L'analyse des gonades chez les 85 exemplaires, étudiés d'Avril à Septembre 1961, longs de 9,5—19,1 cm (sans C) et âgés de 2—4 ans (II—IV+), confirme les données précédentes, ayant trait à la maturation sexuelle du carassin. L'absence des individus à dimensions plus réduites ne nous a pas permis d'établir l'âge et les dimensions minimales de la première maturation sexuelle.

Dans le but d'établir la fécondité absolue et les autres index de maturité des gonades, tout en relevant les relations existant entre eux et les autres index du cycle vital, nous avons utilisé les données biométriques et les ovaires (fixés intégralement dans de la formaline) de 47 exemplaires mûrs sexuellement, provenant du lac Rosu (Delta), pêchés le 7. IV.(1959).

Le tableau 2 comprend les données concernant la variation du poids du corps, des ovaires et du rapport gono-somatique en fonction de la longueur et de l'âge des femelles étudiées, dans le but de savoir quelle est leur fécondité.

Remarquons d'abord les ovaires des femelles disséquées dans la première décade d'Avril, se trouvant aux stades de maturation III et III—IV, qui ont une coloration orange et n'occupent, chez la plupart des exemplaires, que la partie dorso-latérale de la cavité abdominale. Les gonades des mâles étudiées à la même période, la plupart dans le stade de maturation III—IV, sont blanc-rougeâtres; ce n'est que chez un petit nombre d'invididus qu'elles se trouvaient dans le stade IV et présentaient la coloration blanc-laiteuse habituelle.

En examinant la variation du rapport gono-somatique (d'après les chiffres du tableau 2) établi pour la période donnée (7. IV.), aussi bien entre le poids des ovaires et le poids total du corps (I) qu'entre le poids des ovaires et le poids du corps sans ovaires (II) — les femelles examinées ayant 9,6—19,3 cm — il faut remarquer que sa valeur varie entre 2,2 et 9,8% (I) ou entre 2,3 et 10,8% (II) du poids total du corps et de celui sans ovaires.

À la suite de l'analyse numérique des éléments provenant des échantillons (1 gr) pris sur les ovaires des 47 femelles de carassin étudiés, nous avons déterminé la fécondité absolue. Les données obtenues sont présentées dans le tableau 3.

Tableau 2 — La variation des poids du corps et des ovaires et du rapport gono-somatique des femelles de *Carassius carassius* sexuellement matures examinées (à 7 avril 1959), en rapport avec leurs dimensions et leur âge.

Longuer sans C cm	Poids du corps g		Poids des ovaires g		Rapport gono-somatique I		Rapport gono-somatique II		n	Age	Rapport gonosomatique (I)	
	moyenne	variation	moyenne	variation	moyenne	variation	moyenne	variation		ans	moyenne	variation
9,6—11,5	69	55— 95	1,9	1,2— 3,5	2,6	2,2—3,7	2,7	2,3— 3,8	4	II	4,5	2,2—7,5
11,6—13,5	90	80—120	3,6	2,8— 4,0	4,1	2,7—5,0	4,3	2,7— 5,2	5	III	4,9	3,9—8,6
13,6—15,5	150	110—180	7,4	3,5—14,0	4,9	2,3—8,3	5,2	2,4— 8,9	23	IV	7,6	5,8—9,8
15,6—17,5	209	185—250	10,9	7,7—21,3	5,1	4,1—8,6	5,4	4,3— 9,2	8			
17,6—19,5	298	260—330	22,0	15,7—25,4	7,2	5,5—9,8	8,0	5,8—10,8	7			
Moyenne	169	55—330	9,3	1,2—25,4	5,0	2,2—9,8	5,3	2,3—10,8	47	—	5,0	2,2—9,8

Tableau 3 — La variation de la fécondité absolue des femelles de *Carassius carassius* examinées du lac Rosu, en rapport avec la longueur, le poids et l'âge des individus.

Longuer sans C cm	Nombre des ovules et ovocytes en milles		n	Poids du corps g	Nombre des ovules et ovocytes en milles		n	Age ans	Nombre des ovules et ovocytes en milles		n	Coef. de fécondité
	moyenne	variation			moyenne	variation			moyenne	variation		
9,6—11,5	11,4	5,6—21,0	4	50—100	14,7	5,6—21,9	8	II	20,1	5,6—31,3	20	0,07
11,6—13,5	17,5	15,6—21,9	5	101—150	27,1	17,0—52,2	16	III	39,0	27,3—64,9	22	0,10
13,6—15,5	29,7	18,2—52,2	23	151—200	34,4	25,8—44,0	12	IV	74,2	57,3—84,7	5	0,07
15,6—17,5	39,8	33,1—51,2	8	201—250	42,9	35,8—51,2	4	—	—	—	—	—
17,6—19,5	70,9	60,4—84,7	7	251—300	66,1	57,3—76,2	3	—	—	—	—	—
—	—	—	—	301—350	74,5	60,4—84,7	4	—	—	—	—	—
Moyenne	34,7	5,6—84,7	47	moyenne	34,7	5,6—84,7	47	moyenne	34,7	5,6—84,7	47	0,08

Tableau 4 — La variation de la fécondité relative de *Carassius carassius*, étudiés du lac Rosu,

Longueur sans C cm	Nombre des ovules		n	Poids du corps g
	moyenne	variation		
9,6—11,5	156	103—221	4	51—100
11,6—13,5	203	142—258	5	101—150
13,6—15,5	201	123—348	23	151—200
15,6—17,5	190	164—220	8	201—250
17,6—19,5	239	183—293	7	251—300
—	—	—	—	301—350
Moyenne	201	103—348	47	moyenne

Il résulte de l'analyse des données statistiques présentées dans le tableau 3 que la valeur moyenne de la fécondité absolue croît en même temps que la longuer, le poids du corps et l'âge, comme chez les autres poissons.

Le coefficient de fécondité, calculé d'après la formule de B e n n i n g (le rapport entrele produit de la longueur et du poids du corps et le nombre total d'ovules) a oscillé chez les carassins du Delta du Danube entre 0,07—0,10, en moyenne 0,08.

Pour obtenir une image plus complète de la capacité de reproduction du carassin, à côté de la fécondité absolue et de son coefficient, nous avons calculé la fécondité relative, à savoir le nombre d'ovules par gramme de masse du corps. Le tableau 4 montre les données obtenues, rapportées à la longueur, au poids du corps et à l'âge des individus.

Les données du tableau 4 montrent que la valeur moyenne de la fécondité relative varie dans le même sens que les autres index de reproduction, en rapport avec la longueur, le poids du corps et l'âge de individus. La valeur moyenne de cet index croît en même temps que les dimensions du corps et l'âge des femelles. D'après nos données, la femelle de carassin dépose en moyenne de 10 à 30 mille ovules pour chaque 100 g de poids corporel.

À la différence des autres cyprinidés de taille similaire, dont la fécondité réduite est compensée par une maturité sexuelle précoce, leur assurant un rythme reproductif plus accéléré, le carassin est une espèce cumulant les deux qualités — précocité de la maturation et fécondité relativement grande. Ces aspects représentent des adaptations de l'espèce aux conditions en général défavorables dans lesquelles a lieu la reproduction en été, dans les eaux stagnantes.

Afin d'analyser, en lignes générales, le caractère de la dynamique de la fécondité dans l'ontogenèse et relever sa dépendance des dimensions du corps et des autres index du cycle vital, comme nous avons procédé pour d'autres espèces (P a p a d o p o l, 1962—1965) nous avons comparé le rythme d'accroissement de sa valeur absolue avec celui de la croissance en longueur, et en poids du corps et des ovaires (en considérant les valeurs moyennes de la première catégorie d'âge comme unité). Les résultats obtenus sont présentés dans le tableau 5.

D'après les données du tableau 5, il apparaît que la fécondité absolue et le poids des ovaires chez le carassin, comme chez d'autres espèces de cypri-

en rapport avec les dimensions du corps et l'âge des individus.

Nombre des ovules		n	Age ans	Nombre des ovules		n
moyenne	variation			moyenne	variation	
185	103—258	8	II	177	103—258	20
206	123—348	16	III	212	165—348	22
196	165—275	12	IV	250	222—293	5
190	167—220	4	—	—	—	
252	222—293	3	—	—	—	
204	183—257	4	—	—	—	
201	103—348	47	moyenne	201	103—348	47

nidés, croîssent plus vite (au cours des trois années) que la longueur du corps. En même temps, nous remarquons que le rythme de croissance du poids (total et sans ovaires) est plus accéléré et se rapproche du rythme de l'accroissement de la fécondité absolue. Comme chez d'autres espèces aussi, les données obtenues chez le carassin prouvent que le nombre total d'ovules, c'est-à-dire la fécondité absolue, est déterminée par la masse du corps des poissons, fait signalé par une série d'auteurs (Nikolskij, 1953; Iogansen, 1955; Williams, 1959). C'est ainsi que s'explique en grande partie l'influence physiologique des facteurs extérieurs sur la fécondité et le poids des gonades. Dans ce sens, il est bien connu que la fécondité absolue est plus grande chez les individus appartenant à des populations à rythme de croissance accéléré, reflétant les conditions trophiques favorables où ils vivent. Par contre, les conditions trophiques moins favorables, la présence des parasites et d'autres facteurs défavorables aboutissent à la baisse de la valeur de la fécondité.

Tableau 5 — Le rythme de croissance de la fécondité moyenne absolue et relative, de la longueur et du poids du corps et des ovaires des femelles de carassin analysée du lac Rosu.

Age en ans	II	III	IV
Longueur sans caudale	1	1,2	1,4
Poids total	1	2,4	3,0
Poids sans ovaires	1	2,5	2,9
Poids des ovaires	1	2,2	4,6
Fécondité absolue	1	2,0	3,7
Fécondité relative	1	1,2	1,4

Une preuve supplémentaire en faveur de ce qui précède, est fournie par nos données sur le nombre absolu d'ovules de carassin, établies d'après la formule de fécondité préconisée par Williams (1959).

Comme je l'avais déjà remarqué dans mes publications antérieures (Papadopol, 1962, 1964, 1965, 1966), Williams, à la suite de l'analyse

de la relation entre la fécondité absolue, le poids du corps et des gonades, a établi que le nombre total des ovules chez les poissons, c'est-à-dire la fécondité, est directement proportionnel au poids du corps et inversement proportionnel au poids moyen d'un ovule. Sur cette base, il établit que la fécondité absolue (N) peut s'exprimer par la formule $N = \frac{p \cdot F}{m \cdot 100}$, où F — le poids du corps; m — la masse moyenne d'un ovule et p — facteur de proportionnalité, à savoir le rapport gono-somatique.

En calculant la fécondité absolue du carassin selon cette formule et en comparant les valeurs obtenues avec celles établies par l'analyse du nombre des ovules contenus dans les ovaires (tab. 6), nous constatons qu'elles sont pratiquement identiques.

Tableau 6 — La valeur de la fécondité absolue du carassin étudié du lac Rosu, obtenue d'après la formule de Williams et d'après la méthode quantitative pondérale de Fulton.

Longueur sans C cm	Rapport gono-somatique (p)	Poids moyen du corps g (F)	Poids moyen d'un ovule mg (m)	Fécondité absolue établie en milles		n
				d'après la formule $N = \frac{p \cdot F}{m \cdot 100}$	d'après la méthode de Fulton	
9,6—11,5	2,6	69	0,17	10,5	11,4	4
11,6—13,5	4,1	90	0,19	19,4	17,5	5
13,6—15,5	4,9	150	0,24	30,6	29,7	23
15,6—17,5	5,1	209	0,25	42,6	39,8	8
17,6—19,5	7,2	298	0,31	69,2	70,9	7
Moyenne	5,0	169	0,25	35,1	34,7	47

Ces données représentent encore une preuve que la fécondité individuelle montre les rapports les plus serrés avec le poids du corps, comme nous l'avons mentionné précédemment, mais dépend en mesure presque égale de la dimension, à savoir du poids moyen des ovules, mais en rapport inversement proportionnel. Dans cette dépendance, le rapport gono-somatique ou poids relatif des ovaires joue un rôle important, comme facteur constant ou coefficient de proportionnalité. Il peut être considéré comme unité de mesure de l'effort physiologique consommé par la fécondité.

Il résulte donc que pour calculer la fécondité absolue d'après la formule citée, il a été nécessaire d'établir le poids moyen d'un ovule. En connaissant le nombre des ovules contenu dans un gramme d'ovaire, il n'est pas difficile d'obtenir le poids moyen d'un ovule. Les données concernant la variation de poids moyen d'un ovule chez les carassins, rapportées à la longueur des femelles, sont présentées dans le tableau 6.

Il résulte de ces données que le poids moyen d'un ovule croît chez les femelles de carassin, en même temps que les dimensions du corps, de la même manière que chez d'autres espèces étudiées (brême, gardon, ablette — Papadopol, 1961—1963).

b) Caractère de la maturation des produits génitaux; ponte et particularités écologiques de la reproduction

Les indications trouvées dans la littérature roumaine concernant la modalité de la ponte chez le carassin sont aussi générales, que celles concernant sa maturation sexuelle et sa fécondité. Ainsi, Antipa (1909) mentionne que l'époque de la reproduction du carassin est un peu plus précoce que celle de la carpe, d'habitude en Avril, rarement au début de Mai, quand l'eau a une température de 16—20°. Busnitza (1938) montre que la reproduction du carassin a lieu en Avril et Mai, quand l'eau atteint une température de 16° C, et la ponte a lieu en 2 à 3 jours. Il remarque également que d'après les observations de Sabanaev, la reproduction peut se prolonger de Mai jusqu'en Août.

Récemment, Busnitza et Alexandrescu (1963) signalent que la période de la reproduction du carassin dans les eaux de notre pays s'étend en règle générale, entre Avril et Septembre. Carausu, Vasiliu et Antonescu (1957) mentionnent que la reproduction de cette espèce a lieu d'habitude en Avril—Mai, mais peut se prolonger jusqu'en Juin et même plus tard. Selon ces auteurs, la ponte dure de 1 à 3 jours et a lieu surtout au cours de la matinée.

Dréaguine (1939) et Zubkova (1943) (cité d'après Dréaguine, 1949) étudiant la reproduction du carassin dans des lacs de l'Asie Centrale, ont trouvé que cette espèce dépose sa ponte dans plusieurs portions ou intervalles, ayant ce qu'on appelle une ponte échelonnée.

En utilisant les indications des auteurs roumains, ainsi que les résultats des recherches de Dréaguine et d'autres auteurs, nous nous sommes proposé d'étudier plus attentivement cet aspect de la biologie de la reproduction du carassin dans les eaux de notre pays.

C'est pourquoi, procédant de même que chez d'autres espèces étudiées par nous (carpe, brême, rotengle, ablette etc. Papadopol 1962—1965), nous avons eu recours à l'analyse numérique différenciée des oeufs d'après la coloration et les dimensions, sachant que les ovules chez les femelles éxaminées avant la reproduction sont de taille différente. En plus, nous avons procédé au contrôle histologique général des ovaires, examinant en même temps la variation du rapport gono-somatique qui reflète leur développement, tant avant (Avril) que pendant (Juin-Juillet) et après (Septembre) la reproduction.

Au cours de l'analyse numérique des ovules prélevés des échantillons pris dans les ovaires des femelles de carassin (stade de maturation III et III—IV) disséqués avant l'époque de la reproduction (7. IV.), nous avons constaté qu'il est possible de distinguer à la loupe ou au microscope, d'après leurs dimensions et coloration, 4 catégories d'oeufs (ovules et ovocytes). Nous avons fait la même constatation au sujet des ovaires de carpe, brême, rotengle, ablette etc étudiés précédemment. Comme les gonades de la plupart des femelles n'étaient pas encore tout à fait mûres (stade III et III—IV), par conséquent les oeufs étaient assez petits, il a été assez difficile de compter les catégories d'ovocytes trouvés aux stades de maturation plus jeunes. C'est pourquoi nous avons compté séparément les ovules se trouvant dans le stade de maturation le plus avancé, à savoir les plus grands, qui constitueront la première portion, et ensuite les autres catégories, surprises aux stades plus au moins jeunes de maturation. Dans la première catégorie, les ovules au stade le plus avancé de maturation avaient une coloration orange. Toutefois, à la différence de ce que nous avons constaté chez la carpe et la brême (Papadopol, 1962—1965), chez le carassin ils ne constituaient pas le groupe le plus nombreux, mais formaient environ un tiers du nombre total d'ovules et ovocytes inclus dans les ovaires. Le diamètre de ces ovules variait entre 0,9—1,3 mm. Il était d'autant plus élevé chez les individus qui étaient de taille plus grande et plus âgés. Les autres catégories d'oeufs, se trouvant aux stades intermédiaires de développement, plus ou mois précoces, à diamètre au-dessus de 0,9 mm avaient une coloration variant du jaune au blanc-jaunâtre. Ces derniers forment le groupe le plus nombreux dans les ovaires des carassins dans la période précédant la reproduction et seront éliminés au fur et à mesure de leur maturation en 2—3 et même 4 portions successives, après la première ponte.

Le contrôle histologique des ovaires a été fait sur des fragments prélevés sur les femelles pêchées en Avril (1959). En procédant de cette façon nous avons confirmé que le développement des ovocytes contenus dans l'ovaire a lieu de façon asynchrone et que les ovules et les ovocytes aux différents stades de développement présentent la même disposition que chez d'autres aspèces des cyprinidés (P a p a d o p o l, 1962—1965), c'est-à-dire qu'ils sont disposés d'une manière relativement uniforme dans toute la masse de l'ovaire. Ainsi, dans chaque petite portion d'ovaire, se trouvent des ovules et des ovocytes aux différents stades de développement, en commençant par des ovules mûrs ou presque mûrs, contenant une quantité importante de vittelus et en finissant par des ovocytes très jeunes, inclus dans les follicules unistratifiés.

La microphoto 1 (fig. 1) représente la structure de l'ovaire d'une femelle de carassin (stade III—IV de maturation) pêchée en Avril.

On peut remarquer que la structure de l'ovaire du carassin dans la période préreproductive est similaire à celle de la carpe et de la brême, qui déposent leur ponte en deux ou trois portions, avec la différence que chez le carassin prédominent les ovocytes aux stades intérmédiaires de développement (*b* et *c*) et non pas les ovules mûrs ou presque mûrs (*a*). Le contrôle histologique des ovaires confirme donc les données obtenues par l'analyse numérique des ovules des échantillons d'ovaires prélevés chez les femelles pêchées avant la reproduction.

Les données statistiques obtenues à la suite de l'analyse numérique différenciée des ovules contenus dans les ovaires des carassins pêchés dans la première décade d'Avril, sont présentées dans le tableau 7.

Tableau 7 — La composition numérique et structuralle des éléments génitaux (ovules et ovocytes) dans les ovaires des femelles de *Carassius carassius* examinées (le 7 avril 1959) du lac Rosu, en rapport avec la longueur des individus.

Longueur sans C cm	Nombre absolue des elements genitaux en milles					Nombre des elements en % du total		n
	ovules		ovocytes		ovules et ovocytes	ovules	ovocytes	
	moyenne	variation	moyenne	variation				
9,6—11,5	3,3	1,7— 6,2	8,1	3,9—14,8	11,4	28,3	71,7	4
11,6—13,5	4,9	4,5— 5,5	12,5	10,4—16,5	17,4	28,1	71,9	5
13,6—15,5	9,5	6,1—13,5	20,2	11,7—42,2	29,7	31,8	68,2	23
15,6—17,5	13,8	9,4—21,3	26,0	22,2—30,5	39,8	34,7	65,3	8
17,6—19,5	21,5	17,7—25,6	49,4	39,6—59,4	70,9	30,3	69,7	7
Moyenne	**11,0**	**1,7—25,6**	**23,7**	**3,9—59,4**	**33,7**	**31,4**	**68,6**	**47**

L'analyse des données présentées dans le tableau 7, qui comprend la composition numérique quantitative et dimensionnelle, c'est-à-dire qualitative-structuralle des oeufs contenus dans les ovaires, dans la période mentionnée, exprimée en chiffres absolus et relatifs (en %), montre que les ovules presques mûrs, qui constitueront la première portion ou ponte, représentent en moyenne 33,8% du nombre total des oeufs de la génération de l'année respective. Les ovocytes dans des stades plus ou moins précoces de développement, représentent dans la période précédant la reproduction en moyenne 68,6% de leur nombre total c'est-à-dire de la fécondité absolue.

Les résultats obtenus concernant le caractère asynchrone du développement et de la maturation des produits génitaux et le grade de «portionnalité» de la ponte, plus accentués que chez les autres espèces que nous avons étudiées (carpe, brême), nous permettent de considérer le carassin du bassin inférieur du Danube comme appartenant au groupe biologique des cyprinidés polycycliques, à ponte typiquement échelonnée, comme chez le rotengle, l'ablette et la bouvière (Papadopol, 1960, 1961, 1965). Ce type de reproduction est plus utile, car il permet aux jeunes une meilleure utilisation des ressources trophiques, assurant en même temps une fécondité plus grande aux espèces possédant ce genre de ponte.

Afin de compléter les données précédentes concernant la composition numérique et dimensionnelle des ovules dans les ovaires du carassin, au cours de la période précédant la reproduction, nous avons présenté dans le tableau 8 les chiffres qui donnent cette composition pour 1 g de masse ovarienne.

La variation du nombre moyen d'oeufs par gramme d'ovaire chez les carassins appartenant à différentes classes de longueur (tabl. 8), montre que le nombre des ovules presque mûrs, celui des ovocytes aux stades moins avancés de développement, aussi bien que le nombre global (ovules et ovocytes) baisse au fur et à mesure que croîssent les dimensions du corps. Cette variation s'explique, comme nous l'avons déjà mentionné par la croissance du diamètre et du poids des ovules en fonction de la taille (tabl. 6).

La ponte échelonnée ou en portions du carassin, à cause de développement asynchrone des éléments génitaux dans les gonades, se reflète également dans la valeur du coefficient gono-somatique dans la période de reproduction.

Tableau 8 — La variation du nombre des ovules et des ovocytes dans un gramme d'ovaire des femelles des carassins examinées du lac Rosu (le 7 avril 1959), en rapport avec leur taille.

Longueur sans C cm	Nombre des elements dans un gramm d'ovaire						Nombre des elements en % du totale		n
	ovules		ovocytes		ovules et ovocytes				
	moyenne	variation	moyenne	variation	moyenne	variation	ovules	ovocytes	
9,6—11,5	1637	1340—1770	4240	3100—4230	5877	4700—6000	28,3	71,7	4
11,6—13,5	1386	1200—1610	3696	2590—4640	5082	3900—6250	28,1	71,9	5
13,6—15,5	1180	910—1900	3012	1470—4800	4192	2500—6400	31,8	68,2	23
15,6—17,5	1315	1000—1600	2617	1400—3460	3932	2400—5600	34,7	65,3	8
17,6—19,5	996	840—1140	2247	2000—2610	3243	2950—3750	30,3	69,7	7
moyenne	1236	840—2900	3009	1400—4800	4245	2400—6400	31,4	68,6	47

Au printemps et au cours de l'été de 1961, nous avons examiné 85 exemplaires mûrs au point de vue sexuel, pour connaître l'état des gonades et la variation du rapport gono-somatique. Des fragments d'ovaires prélevés sur des femelles (pêchées au mois IV, VI, VII et IX) furent fixés pour le contrôle histologique. Au cours de ces mois, nous avons disséqué chaque mois 20—25 femelles adultes sexuellement, pêchées dans les lacs du Delta et l'étang Jijila. La majorité des femelles examinées le 4 Avril 1961 avaient les gonades au même stade de maturation (III et III—IV) que les femelles examinnées à la même époque en 1959. La valeur du rapport gono-somatique (I) a varié entre 3,2 et 9,5%, représentant en moyenne 5,8% du poids total de leur corps.

La valeur maximum de ce coefficient a été observée chez les femelles examinées au cours de la deuxième décade de Juin (15. VI.). La majorité des exemplaires disséqués à cette date (80%), avaient des ovaires bien développés dans le stade IV de maturation, comme le prouve aussi la valeur importante du coefficient de maturation, égal en moyenne à 15,4% du poids de leur corps, variant de 11,2 à 22,2%. Il est remarquable que chez 20% des femelles disséquées à cette date, les produits génitaux étaient en partie éliminés, les gonades se trouvant au stade III_1 de maturation (stades caractérisant l'ovaire des poissons à ponte échalonnée, après avoir déposé la première ponte). Le rapport gono-somatique de ces femelles a été beaucoup plus réduit (6,7—7,7%). La microphoto 2 (fig. 2), montre la structure de l'ovaire d'une femelle de carassin au stade IV de maturation, disséquée le 15 Juin 1961.

Chez une partie des mâles disséqués à cette date, les produits génitaux étaient en train d'évacuation (stade V de maturation). L'analyse similaire des gonades, effectuée environ un mois plus tard (11. VII.) a montré que la majorité des femelles avaient déjà déposé leurs oeufs, donc la reproduction était terminée. Les ovaires des exemplaires disséqués dans la période mentionnée se trouvaient dans des stades moins avancés de développement, contenant chez certaines femelles un petit nombre d'ovules mûrs non éliminés, qui persistent habituellement dans les ovaires après chaque ponte. Le rapport gono-somatique de ces femelles variant entre 1,1 et 3,5% du poids total de leur corps. Il est toutefois nécessaire de remarquer que chez un petit nombre des femelles (15%) de petites dimensions, disséquées à la même époque, les gonades se trouvaient dans le stade III_2—III_3 de maturation. La valeur du coefficient gono-somatique de ces femelles a été plus grande, variant entre 4,4 et 5,6% du poids de leur corps.

Nous pouvons donc dire qu'en 1961 la reproduction la plus intense du carassin dans les lacs Rosu (Delta) et Jijila (zone inondable du Danube) a eu lieu au cours des mois de Juin et de Juillet. L'analyse des gonades montre que chez les individus à dimensions plus grandes et plus âgés, la reproduction a commencé plus tôt; les premières portions d'ovules furent déposées probablement dès la première moitié du mois de Mai (à juger d'après la valeur du rapport gono-somatique et le stade de maturation des gonades). Il doit aussi être remarqué que la reproduction des petits exemplaires a commencé plus tard, après le 15 Juin et a continué jusqu'à la deuxième moitié du mois de Juillet.

Les gonades des femelles examinées dans la 2-e moitié du mois du Septembre (20. IX.) se trouvaient au début de stade III de maturation, le rapport gono-somatique étant de 3,5—5,8% du poids total de leur corps.

On voit d'après la fig. 3, que les ovocytes dans les premiers stades de développement (*c* et *d*) prédominent dans les ovaires examinés à cette période.

Il est plus difficile d'observer chez le carassin les migrations vers les lieux de reproduction et le dépôt des ovules des différentes portions à un intervalle d'environ 10—15 jours, parce que ses sites habituels de ponte sont bordés ou cachés par la dense végétation littorale.

Comme tant d'autres cyprinidés, en vue de la reproduction, les carassins s'assemblent en bancs dans la zone littorale. Les femelles (voir tabl. 1) sont moins nombreuses que les mâles dans les populations de carassins, se qui explique probablement leur groupement à l'époque de la reproduction. Ils se reproduisent dans des endroits voisins du rivage à eau peu profonde et à riche végétation, près de la zone littorale des roseaux. Les oeufs visqueux sont déposés sur la végétation submergée; l'élimination a lieu comme chez la carpe la brême et les autres espèces phytophiles le matin.

D'après les données de la littérature (Dréaguine, 1949), la période d'incubation à une température de 20—21° C dure 85—95 heures. Au moment de leur éclosion, les larves ont 3,8—4,2 mm, après 10 jours elles atteignent 7,6—11,8 mm. Les larves de carassin, comme celles des autres cyprinidés phytophiles ont un appareil respiratoir larvaire bien développé, ce qui leur permet de vivre immobiles, fixées sur le substratum végétal jusqu'à la résorbtion du sac vitellin.

DISCUSSION

Les index que nous avons établi concernant l'âge, mais surtout les dimensions quand se produit la maturité sexuelle chez les carassins populant le Danube inférieur, complètent et rectifient les données respectives de la littérature roumaine (Antipa, 1909; Carausu, 1952; Vasiliu, 1959; Banarescu, 1964). Selon Carausu, les carassins deviennent adultes sexuellement à l'âge de trois ans, lorsqu'ils atteignent la taille de 13—15 dm, tandis que Vasiliu affirme que la maturité sexuelle se produit à deux

Tableau 9 — Les valeurs de la fécondité absolue des femelles des *Carassius carassius* de divers bassins fluviaux et lacs.

Bassin et la source bibliographique	Longueur sans *C* cm	Nr. des ovules en milles		n
		moyenne	variation	
Volga moyenne Lukin, 1949	10,5—26,5	60,2	11,0—125	19
	10,5—18,5	30,3	11,0— 38	14
Les lacs de la reg. inondable du Tatare, Varfolomeev, 1954	11,4—20,0	30,4	11,7—119,4	39
	11,4—18,9	25,6	11,7— 73,2	37
Lac Ilmeni Dréaguine, 1939	18,4—21,7	193,3	137,2—206,9	3
	—	—	—	—
Delta du Danube Papadopol	9,6—19,5	34,7	5,6—84,7	47
	11,6—19,5	36,9	15,6—84,7	43

Tableau 10 — La croissance linéaire et en poids chez le carassin du Danube inférieur et d'autres bassins fluviaux.

Bassin et source bibliographique	n	Longueur sans C cm pour chaque an							Poids du corps g pour chaque an						
		1	2	3	4	5	6	7	1	2	3	4	5	6	7
Etang Braila-Danube M. Papadopol 1958	290	7,8	13,4	17,1	—	—	—	—	20	93	184	—	—	—	—
Delta du Danube M. Papadopol 1967	74	6,6	11,4	15,4	18,4	—	—	—	15	70	174	258	—	—	—
Lac Jijila-Danube M. Papadopol 1967	182	5,9	10,5	13,7	—	—	—	—	6	56	101	—	—	—	—
Niemen (Belorusia) P. I. Jukov 1958	41	1,9	4,3	6,4	8,9	11,1	13,5	15,2	0,3	3	10	28	58	95	140
Dniepre (Belorusia) P. I. Jukov 1965	89	3,3	6,7	9,0	12,4	15,4	17,2	—	1,5	13	30	84	163	228	—
Drissa (Belorusia) d'après P. I. Jukov 1965	60	3,6	7,2	10,2	13,2	16,4	18,8	20,5	2,2	17	49	108	206	310	402

ans, point de vue accepté aussi par Banarescu, qui cite nos résultats d'après notre manuscript. Nos résultats ont aussi prouvé que *Carassius carassius* du Danube inférieur, à l'instar d'autres cyprinidés (carpe, brême, rotengle etc. Papadopol 1962—1965) est en général plus précoce que les carassins qui peuplent des bassins centraux et du N—E d'Europe. Ainsi, Cerphas (1956) relate que les carassins des bassins du midi de l'U. R. S. S. deviennent sexuellement mûrs à l'âge de trois ans, et dans les bassins se trouvant à des latitudes supérieures, à 4—5 ans. Jukov (1958, 1965) montre que dans les eaux stagnantes de la région inondable du Niemen, le carassin atteint la maturité sexuelle dans sa 4-e année. Les dimensions linéaires moyennes des individus se reproduisant pour la première fois sont toutefois presque égales dans les bassins des différentes latitudes (tabl. 9).

On remarque, comme chez les autres cyprinidés, une étroite interdépendance entre le rythme de croissance au cours des années qui précèdent la maturité sexuelle, rythme portant l'empreinte des conditions climatiques et trophiques, et l'âge quand survient la maturité sexuelle des individus formant les populations des carassins des différents bassins. En général, les carassins des bassins méridionaux, par exemple du Danube inférieur, qui montrent un rythme de croissance plus intense dans la période précédant la maturité sexuelle, sont plus précoces que les carassins vivant dans les bassins situés à des latitudes plus grandes (Dnieper, Niemen), qui présentent une croissance moins accélérée (tabl. 10).

Nos données statistiques concernant la valeur moyenne et les variations de la fécondité absolue des femelles de carassin de dimensions et d'âges les plus habituels pour les populations exploitées par la pêche (10—20 cm,

2—4 ans), montrent que le nombre des oeufs déposés pendant une période de reproduction est beaucoup plus petit (entre 5,6 et 84,7 mille) que celui que mentionne d'habitude notre littérature (100—300 mille ovules, Antipa, 1909; Antonescu, 1957; Vasiliu, 1959); font exception Carausu 1952 (50—70 mille ovules) et Banarescu (1964), ce dernier utilisant nos données communiquées en manuscrit. En comparant nos données avec celles de la littérature étrangère (tabl. 9) on constate que la valeur moyenne de la fécondité absolue des femelles examinées, provenant du Delta du Danube, de la fécondité absolue des femelles examinées, provenant du Delta du Danube, est en général plus grande que celle des carassins, qui ont environ les mêmes dimensions linéaires, mais vivent dans les lacs de la région centrale du fleuve Volga et dans lea eaux de la région inondable de la R. S. Tartare. Ces valeurs sont toutefois assez proches.

Le fait que la valeur de la fécondité absolue est plus grande chez le carassin du Delta du Danube que chez la même espèce vivant dans les bassins mentionnés, s'explique tout d'abord par le rythme de croissance (linéaire et pondéral) plus intense du premier (tabl. 10).

A la suite de l'étude numérique et histologique des éléments de l'ovaire et du stade des gonades, nous avons précisé en détail chez le carassin du Danube inférieur, le mode asynchrone du développement et de la maturation des ovocytes, et en conséquence, le type échelonné ou par portions de sa ponte. Nos données et observations dans ce sens, expliquent et complètent certaines mentions de notre littérature (Busnitza, Antonescu, Vasiliu, etc.) concernant le type de ponte et l'époque de la reproduction du carassin dans nos bassins. D'après les tableau 7 et 8, on constate que l'ovogenèse a lieu graduellement ou de façon asynchrone, les ovules étant déposés de manière échelonnée, au fur à mesure de leur maturation, en 4—5 portions ou pontes successives, à intervalle de 10—15 jours environ l'une de l'autre. Ceci explique pourquoi la période de reproduction est relativement longue, c'est-à-dire d'environ deux mois, débutant d'habitude dans la deuxième moitié de Mai et continuant jusqu'en Juillet.

Nos résultats et observations concordent avec ceux de Dréaguine (1939) sur le carassin du lac Ilmeni; l'auteur y étudia en détail, pour la première fois, la biologie de la reproduction. Ainsi, le pourcentage des ovules déposés à la première ponte (27,6%) est très proche de celui que nous avons trouvé chez les femelles du Delta du Danube (31,4% de la valeur de la fécondité absolue). La durée de l'époque de la reproduction (Mai—Juillet) montre par ailleurs que l'ovogenèse et la ponte de cette espèce se déroulent de la même manière chez les populations des deux bassins.

CONCLUSIONS

I. L'analyse des données statistiques et de nos observations concernant la biologie de la reproduction du carassins vivant dans les eaux du Danube (lacs Rosu et Jijila) montre que:

1. a) Les individus des deux sexes atteignent en masse la maturité sexuelle à l'âge de 2 ans. Les mâles de cet âge ont une longueur moyenne (sans C) de 11,8 cm et les femelles de 13 cm; leur poids varie entre 85 et 100 gr. Un important pourcentage de femelles, mais surtout de mâles, deviennent sexuellement adultes même à une taille moindre de 10 cm (sans C), poids 50 gr (tabl. 1).

b) La fécondité absolue des femelles pêchées dans le lac Rosu (Delta) longues de 9,5—19,3 cm (sans C) et âgées de 2—4 ans, varie de 5.600—84.700 ovules en moyenne 34.700. Sa valeur croît, comme chez les autres poissons, en corrélation avec la croissance des dimensions du corps et l'âge des individus (tabl. 3), à savoir en proportion directe avec le poids du corps et inverse avec le poids moyen individual des éléments génitaux, oeufs formant la masse des ovaires (tabl. 6 et 7). Dans cette corrélation, le rapport gonosomatique représente le facteur de proportionnalité (tabl. 7).

c) Les femelles de carassin du Delta du Danube sont en général plus prolifiques que les individus de dimensions égales vivant dans d'autres bassins (tabl. 9).

d) La fécondité relative moyenne du carassin étudié dans le lac Rosu est de 201 oeufs, variant individuellement en rapport avec les dimensions du corps et l'âge des femelles, entre 103—348 oeufs, ce qui signifie qu'un exemplaire de taille et d'âge habituel (10—20 cm; 2—4 ans) dépose en moyenne entre 15.000 et 24.000 ovules pour chaque 100 gr de son propre poids.

2. a) Le développement et la maturation des ovocytes ou l'ovogenèse sont asynchrones, comme chez la rotengle, l'ablette, la bouvière, la carpe et la brême (P a p a d o p o l, 1960—1965). Ceci explique pourquoi dans la période précédant la ponte (Avril et début de Mai) ou même avant, on trouve dans les ovaires 4 catégories d'ovules (*a*) et d'ovocytes (*b*, *c*, *d*) aux différents stades de développement, qui diffèrent nettement entre eux par leurs dimensions, leur coloration et surtout par leur structure histologique (fig. 1—3). Les ovules et les ovocytes dans des stades différents de développement sont disposés presque uniformément dans toute la masse des ovaires, comme chez les espèces mentionnées précédemment.

b) À cause de l'ovogenèse asynchrone, c'est-à-dire de la maturation graduelle, par groupes de ovocytes, l'évacuation des ovules mûrs se produit aussi graduellement en plusieurs portions ou pontes successives, comme chez le rotengle, l'ablette, la bouvière et diffère un peu de la ponte de la carpe et de la brême (P a p a d o p o l, 1960—1965). D'après nos données statistiques, la première ponte contient en moyenne 28,1—34,7% de oeufs de la génération de l'année respective. Les ovocytes aux différents stades de développement, restés dans les ovaires après l'élimination de la première ponte, représentent en moyenne 65,3—71,9% de la fécondité absolue et mûrissent successivement, étant déposées habituellement en 3—4 et même 5 pontes après la première, dans une période de reproduction relativement longue, de deux mois, à partir du mois de Mai, en Juin et jusqu'en Juillet (tabl. 8—9 et fig. 1—3).

c) La reproduction intense du carassin dans les lacs du Delta du Danube et dans les étangs de Jijila en 1961, a eu lieu en Juin et Juillet. Les individus de dimensions plus grandes et plus âgés ont commencé à déposer leur première ponte dans la seconde moitié de Mai, tandis que les carassins de petite taille ont commencé la ponte plus tard, en continuant jusqu'au début d'Août.

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Les figures voir la fin de la livraison.

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NOTES TO THE INCUBATION PERIOD, GROWTH AND MORTALITY OF THE CHUB, LEUCISCUS CEPHALUS (LINNÉ, 1758), IN THE EARLY LIFE-HISTORY STAGES

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A b s t r a c t : The development of the chub was investigated under experimental condition, which resulted in ascertaining the following parameters: the incubation period, hatching process, growth-rate of the hatched embryos and larvae, as well as mortality in the course of the individual stages of development. The investigations were carried out in correlation to the various quality of the parental fish and with regard to the quality of their sex products. The average incubation period of the individual combinations of the parental partners varies considerably, being it influenced mostly by females: the influence of males is negligible. The rest of the indices investigated (intensity of growth and development, mortality), however, are affected by both sexes. The causes of the increased mortality in the early stages of development are presumed to consist in the inner factors quite independent on the environment.

INTRODUCTION

One of the most vital tasks of the contemporaneous ichthyology is the research of the fish population and determination of the correlations by which it is affected and governed. The complex of all vital actions described briefly as reproduction has naturally a primary importance for the dynamics of population and therefore an increased attention has recently been paid to the questions of reproduction.

Compared with other questions, however, comparatively little attention has been paid to the investigation of the influence of the quality of sexually matured fish on the quality of their sex products (especially as far as the males are concerned), on their fertilization ability, incubation period, hatching process as well as growth in the postnatal stages of life and on the vitality of the brood in general. The clarification of the outlined complex of questions, which was at least informatively fixed as the aim of our work, has — apart from the already mentioned theoretical importance of the investigation of the dynamics of populations — also an indisputable practical significance, because it may immediately help to create the most effective and biologically most advantageous methods of intensive fish management. This may be effected not only in the cases of the progressive development of the population of a certain species, but also in cases that will require to reduce the quantity of the undesirable species of ichthyocoenosis. In the intensively managed sections of our trout-zones it will be the chub whose natural re-

production and frequently even expansivity will have to be adequately regulated.

These questions can be reliably investigated only experimentally, because in a great complex of the ungovernable ecological, physiological, and other factors affecting every biological process it is usually impossible to estimate the significance of the individual affecting factors and to grasp the factors which are decisive for a phenomenon or situation given if we use methods of field ecology.

This paper is a survey of some of the results of this research task the solution of which will be perspectively continued.

MATERIAL AND METHODS

The way of acquiring material: The fish were caught by means of an electro-fishing gear in the river Oslava near Náměšť on the Oslava. This station was visited several times in the endeavour of determining the period in which as many individuals as possible were in a full sexual ripeness. The bags of fish to which the artificial spawning was applied (every time 1 female was spawned) were carried out in two terms: 31st May and 22nd June 1967. The fish picked out for artificial spawning (10 males and 2 females — see Tab. 1) were measured and weighed in the usual way and their scales were removed to determine their age. All the individuals were at the 5th stage of sexual maturity of the gonads (according to Nikolský's scheme for fish of portional type of spawning — P r a v d i n, 1966), i.e., the sex products flowed out even at a slight pressure of the abdomen. The description of samples in the following paragraphs corresponds to that of males (Tab. 1), which were used to fertilization of portions of eggs in these samples.

Table 1. Description of the fish used to artificial spawning

Date of the catch	31. 5. 1967							22. 6. 1967				
No. of the fish	1	2	3	4a	4b	4c	5	1	2	3	4	5
Sex	♂	♂	♂	♂	♂	♂	♀	♂	♂	♂	♂	♀
Total length	224	298	278	270	253	220	324	250	270	310	211	356
Standard length	188	252	236	227	215	185	278	213	225	270	180	304
Weight	120	240	200	180	158	96	395	160	180	300	95	485
Age group	VII	?	VIII	VIII	IX	VII	VIII	IX	IX	VIII	VIII	?
Condition factor	0.63	0.80	0.84	0.79	0.73	0.52	1.42	0.75	0.80	1.11	0.53	1.60
Fat content in musculatur	—	1.12	1.12	1.06	0.96	0.68	0.78	4.73	4.71	4.06	6.70	9.02

The fat contents in the musculature of all spawned fish was determined by means of etheric extraction.*)

As much as the fat contents of fish are concerned, particularly striking was the difference between the materials from both terms. Considerably lower contents of fat of the individuals caught on 31st May in contrast to those caught on 22nd June can only be explained partly by the less favourable habitat conditions in this as well as in the preceding period, partly by the intensive growth of the gonads. As far as the correlation of the size of the fish and the fat contents are concerned, positive correlation can be noticed in the first term of bags, while in the later term the tendency is contradictory (Tab. 1).

Estimation of the quality of the milt

We could macroscopically examine the contents of the milt stripped, its colour, consistency and alien admixtures. The duration of the period of active viability of the activised sperms was examined microscopically (S c h e u r i n g, 1924; D y k and L u c k ý, 1956) a and we also

*) We are indebted for the execution of the analyses to the Chair of Hygiene and Technology of Food at the Faculty of Veterinary Medicine of the University of Agriculture in Brno (MVDr. Sadil) and the State Veterinary Institute in Brno (MVDr. Medek).

tried to carry out — within limits — the morphological examination of the sperm smears stained by methyl-violet, methyl-blue, Giemsa-Romanowski and Brendan stainings.

In the contents of the milt stripped and in a number of other items investigated, certain differences were ascertained between the individuals males (Tab. 2) which have most probably their consequence even in the biologically different quality of sperms. So far we have not succeeded in proving an explicit correlation between the indices of the quality of sperms investigated and the morphometric signs of the spawned fish (Tab. 1).

Table 2. Quality of the milt of individual males

Date of the spawning	No. of the males	Content of the milt stripped ml	Colour	Consistency	Alien admixtures	Active viability of the sperms sec.	Percentage of pathological and dead sperms
May 31st 1967	1	4,0	white	normal	—	130	15
	2	2,5	yellowish	normal	—	115	30
	3	3,0	white	dropsical	blood	120	25
	4a	3,5	white	normal	—	110	25
	4b	2.0	yellowish	dropsical	blood	115	20
	4c	3.0	white	normal	—	100	20
June 22nd 1967	1	2.0	white	dropsical	—	125	25
	2	4.0	white	normal	blood	115	25
	3	3.0	white	normal	—	130	25
	4	2.0	white	normal	blood	120	20

The method of artificial spawning

The artificial spawning of the fish was effected directly on the fishing-ground, as soon as the bag had been fished out. The spawned eggs were divided into 4—5 groups (each containing about 700 pieces in one sample), each of which was — by means of "the dry method" individually fertilized by milt of the individual males. One sample of eggs (No. 4) from the first series of experiments (artificial spawning on 31st May 1967) was fertilized also heterospermically by a mixture of milt from 3 males (Tab. 2: males No. 4a, 4b, 4c) and one further sample was — on account of the control of development — left unfertilized, whereby it was subject to the same procedures as the samples of fertilized eggs, i.e., stirring about by means of fine bird-feathers, washing with water and finally pouring into special hatching-boxes made of plastic (P e ň á z, 1968a) submerged in the water for about 30 minutes, during which time the eggs got expanded and stuck to the bottom of the boxes. After this period the boxes with the eggs were placed in a special transport-case made of soft polystyrene and transported to the laboratory, not being submerged in water, but merely enveloped in a damp atmosphere. The other series of experiments (artificial spawning on 22nd June 1967) consisted of 4 samples of eggs fertilized only individually, i.e. by milt of one, but each time a different male.

The method of incubation of eggs and rearing of the fry

As soon as the boxes containing eggs arrived at the laboratory of Division of Experimental Ecology of the Institute of Vertebrate Zoology ČSAV at Studenec, they were put in a hatching apparatus and the whole process of incubation was effected at the constant temperature of water 18° C. The description of the hatching apparatus and conditions of hatching are the subject of a separate study (P e ň á z, 1968a). The perished eggs were not removed during the incubation. Nevertheless, they were counted. Perished eggs were considered to be those, on which it was possible to notice macroscopically a shade of white caused by coagulated globuline which was at least half the size of an egg. Closely before the beginning of the hatching process the boxes with eggs were placed in all-glass aquariums and the final stage of the hatching process, the course of which was numerically registered at regular intervals took place in non-flowing water

at the constant temperature 18° C. The further development of embryos and larvae*) was effected in the all-glass aquariums mentioned before, only with the difference that the water-temperature was not controlled; it varied in dependence with air-temperature of the cellar-room where the experiment took place (Fig. 1). As a matter of fact, it varied within the limits of 14.0—17.8° C. The aquariums were sufficiently supplied with fresh air and the contents of the dissolved oxygen varied according to the 11 control-analyses within the limits of 8.08—9.59 mg/l, i.e. 84.6—100.2% of saturation.

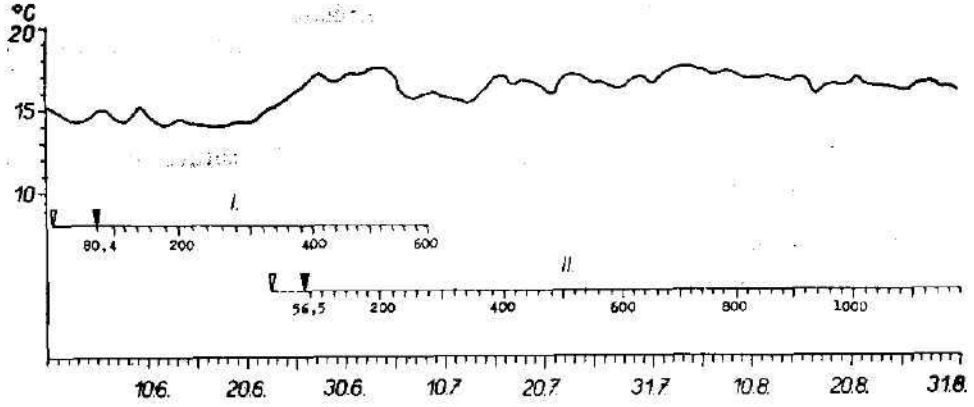

Fig. 1. Course of water temperature in experimental aquariums. Explanations: I — total sum of the day degrees expressed in °C for the 1st spawning on May 31st, 1967; II — the same for the 2nd spawning on June 22nd, 1967; dashed line = incubation period; ▼ = fertilization; ▽ = middle time of hatching.

Feeding of larvae

The larvae were fed with the strained mixed pond-plankton, which — for the most part — abounded in Rotatoria and minute forms of Cladocera and Copepoda and from the phytoplanktonic species by Volvox sp. Later on the small fish were additionally fed with dried crushed Cladocera.

The method of measurements and weights of embryos is described in detail in P e ň á z's paper (1968b). The characters used in Tab. 4 represent the following dimensions:

L — longitudo totalis
l — longitudo corporis
lc — longitudo capitis
dD — distantia praedorsalis
dpA — distantia postanalis
dA — distantia praeanalis
ac — altitudo corporis
mac — altitudo corporis minima
dpr — distantia praeorbitalis
dpo — distantia postorbitalis
doc — diameter oculi
s — distance from the rear edge of eye up to the front edge of the otocyst
ls — longitudo capsulae oticae
lv — longitudo sacculi vitelini (maxima)
av — altitudo sacculi vitelini (maxima)

*) When indicating life-history stages and periods we stick to B a l o n's terminology (1960).

The beginning of the hatching process, its intensity, incubation period

The number of the embryos hatched was controlled in the first series of experiments 3 times a day, in the second series of experiments at regular 2—4 hour-intervals and in the most intensive phase of the hatching process (26. 6.) at one hour-intervals. The mean period of incubation (Tab. 3) was ascertained graphically, it being the one when 50% embryos were hatched. The hatching period was also ascertained graphically as the range of interdeciles, i.e., the time expired from the instant when 1/10 of all embryos was hatched until the instant when 9/10 out of the total quantity were hatched (Cf. Lillelund, 1961).

Tab. 3. Results of the hatching. (Incubated at the constant water temperature 18,0° C.)

Date of the spawning	No. of the sample	Number of eggs	Number of embryos hatched	Per cent	Beginning of hatching (hours from the beginning of development)	Finishing of hatching (hours from the beginning of development)	Middle time of incubation (hours from the beginning of development)	Middle time of incubation (day degrees)	Duration of hatching hours
May 31st, 1967	1	448	425	94.8	73	132	111.5	83.6	37.6
	2	367	309	84.2	76	129	108.1	81.1	28.0
	3	215	172	80.0	73	139	104.0	78.0	37.0
	4	544	473	87.0	71	130	105.5	79.1	32.0
	$\bar{x}$	393	345	87.7	71	139	107.3	80.4	33.6
June 22nd, 1967	1	921	892	96.8	71	106	75.5	56.6	6.2
	2	1445	1272	87.9	72	100	74.0	55.5	5.6
	3	477	445	93.5	71	101	77.0	57.8	8.1
	4	387	347	89.7	70	102	75.0	56.2	7.6
	x	808	739	91.5	70	106	75.4	56.5	6.9

The beginning of the hatching process took place in both series of experiments practically at the same time in all samples, so that there is practically no difference in the period of the beginning of the hatching process between the two series of experiments (Tab. 3). There is, however, a great difference in the duration of the hatching process as well as in the mean incubation periods. While in the first experiment (spawning on 31st May) the hatching process alone took altogether 68 hours and the mean incubation period was 107.3 hours (i.e. 80.4 d.st.), in the other series (artificial spawning on 22nd June) the hatching process took only 36 hours and the mean incubation period was merely 75.4 hours (i.e. 56.5 d.st.). The period during which most of the embryos were hatched (the range of interdeciles — Tab. 3) was in average 4.8 times longer in the first experiment than it was in the other experiment. The mean incubation periods of the individual specimens differed

only negligibly from each other, considering either series of experiments. The maximum difference ascertained — compared to the medium value — was 3.1% (sample 1) in the first experiment, in the other one only 2.1% (sample 3).

The intensity of hatching has from the beginning an increasing, later on a decreasing trend. While in the case of the first series of experiments the course of the increasing and decreasing parts is roughly equal, in the other series of experiments a considerably higher intensity of hatching was ascertained at the first phase of the hatching process. This experiment showed that the first half of all embryos had been hatched in average in 4.3 hours the other half, however, had taken 28.6 hours (Tab. 3). Kryžhanovskij (1949) ascertained that the period of development up to the stage of the hatching of the chub was — at the same temperature of water as that of our experiment, i.e., 18.0° C — 97 hours, which lies in between the mean values ascertained at both series of our experiments. According to Gyurko et coauct. (1954) the incubation period at the average temperature of water 16.7° C equals 80.91 daily degrees, i.e., practically the same value as the average one ascertained by us for the first series of experiments.

It results from the estimation of the two series of experiments that the males have only a negligible significance for the duration of prenatal period and the differences ascertained in the incubation period in either series of experiments are within the limits of the variability of this phenomenon without any evident correlation to the quality of the males used for the fertilization of eggs. The period of development at the instant of hatching, however, differed considerably at both females and there is no doubt that it was caused by different qualities these females, used for artificial spawning. For the moment, however, we cannot say which of the indices of quality of parents (size, age, coefficient of condition, fat contents) is in closest correlation to the mean period, which will only be possible when a specially-aimed experiment is carried out and a greater number of individuals is estimated. There is a question, too, whether even the individual portions of spawns of the fish of type of portional spawning, to which the chub also belongs, do not differ in the period of development, which could also account for the differences ascertained by us. In every case, there are some more questions to be clarified, which will no doubt be the subject of further investigations.

The size of the hatched embryos

Eleuterembryos of the individual samples measured on the day of the most intensive hatching reached the following total lengths of body (L):

Sample	1st series of exp.	2nd series of exp.
1	6.03	4.98
2	6.18	5.52
3	6.16	5.45
4	6.15	5.31
$\bar{x}$	6.09 mm	5.31 mm

The values of average lengths do not differ very much from one other considering individual series of experiments, excepting the sample No. 1 in the 2nd series where the value is a trifle below the average.

When the lengths of embryos hatching in both series of experiments are compared to each other, the difference is more striking, which is no doubt due to the afore-mentioned differences of the length of the incubation period and to the different stage of development of the hatching embryos (Cf. Lillelund, 1961). In the first experiment when the incubation period was longer more than 1 day, the hatching embryos were straighter and their heads were more distinctly separated from the yolk sac, i.e., they were longer. In the other experiment the embryos reached this status only the second day after being hatched.

In some samples (samples No. 3, 4 and particularly sample No. 2 after the second spawning) there was a greater number of morphologically deficient individuals (cf. Peňáz, 1968b) among the hatched embryos which were considerably backward in the further development and — sooner or later — they perished completely. At this phase of research these problems were not paid a particular attention because of a number of other tasks. It is evident, however, that in the future it will be necessary to cope with these questions with more attention, because they are closely connected with the stage of vitality of the brood and its mortality.

Based on the results of our experiments it can also be presumed that a greater size of hatchlings need not necessarily mean their greater vitality. As a matter of fact, the highest mortality in both experiments was noticed in the samples with the hatchlings of the greatest length, and on the other hand, the lowest mortality in the specimens with those of the smallest length. Also the general comparison of both series of experiments is in full accordance with the above-mentioned.

THE GROWTH OF EMBRYOS AND LARVAE IN THE POSTNATAL LIFE-HISTORY PERIOD

From the point of view of estimating the quality and vitality of brood the most important index is the growth of the total length of body (Fig. 2). In this respect, significant differences were ascertained both between either series of experiments and between the individual samples. The quickest growth — practically throughout the whole course of the experiment — was noticed in the embryos and larvae in the sample No. 1, i.e., in the specimens of a relatively lower mortality or where the mortality had a slower decline during the development. In contrast to the mere size of embryos in the instant of hatching it is necessary to claim that the intensity of the growth of length appears as an outstanding index of quality and vitality of the brood.

The results of the investigation of the relative growth in the individual body dimensions are given in Tab. 4.

MORTALITY IN THE COURSE OF DEVELOPMENT

Succesfulness of fertilization

In order to make it possible to ascertain the percentage of the unfertilized eggs in the samples of the developing eggs, it was necessary to observe also one sample of uninseminated eggs in the first experiment. Even in this

particular case it could be noticed that the initial phases of cleavage appeared on the eggs, but the development stopped at the stage of the bi-celled morula with regular cells. It is interesting, however, that practically untill the end of the incubation period no shade of white appeared on these unfertilized and undevelopping eggs, which is for instance in the trout practice (P o d u b s k ý and Š t ě d r o n s k ý, 1967) considered characteristical right during the first day of development after the insemination.

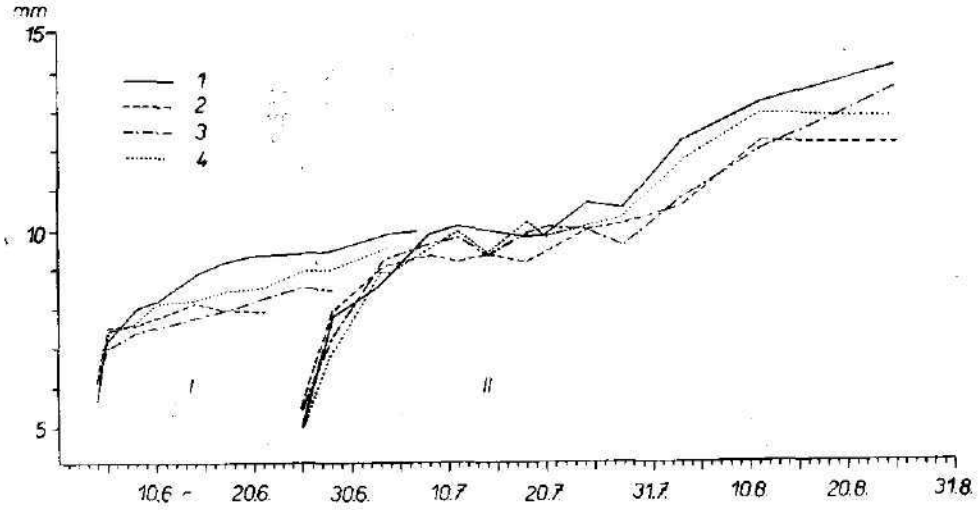

Fig. 2. Growth rate of the total length — longitudo totalis — during the early posthatching life-history period. Explanations: I, II = the 1st and 2nd series of experiments; the numbers 1—4 denote individual samples of brood.

On other samples of eggs, which had been inseminated, one could generally notice a shade of white on a smaller number of eggs soon after the fertilization. As the microscopical examination showed no difference in their development in contrast to the checked uninseminated eggs, it can not be said with certainty whether they have been fertilized or not. Most of the eggs that perished and got white in the later incubation period showed a more advanced stage of development than in the control experiment with the uninseminated spawns, so that it can be said with certainty that these spawns were fertilized. The percentage of fertilization was very high in all the samples, and the percentage of the eggs unfertilized amounted maximally to 1—2% out of the total quantity.

Mortality in the prenatal life-history period

The average mortality of eggs (including the unfertilized ones) during the incubation period did not differ considerably from each other between the two series of experiments and amounted to 8.5 and 12.3% (derived from Tab. 3). There are, however, certain differences between the individual samples. The highest mortality at this stage of development was — what with one thing and another — ascertained in both series of experiments

Tab. 4. Average body measures and weights during the early

	Dimension		4. 6. 1	4. 6. 2	5. 6. 1	5. 6. 2	8. 6. 1	8. 6. 2	10. 6. 1	10. 6. 2	14. 6. 1	14. 6. 2
31. 5. 1967	L		6.03	6.2	7.2	7.5	8.0	7.5	8.1	7.8	8.8	8.1
	l	mm	5.9	6.0	6.9	7.2	7.6	7.3	7.8	7.7	8.4	8.0
	lc		1.0	—	1.2	1.1	1.2	1.3	1.3	1.3	1.4	1.4
	dD		48	45	42	42	43	42	40	44	40	*
	dA		74	73	70	70	68	71	68	68	67	69
	dpA	in % long.	28	29	33	33	35	32	36	32	37	32
	ac	corp. l	13	14	14	14	11	14	12	12	14	13
	mac		9	11	12	13	9	10	9	7	10	8
	lv		64	64	56	57	52	54	51	49	49	45
	av		12	15	9	10	8	8	7	8	7	8
	dpr		13	*	18	18	15	16	11	10	16	16
	dpo		40	*	43	40	43	41	47	51	45	42
	dol	in % long.	32	*	39	43	39	45	40	44	40	38
	s	capitis	19	*	8	8	10	10	11	14	10	10
	ls		17	*	23	23	24	26	30	32	34	30
	pondus	mg	21.0	22.2	22.6	23.0	23.0	24.8	21.4	26.4	29.4	25.4

	Dimension		25. 6. 1	25. 6. 2	28. 6. 1	28. 6. 2	3. 7. 1	3. 7. 2	8. 7. 1	8. 7. 2	11. 7. 1	11. 7. 2
22. 6. 1967	L		5.0	5.5	7.8	7.1	8.6	9.1	9.9	9.3	10.1	9.2
	l	mm	4.9	5.4	7.5	6.7	8.2	8.6	9.4	8.7	9.5	8.6
	lc		*	*	1.2	1.1	1.5	1.6	1.8	1.7	1.8	1.8
	dD		49	48	43	48	43	44	42	44	41	44
	dA		75	76	69	73	67	69	66	67	66	68
	dpA	in % long.	26	26	35	34	37	36	38	38	38	37
	ac	corp.	28	13	13	15	13	13	13	12	13	15
	mac		9	10	9	10	6	9	7	7	7	8
	lv		64	63	54	58	46	48	—	—	—	—
	av		26	22	10	11	8	7	—	—	—	—
	dpr		*	*	14	19	11	13	12	11	14	13
	dpo		*	*	43	46	50	47	46	50	49	52
	doc	in % long.	*	*	40	44	40	41	39	39	40	38
	s	capitis	*	*	10	8	13	10	13	11	11	9
	ls		*	24	21	29	26	32	33	34	32	32
	pondus	mg	24.2	22.0	24.1	22.5	26.4	24.0	25.6	24.6	25.4	24.4

* All individuals dead.

posthatching life-history period under experimental conditions

17. 6.		20. 6.		25. 6.		28. 6.		4. 7.		7. 7.	
1	2	1	2	1	2	1	2	1	2	1	2
9.1	7.9	9.3	7.9	9.4	*	9.4	*	9.9	*	9.9	*
8.7	7.8	8.9	7.8	9.0		8.9		9.4		9.4	
1.6	1.4	1.5	1.4	1.6		1.7		1.9		2.1	
40	*	44	*	41		45		42		43	
68	68	66	69	65		65		65		67	
37	33	39	32	39		39		39		37	
13	12	12	13	11		12		12		12	
9	6	6	5	6		6		5		6	
47	44	45	49	—		—		—		—	
6	7	6	7	—		—		—		—	
11	10	11	6	10		13		15		19	
49	46	50	54	45		48		48		46	
39	35	39	36	36		37		37		35	
10	7	11	10	10		10		9		10	
31	30	33	36	33		32		31		31	
26.4	25.0	25.2	24.4	25.8		25.0		26.2		25.5	

14. 7.		18. 7.		20. 7.		24. 7.		28. 7.		3. 8.		11. 8.		25. 8.	
1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
10.0	9.3	9.8	9.1	9.8	9.4	10.7	10.0	10.6	10.1	12.3	10.6	13.2	12.2	14.2	12.2
9.4	8.8	9.2	8.6	9.3	8.8	9.9	9.2	9.8	9.4	10.9	9.6	11.7	10.7	12.4	10.8
1.8	1.7	1.8	1.7	1.9	1.8	2.2	2.1	2.3	2.1	2.8	2.4	3.1	3.1	3.2	2.8
43	46	46	45	42	44	43	49	47	46	52	52	53	53	56	53
66	68	66	64	66	68	67	68	67	66	69	68	68	69	70	71
38	37	38	41	38	37	39	39	39	37	42	39	43	42	46	43
13	12	10	12	13	14	13	13	12	12	19	16	16	18	19	16
6	6	5	6	6	7	6	6	6	6	6	6	7	7	7	6
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
13	15	13	11	13	16	17	15	16	16	15	20	21	24	24	20
45	48	48	48	49	54	51	50	52	47	43	45	44	46	45	51
40	39	40	40	35	40	35	37	34	36	34	34	33	35	33	34
9	9	9	10	11	12	10	12	11	11	9	9	9	7	7	10
32	33	31	32	29	23	22	22	21	30	27	29	27	29	25	28
24.6	25.0	24.2	23.6	25.0	24.0	26.2	23.0	26.0	23.6	29.2	26.0	30.0	27.2	31.8	28.2

always in the specimens No. 2, i.e., in those samples, which had characteristically a high mortality, a lower growth-rate and retarded development even in the later life-history periods.

Mortality in the postnatal life-history period

(By postnatal life-history period we denote — in this paper — perhaps a bit too narrowly — the stage of development from birth up to passing into the juvenile period of development, i.e., the eleuterembryonal phase of the embryonal period and the whole larval period of development according to Balon's 1960 terminology).

Tab. 5. Mortality of hatchlings and larvae during the posthatching life-history period. (Expressed in per cent of total numbers of individuals hatched.)

Total mortality in stage	1st series of experiments					2nd series of experiments				
	1	2	3	4	$\bar{x}$	1	2	3	4	$\bar{x}$
Beginning of active feeding with endogenous food	29.0	96.4	71.0	54.4	62.7	2.1	10.6	10.3	10.6	8.4
Finishing of the yolk sac consumption	66.8	100,0	97.1	96.2	90.0	4.2	21.0	13.0	13.7	13.0
Transition to juvenile life-history period	(100)	(100)	(100)	(100)	(100)	41.2	78.7	51.3	47.6	54.7

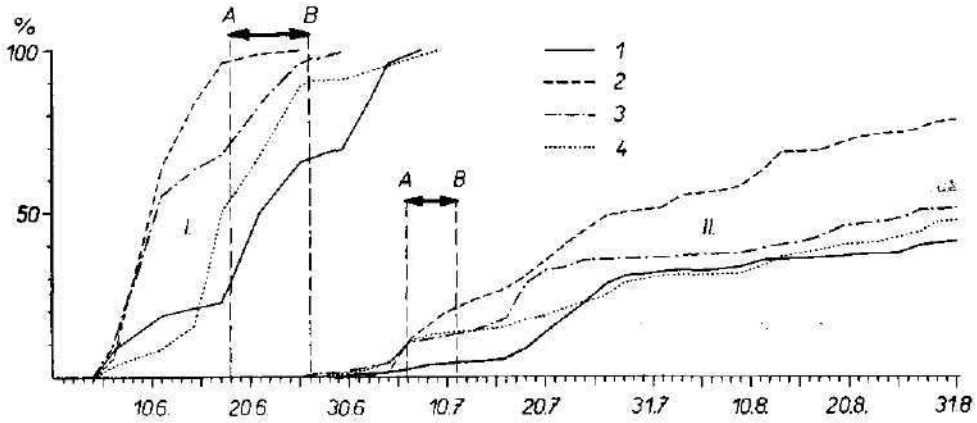

Fig. 3. Mortality of embryos and larvae during the early posthatching life-history period. Explanations: I, II = 1st and 2nd series of experiments; A = beginning of the active oral feeding; B = consumption of the yolk sac finished.

Mortality at this period was comparatively high, particularly in the 1st series of experiments (spawning on 31st May 1967) where all individuals perished with no regard to the intensity of mortality, whereby most of the

embryos hatched (66,8%) perished, although their supply of the yolk sac was still sufficient well before they started obtaining food actively and, for the most part, they perished with symptoms of yolk sac-disease (Hydrocoele embryonalis) — cf. Tab. 5. Perishing increased in a greater extent as early as in the transition period passing over to the gill respiration, i.e., when the contact with the outer surroundings was intensified. On the other hand, in the second series of experiments (spawning on 22nd June) where the average mortality came up to 54.7% (up to the end of the larval period) only a negligible percentage of brood perished in the period of resorption of the yolk sac and in the period of the mixed endo- and exogenous food and the highest percentage of mortality was noticed in the larval period of development (Fig. 3). Analogically, as was described in the preceding chapters, there were ascertained individual differences both in the rate of mortality and in their total values between the individual samples of eggs of the same females fertilized by sperms of various males (Fig. 3), which roughly corresponds to the differences found out in mortality during the incubation period, as well as to the intensity of growth and development. It results from our experiments that there was no considerable percentage of mortality in the so-called "critical period of development" setting in when the resorption of the yolk sac is being finished (M a a r, 1956; B a l o n, 1961), particularly in the 2nd series of experiments, which is no doubt due to the appropriate feeding. The fact that a higher percentage of mortality was ascertained in the preceding and even in the later periods of development only shows that this was due to some other unclarified intriasic or extriusic factors.

DISCUSSION

So far little attention has been paid to the part of males and quality of their sex products in the reproduction of fish in the scientific works and so there is still quite a lot to be desired in this respect. Critical estimation of some more important publications concerning this problem was done by Ž u k i n s k i j (1965), who — among other things — asserts that there are tendencies inclined to underestimate the significance of males in this respect.

Originally our intention was to work out simple quick methods which would enable — in the shortest time possible — to estimate reliably the quality of the sperm. The question, however, turned out to be considerably complicated.

The fish sperms are — as it is known — in the gonads in the immobile condition. B e l j a e v (1957) presumes that this is caused by an osmotic equilibrium between the sperms and colloids of the spermatic liquid. When in contact with water this equilibrium is destroyed and a short-time activation of sperms immediately occurs, which can be externally seen from conspicuous movements. This property makes it possible to use most of the investigating methods applied at the research of the mammals' sperms. Therefore in the initial stage we focussed our attention on the basic orientation investigation which does naturally not solve all the questions originally intended to, it gives, however, a primary orientation piece of knowledge.

Among the most applicable tests of the quality of fish sperms ranks the determination of the period of the active viability of sperms (S c h e u r i n g, 1924; D y k and L u c k ý, 1956; Ž u k i n s k i j, 1965; H o c h m a n, 1966 and others). Even if some authors (Ž u k i n s k i j l.c.) estimate the

value of this index from the point of view of testing the abilities of fertilization and influence of further development somewhat sceptically, in our case — the ascertained differences in the period of viability of sperms of the individual males seem to be in a close relation to the mortality in the prenatal as well as postnatal period and they are also closely connected with the growth-rate and intensity of development of eleuterembryos and larvae in the respective samples. One of the hopeful indices of the quality of sperms suggested even by Žukinskij (1965) seems to be the percentage of the immobile (as well as morphologically abnormal) sperms, the exact determination of which is still impeded by certain methodical difficulties which will have to be spanned in the further research.

The advantage of the heterosperm — apart from the chance of getting a sufficient quantity of sperm — can be seen in the fact that the participation of the second-rate males is eliminated in the reproduction process, because the ova are evidently fertilized only by the most active sperms from the best males. The successfulness of the development of the brood created by the heterospermatic fertilization of a certain group of fish cannot be — in our opinion — higher than that achieved by the first-rate males of the same group by means of individual fertilization.

The question of mortality of the fry in the course of development has been for quite a few years the centre of interest of the ichthyologists and it is generally presumed that the main critical period of development which affects the fertility of the individual year-classes in its consequences is the final phase of resorption of the yolk sac, i.e., the period of transition from the endogenous to the exogenous food when the larvae must have a sufficient quantity of suitable food or they perish in masses (Hjort, 1914; Fabre-Domergue et Felix, 1897 — according to Maar, 1956; Soleim, 1942, Ahlstrom, 1954; Balon, 1961 and others). Our experiments, including some of the preceding ones (Peňáz, 1965) testify that the period of an increased sensibility and higher mortality occurs earlier, possibly before the resorption of the yolk sac, which is in the period when the embryonal organs of respiration recede, the oral orifice is broken through and the gill respiration begins, i.e., at the stage when the organism gets into a far more immediate contact with the environment. Particularly in cases when the structure of water is unsatisfactory or if there are increased contents of toxic substances, a higher percentage of mortality can be expected as early as at this stage.

So far only the part of the external factors affecting mortality has been considered. A completely new attitude to these problems is reflected in the papers of Vladimirov and Semenov (1959) and Vladimirov (1964) who criticized the abovementioned axiomatically deep-rooted hypothesis accounting for the mortality of embryos and larvae of fish on the basis of a number of experimental tests, some of them being the experiments of their own, some of them being experimented by other authors. These authors prove that the cause of mortality in the so-called "critical larval period", which occurs towards the end of the resorption of the yolk sac, is not famine, because the resistance against the lack of exogenous food is even at this stage of development of normal and healthy individuals high. The cause of mortality — as Vladimirov sees it — lies in the inner effect, primarily in the realization of defects which took place during the oogenesis

inside the mother's body and in the course of the ovular and embryonal phase of development. The organic defects of parents are therefore passed on to their brood by means of sex products, before all by means of eggs (emphasized by V l a d i m i r o v, 1964), whereby the vitality and mortality of embryos and larvae at certain stages of development are primarily determined.

The results of our experiments which have proved — among other things-that

1. the mortality in the period of the final resorption of yolk sac is not decisive for the genera course of mortality

2. the mortality is independent of the administration of exogenous food which had been in plenty,

fully support the hypothesis of the Kiev ichthyologists on the causes of mass-mortality of fish at early stages of ontogenesis.

SUMMARY

Two females *Leuciscus cephalus* were artificially spawned and samples of eggs fertilized individually by the sperm of 10 different males were put in a special hatching apparatus. The investigation was focussed on the incubation period, the hatching process, rate of growth and mortality of the brood in the individual samples.

The average incubation period in the first series of experiments equalled to 107.3 hours, in the second series to 75.4 hours, there being constant temperature 18.0° C in both cases. The influence of males on the incubation period was not noticed.

The size of hatchlings is in no correlation to their mortality. Yet, if there is any at all, it is rather negative, i.e., the hatched embryos of the greatest lengths are subject to a higher mortality in the further development and the intensity of their growth and development is slower.

The growth of the body-length appears to be quite a good index of quality and vitality of the fish brood for it is in a close dependence on the velocity of development and on the rate of mortality.

In all these indices there were ascertained considerable differences, both when the brood of either females had been compared to each other, i.e., neglecting the influence of males, and when the brood of the same female but different males were compared. So far, however, we have not succeeded in finding out the dependence of the quality of brood either on one of the investigated morphological features or on the age of the males picked out for this experiment. What has been ascertained is a certain dependence on the quality of sperm, especially as far as the results of the microscopical examination are concerned, i.e., the period of active motion of sperms and the participation of pathological and dead sperms.

The percentage of unfertilized eggs attained 1—2%, the mortality in the prenatal period 3.2—20.0%, in the period after hatching up to the transition to the juvenile period of life-history 41.2—100%.

Quite a few discussions were focussed on the hypotheses clarifying the causes of the high mortality of fish at the early stages of development and — based on some results of the experiments — the authors are inclined to share V l a d i m i r o v's and S e m e n o v's hypothesis (1959) suppose

that the inner factors determined for the most part genetically are also some of possible causes of mortality.

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

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SOME SPECIES OF WATER-MITES (HYDRACHNELLAE) FROM MOUNTAIN SEEPAGE-WATERS OF CZECHOSLOVAKIA

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Abstract: The present study contains some new knowledge of the water-mite fauna from mountain and sub-mountain seepage-waters of Czechoslovakia. The studied localities are situated in the *Jizerské*, *Vysoké Tatry* (High Tatra) and *Jeseníky* Mountains in the range of 600—1,400 m above sea level.

In total 15 species of water-mites were collected from 9 seepage-waters; 3 of them are new for Czechoslovak fauna.

This faunistic contribution follows up the extensive hydrachnological investigation performed on the territory of Czechoslovakia by Prof. Dr. F. Láska and the papers on water-mites from the High Tatra Mountains written by Prof. Dr. Szalay and Prof. Dr. Lundblad. It enables to compare the fauna of water-mites from seepage-waters of Czechoslovakia with that of Sweden, Germany, and Great Britain.

The collections from the Jeseníky Mountains were placed to my disposal by Dr. V. Kořínek. I collected the rest of the studied species on the occasion of excursions to the High Tatra (Roháče) and the Jizerské Mountains carried out by the Department of Hydrobiology of the Faculty of Science of Charles University in Prague.

Brief descriptions are given of the specimens of species that are new and rare for our fauna. More common species are listed in a survey of the studied localities.

SURVEY OF LOCALITIES

(1) Jeseníky Mountains (June 18, 1957)
Seepage-water on the Kralický Sněžník, 1,400 m a.s.l.; limnocren with grassy margin. Leg. V. Kořínek.
Species: *Lebertia (Lebertia) longispinerata* Láska, 1953; *Lebertia (Pseudolebertia) tuberosa* Thor, 1914; *Sperchon (Porosperchon) mutilus* Koenike, 1895; *Hygrobates (Rivobates) norvegicus* (Thor, 1897).

(2) Jeseníky Mountains (June 21, 1957)
Seepage-water at Domašov near Malá Bělá, 950 m a.s.l.; stony limnocren. Leg. V. Kořínek.
Species: *Panisus michaeli* Koenike, 1896; *Sperchon (Porosperchon) mutilus* Koenike, 1895; *Sperchon (Porosperchon) glandulosus* Koenike, 1886 — I am including the form *thienemanni* according to Lundblad, 1962; *Lebertia (Pseudolebertia) tuberosa* Thor, 1914; *Hygrobates (Rivobates) norvegicus* (Thor, 1897).

(3) Jeseníky Mountains (June 22, 1957)
Seepage-water near the stream Bělá, 800 m a.s.l.; limnocren in a forest; the out-flow covered with moss and grass. Leg. V. Kořínek.

Species: *Hydrovolzia halacaroides* (Monti, 1905); *Sperchon (Porosperchon) mutilus* Koenike, 1895; *Sperchon (Porosperchon) glandulosus* Koenike, 1886; *Lebertia (Pseudolebertia) tuberosa* Thor, 1914; *Lebertia (Hexalebertia) cuncifera* Walter, 1922; *Hygrobates (Rivobates) norvegicus* (Thor, 1897); *Partnunia angusta* Koenike, 1893.

(4) Vysoké Tatry Mountains (Roháče) (June 14, 1965)
Seepage-water near Zvěrovka Hotel on Studený stream, 1,050 m a.s.l.; rheocren with moss.
Species: *Thyas palustris* Koenike, 1912; *Sperchon (Porosperchon) mutilus* Koenike, 1895; *Lebertia (Pseudolebertia) zschokkei* Koenike, 1902; *Hygrobates (Rivobates) norvegicus* (Thor, 1897).

(5) Vysoké Tatry Mountains (Roháče) (June 14, 1965)
Seepage-water high above Zvěrovka Hotel in a steep slope, 1,100 m a.s.l.; heleocren with stones, moss, grass, and detrital layer.
Species: *Sperchon (Porosperchon) glandulosus* Koenike, 1886; *Lebertia (Pseudolebertia) zschokkei* Koenike, 1902; *Lebertia (Pseudolebertia) tuberosa* Thor, 1914; *Hygrobates (Rivobates) norvegicus* (Thor, 1897); *Feltria setigera* Koenike, 1896.

(6) Vysoké Tatry Mountains (Roháče) (June 18, 1965)
Seepage-water above the village Habovka, 780 m a.s.l.; limnocren below a forest with coniferous trees.
Species: *Parntunia angusta* Koenike, 1893; *Lebertia (Pseudolebertia) zschokkei* Koenike, 1902.

(7) Vysoké Tatry Mountains (Roháče) (June 19, 1965)
Sulphuric seepage-water below the Osobitá Mountain, 850 m a.s.l.; limnocren, stones with moss covered with colloid sulphur. The water smells of hydrogen sulphide.
Species: *Lebertia (Pseudolebertia) tuberosa* Thor, 1914

(8) Jizerské Mountains (October 9, 1965)
Seepage-water in a woody slope above the village Harcov near Liberec, 600 m a.s.l.; heleocren, stones with moss and detrital layer.
Species: *Panisus torrenticolus* Piersig, 1898; *Sperchon (Porosperchon) mutilus* Koenike, 1895; *Sperchon (Porosperchon) glandulosus* Koenike, 1886; *Sperchon (Sperchon) squamosus* Kramer, 1879; *Hygrobates (Rivobates) norvegicus* (Thor, 1897); *A-Thienemannia schermeri* Viets, 1920.

(9) Jizerské Mountains (October 10, 1965)
Seepage-water at the foot of the Ještěd Mountain, 600 m a.s.l.; stony rheocren.
Species: *Protzia invaluaris* s. str. Piersig, 1898; *Sperchon (Porosperchon) mutilus* Koenike, 1895.

COLLECTED SPECIES

Hydrovolzia halacaroides (Monti, 1905)

syn. *Polyxo placophora* Monti, 1905

Distribution: Italy, Sweden, Finland, France, Denmark, Switzerland, Roumania, Great Britain, and Czechoslovakia. Láska mentions in a survey of water-mites that the species was found in Czechoslovakia by foreign authors. The species is new for the territory of Moravia.

I found one single specimen of a male insect. This water-mite is characteristic of seepage-waters at higher altitudes where there is a low water temperature throughout the whole year.

Thyas palustris Koenike, 1912 (Fig. 1)

syn. *Thyas rivalis* Koenike, 1912.

A new species of water-mites for our territory is identical with *Thyas rivalis* Koenike, 1912 according to Lundblad, 1962.

Up to the present, 4 species of this genus and 1 sub-species were recorded in Czechoslovakia; 2 of these in Slovakia (from where there my finding): *Thyas barbigera* Viets, 1908 and *Thyas pachystoma* Koenike, 1914.

Length of the taken female 1008 μm, width 765 μm. Length of the roundet frontal platelets 72, 99, and 54 μm. Length of the genital field 288 μm.

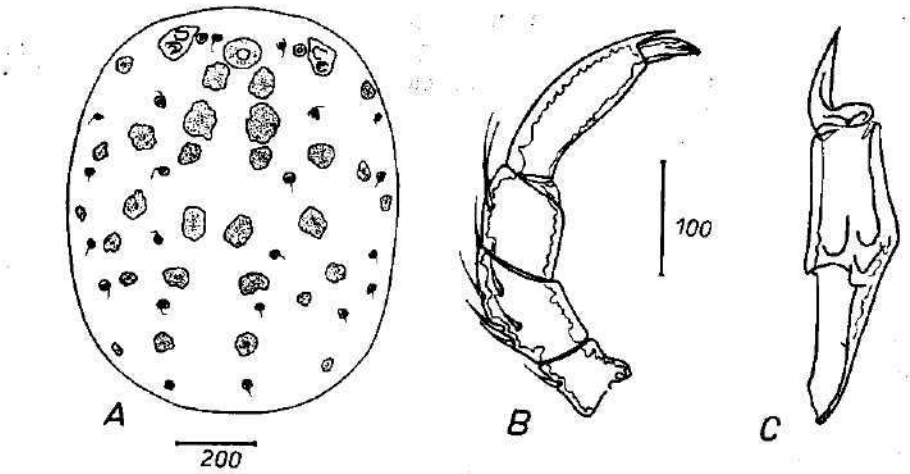

Fig. 1. *Thyas palustris* K o e n i k e, 1912 (female)
A — dorsal surface of body; B — right palp; C — mandible.
The numbers in μm. Orig.

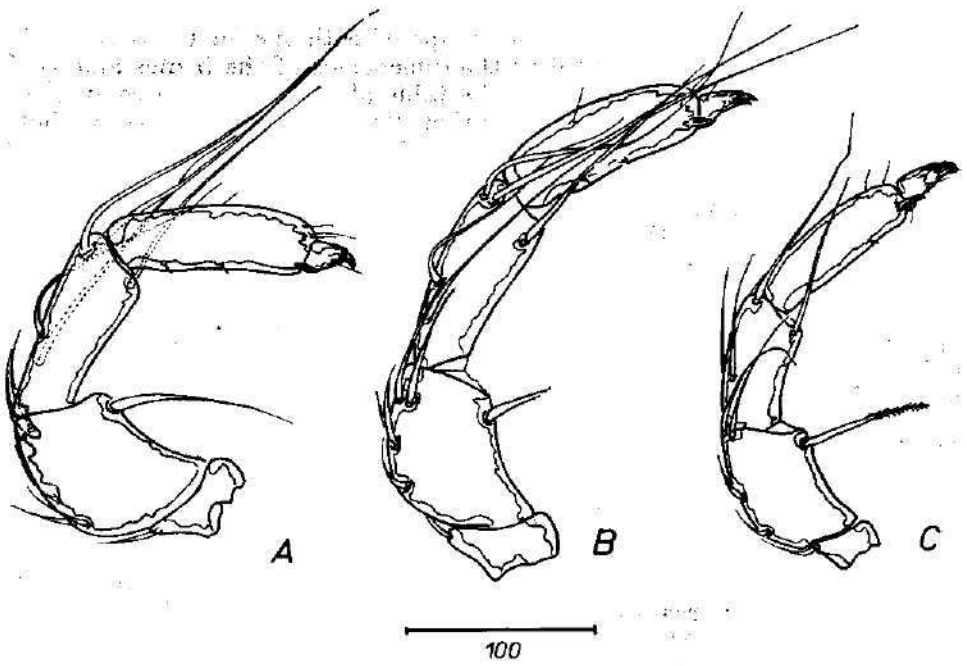

Fig. 2. *Lebertia longiepimerata* L á s k a, 1953 (female)
A — right palp; B — left palp
Lebertia pusilla K o e n i k e, 1911 (female)
C — left palp.
The numbers in μm. Orig.

The 3rd and the 4th genital acetabulum are only slightly oblique below one another. Palps very large, strongly chitinized; dorsal lengths of the single segments: 62, 108, 60, 160, and 44 μm. The length of the 4th segment of the palps is given together with the dorsal tubercle on the distal end.

Distribution: Germany, Sweden, Czechoslovakia.

Partnunia angusta Koenike, 1893

syn. *Partnunia steinmanni* Walter, 1906

The species was found in Slovakia (Láska, 1953) and Moravia (Láska, 1956) under both names. It was also recorded from the High Tatra Mountains by Szalay, 1956. The species represented in great numbers the only fauna of water-mites on locality Nr. 6, with the exception of *Lebertia (Pseudolebertia) zschokkei* Koenike, 1902.

Distribution: Switzerland, France, Germany, Austria, Roumania, Italy, Hungary, and Czechoslovakia.

Lebertia (Lebertia) longiepimerata Láska, 1953 (Fig. 2A–C)

This species was described from the Jeseníky Mountains in Czechoslovakia. The author mentions in his original description (Láska, 1953) that it is near to the species *Lebertia (Lebertia) pusilla* Koenike, 1911. The female insect that I collected also resembles this species and at the same time differs from description of *Lebertia (Lebertia) longiepimerata* Láska, 1953.

I am including the pictures of the palps of both species to compare the differences (Fig. 2A–C), as well as the dimensions of the bodies and some additional characteristics (Tab. 1). The table also contains the comparison with the original data of the description. The most conspicuous in both species is the size, which is substantially different. In the specimens that I found there are differences from the holotype particularly in the construction of the palps, as well as in the length of the sutures of the 1st and 2nd epimerite and in the dimensions of the epimeral region. The feeling pores are well visible on the lower part of the 4th segment of the palps; the distal hairs of the 3rd segment of the palps extend far behind the ter-

Table 1. Comparison of the dimensions of the characteristic features of *Lebertia pusilla* Koenike, 1911 and *Lebertia longiepimerata* Láska, 1953 as well as the differences from the original description. The data are given in μm. The number in parentheses stand for the data on the holotype.

	Lebertia pusilla Koenike, 1911	*Lebertia longiepimerata* Láska, 1953
Length of epimerites	576	648 (700)
Width of epimerites (body width)	441	522 (480)
Body length	648	720 (834)
Fusion of the 1st pair of epimerites	117	189 (160)
Median suture of the 2nd pair of epimerites	153	153 (190)
Width of the end of the 2nd pair of epimerites	36	24 (25)
Dorsal lengths of the segments of the palps	28, 72, 68, 88, 36	36, 100, 102, 108, 28 (27, 104, 100, 110, 34)

mination of the 5th segment. The longest is the distal medial hair, which measures 324 μm. The length of the fusion of the 1st pair of the epimerites is larger than the median suture of the 2nd pair.

Lebertia (Lebertia) longiepimerata Láska, 1953 was found for the second time in the region of the original description. As the genus *Lebertia* Neuman, 1880 has a great variability, it is impossible to make valid conclusions about the classifications of this species on the basis of several specimens.

Lebertia (Pseudolebertia) tuberosa Thor, 1914

A species found in our country (in the Krušné Mountains, Jeseníky Mountains, High Tatra Mountains — Liptovské Hole) by Láska, 1955 and 1957. Noteworthy is its occurrence on locality Nr. 7, where it represented the only fauna of water-mites in the out-flow of sulphuric seepage-water. I collected the specimens from flocks of eliminated colloid sulphur on moss phylloids.

Distribution in Europe: USSR (Caucasus), Germany, Roumania and Italy.

Lebertia (Hexalebertia) cuneifera Walter, 1922 (Fig. 3A, B)

A new water-mite for the fauna of Czechoslovakia. I found a single specimen, a female. It is the ninth species of this sub-genus which occurred on

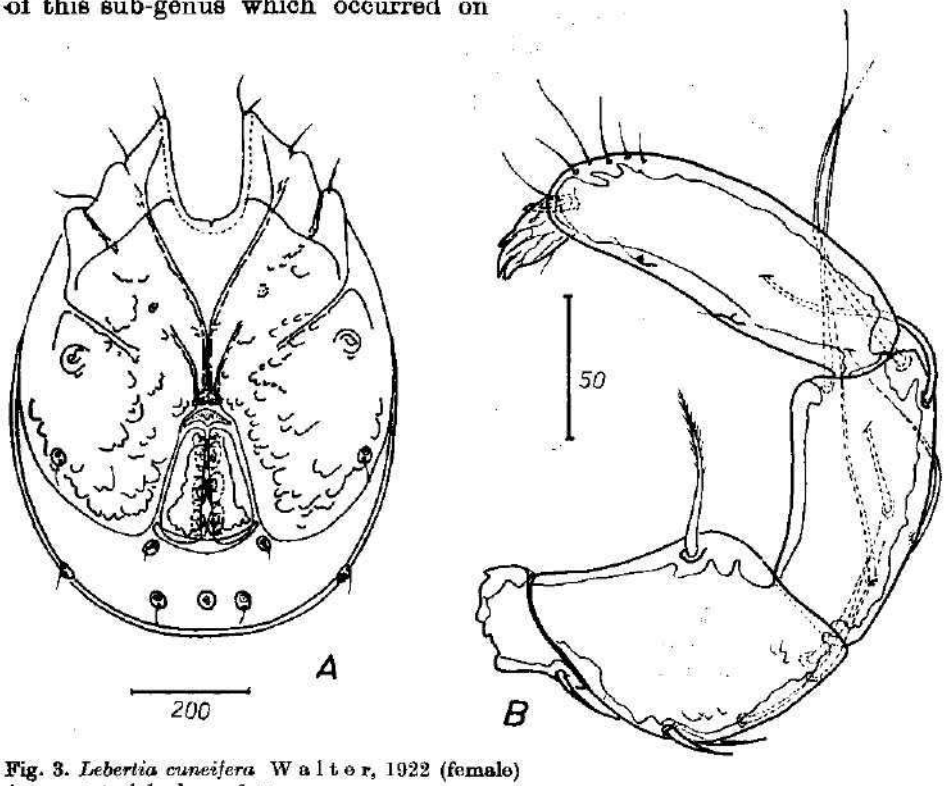

Fig. 3. *Lebertia cuneifera* Walter, 1922 (female)
A — ventral body surface
B — left palp. The numbers in μm. Orig.

the territory of Czechoslovakia. The finding of the subgenus *Hexalebertia* Thor, 1906 is characteristic of the fauna inhabiting seepage-waters. This is confirmed by Viet's (1920 and 1925) collections from German and Swedish seepage-waters. A brief description of the collected female:

Body length with the exceeding 1st pair of the epimerites 648 μm. The fusion of the 1st pair of epimerites is longer than the median suture of the 2nd pair (171 : 99 μm). The depth of the incision for the maxillar organ is 117 μm. On the sides of the outlet of the excretory organ, which is more sclerotized in the posterial part, are the sclerotized pores of 30 μm in diameter. Similar, but much smaller pores are on the sides of the posterial termination of the genital field (diameter 20 μm). The first segment of the 4th pair of feet has 4 thorns on the dorsal side of the distal half; one of them is in about the middle, two of them are placed in the proximate half. Two thorns are also on the ventral side in the distal half. In total, there are 9 thorns on the 1st segment.

The dorsal length of the palps measures 412 μm (of individual segments: 32, 96, 96, 132, and 40 μm). The 4th segment of the palps has 2 marked feeling pores on the lower part of this segment 38 μm from one another.

To the above distribution in France, Switzerland, Germany, and Austria, we may add Czechoslovakia.

Feltria setigera Koenike, 1896 (Fig. 4)

This rare water-mite was recorded on our territory as *Feltria georgei* Piersig, 1899, in Slovakia in the High Tatra Mountains (in Viets, 1925). The one I collected is the second specimen for Czechoslovakia. Body length with the epimerites of the 1st pair 446 μm, without the 1st pair 396 μm. Body width 324 μm. Dorsal lengths of the segments of the palps: 20, 56, 32, 76, 48 μm. Noteworthy is the structure of the 4th segment of the palps. (Fig. 4). Seven species of this genus were found in Czechoslovakia.

Distribution: Germany, France, Roumania, Poland, Italy.

A-*Thienemannia schermeri* Viets, 1920 (Fig. 5)

A species new for the fauna of Czechoslovakia.

A typical cold-stenotherm species from seepage-waters; I found a single female in moss and detritus on the locality in the Jizerské Mountains. A brief description of the collected female: The strongly sclerotized, somewhat dorsoventrally flattened body is broadly oval-shaped. Length 697 μm, width 612 μm. The dorsal shield is 648 μm long, 540 μm wide. The genital field is rounded, the width (188 μm) is larger than the length (148 μm). The maxillar organ with a short rostrum, mandibles very strong. Their distal claw bent, large in relation to the basal part. Dorsal length of individual segments of the palps: 36, 80, 52, 92, 34 μm.

Colour of the body brownish-red with several lighter spots on the dorsal surface.

Distribution: Germany, Holand, Denmark, Sweden, Great Britain, and Roumania.

The other collected species are given together with each of the localities.

SUMMARY

Fifteen species of water-mites were collected from 9 seepage-waters in Czechoslovakia. All species, except for *Sperchon (Porosperchon) mutilus* Koenike, 1895 are typical of the fauna of water-mites (Hydrachnellae)

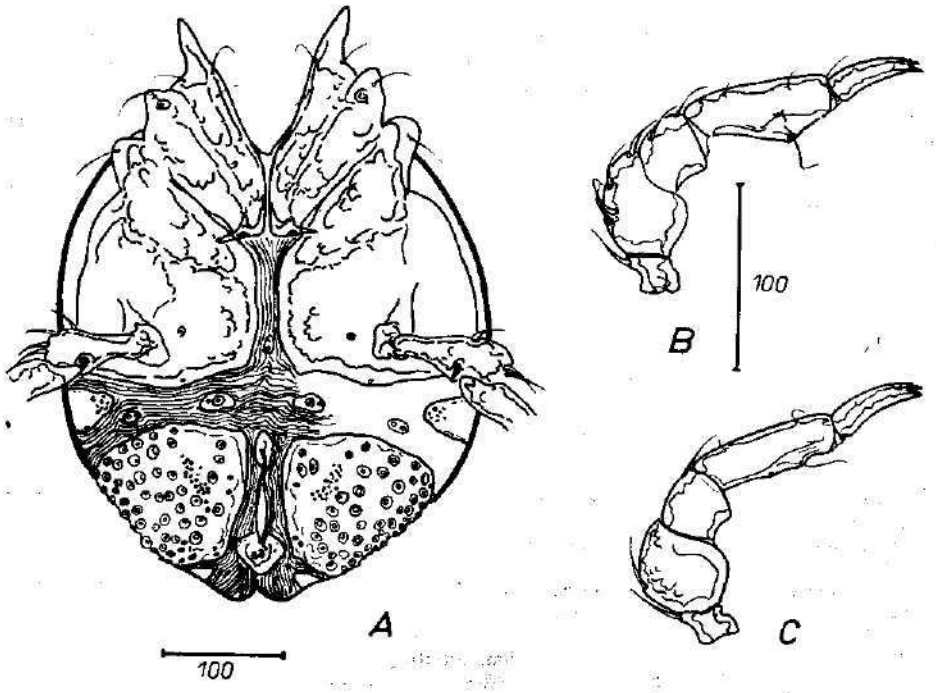

Fig. 4. *Feltria setigera* K o e n i k e, 1896 (female)
A — ventral body surface; B — right palp; C — left palp.
The numbers in µm. Orig.

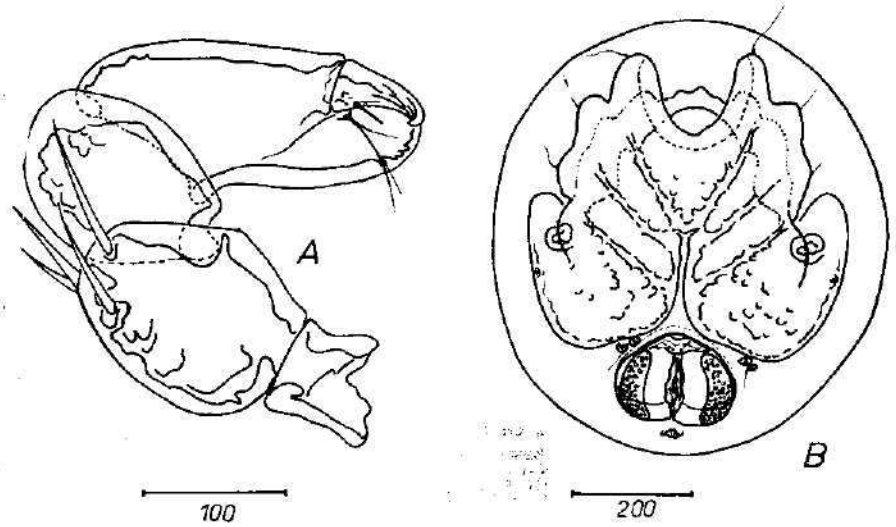

Fig. 5. *A-Thienemannia schermeri* V i e t s, 1920 (female)
A — left palp; B — ventral body surface. The numbers in µm. Orig.

from seepage-waters, which were also recorded from other countries (Germany and Sweden — Viets, 1920 and 1925; Sweden — Lundblad, 1956 and 1962; Gledhill, 1960 from Great Britain).

Three species are new for Czechoslovakia: *Thyas palustris* Koenike, 1912; *Lebertia (Hexalebertia) cuneifera* Walter, 1922 and A-*Thienemannia schermeri* Viets, 1920.

The species *Feltria setigera* Koenike, 1896 and *Lebertia (Lebertia) longiepimerata* Láska, 1953 were found in Czechoslovakia for the second time. *Hydrovolzia halacaroides* (Monti, 1905) is a new species for Moravia.

The collected female *Lebertia (Lebertia) longiepimerata* Láska, 1953 differs from the original description and further work with more material ought to clarify its classification.

Noteworthy is the finding of *Lebertia (Pseudolebertia) tuberosa* Thor, 1914 in the eliminated colloid sulphur in the outlet of sulphuric seepage-waters in the High Tatra Mountains.

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FINDINGS OF TREMATODES (TREMATODA) IN WILD BIRDS OF CZECHOSLOVAKIA

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Abstract: Eight trematode species were found and described for the first time in Czechoslovakia: *Leucochloridiomorpha lutea* (Baer, 1827), *Schistogonimus rarus* (Braun, 1901), *Leyogonimus polyoon* (Braun, 1902), *Eucotyle zakharovi* Skrjabin, 1920, *Cyclocoelum brasilianum* (Stossich, 1829), *Parastriega robusta* (Szidat, 1928), *Diplostomum sudarikovi* Schigin, 1960, *Neodiplostomum perlatum* (Ciurea, 1911). On the grounds of our material the species *Leucochloridiomorpha skrjabini* Chaziev, 1964 was identified as a synonym of the species *Leucochloridiomorpha lutea* (Baer, 1827).

The study of trematodes parasitic in wild birds of Czechoslovakia received little attention until 1950. The first comprehensive studies on this topic were published by Vojtěchovská-Mayerová, 1953; Ryšavý, 1957, 1960; Macko, 1956, 1960a—c, 1961, 1963; Zajíček Páv, 1961, 1962, 1963; Baruš, Lelek, 1961; Kopřiva, Tenora, 1961; Tenora, Lusk, 1960; Škarda, 1964; Vojtek-Vojtková, 1961.

The paper presents our findings of trematodes from birds, which have not yet been described from Czechoslovakia. In this investigation, performed in the years 1962—1964, we examined 84 birds belonging to 39 species. Most of the material was obtained from localities in southern and central Moravia except a small portion, which was collected during an excursion to Komárno in southern Slovakia.

1. *Leucochloridomorpha lutea* Baer, 1827 — Fig. 1, 2, 7

Host: *Anas platyrhynchos* (L.)
Location: Bursa Fabricii
Locality: Strachotín, Komárno
Geographical distribution: Europe, North-America

This species was recorded by Allison (1943) from North-America, by Smogorževskaja (1956) from the European part of the U.S.S.R. and by Voelker (1963) from Germany.

Description: Trematodes of a small size. Body ovoid, length 0.572 to 1.437 mm, width 0.353—0.753 mm. Very attenuated towards the oral suckers. Cuticle fine without cuticular spines. Suckers well developed. Ventral sucker strikingly large, oral sucker up to 2.8-times smaller. Measurements of oral sucker 0.303—0.681 by 0.278—0.631 mm. Prepharynx not present. Pharynx distinct, size 0.059—0.100 by 0.052—0.093 mm. Esophagus short. Caecal branches bifurcating close behind the pharynx and extending to the anterior, sometimes even to the posterior end of the testes (Fig. 1a—d). Testes equal, moderately oval, seldom spherical, situated at the end of the body. Measurements 0.067—0.230 by 0.056—0.186 mm. Genital pouch placed behind the testes, size 0.052—0.130 by 0.045 to 0.111 mm. Vitellaria at the

level of the posterior end of the pharynx; their termination is variable, sometimes they reach the mid-line, sometimes the end of the ventral sucker (Fig. 2a—d). Uterus with eggs highly developed, extending from above the ventral sucker to far below it, sometimes covering even part of the testes. Size of eggs 0.033 by 0.015 mm. Ovary oval till spherical, size 0.049—0.100 by 0.089—0.174 mm, situated slightly above the testes.

Comparisonf of the measurement of *Leucochloridiomorpha lutea* (Baer, 1827) with *Leucochloridiomorpha skrjabini* Chaziev, 1963.

Species	*Leucochloridiomorpha lutea* (Baer, 1827)			*L. skrjabini* Chaziev, 1963
Author	Smogorževskaja, 1954	Allison, 1943	our findings	Chaziev, 1963
Body length	0.694—0.737	1.232—1.814	0.572—1.437	1.44—1.49
Body width	0.348—0.406	0.570—0.846	0.353—0.757	0.65—0.69
Oral sucker	0.107—0.129 × 0.124—0.127	0.190—0.215	0.139—0.207 × 0.122—0.297	0.18—0.23
Pharynx	0.043—0.051 × × 0.086	0.061—0.092	0.059—0.100 × 0.052—0.093	0.09
Ventral suck.	0.318—0.330 × 0.310—0.320	0.354—0.569	0.303—0.681 × 0.278—0.631	0.32—0.37
Testes	0.103—0.073 × × 0.086	0.171—0.276 × 0.087—0.194	0.067—0.230 × 0.056—0.0186	0.13—0.14
Ovary	0.043—0.064 × 0.060—0.064	0.105—0.169	0.049—0.100 × 0.089—0.174	0.10—0.13
Cirrus pouch	0.043—0.086	0.114—0.145 × 0.048—0.081	0.052—0.130 × 0.045—0.111	0.02—0.08
Ova	0.021—0.024 × 0.010—0.016	0.032×0.013	0.033×0.015	0.037×0.018

At the present, the genus *Leucochloridiomorpha* (Gower, 1938) received two species, the species *L. skrjabini* Chaziev, 1963 described from *Anas clypeata* (L.) and the species *L. lutea* Baer, 1827 described from *Anas rubripes*. Tab. 1 comparing the measurements given by Smogorženskaja (1954), and Allison (1943) for the species *L. lutea* with our data and those of Chaziev (1963) for the species *L. skrjabini*, shows very littel differences. Chaziev (1963) distinguished both species by their shape and the extent of the vitellaria, the length of the intestinal branches, the number of uterine loops and the shape of the testes.

Our studies of 50 specimens showed that all morphological signs are most variable (Fig. 2a—d, 3a—d) and are, therefore, not suitable to be taken for differentiating features. I suggest, therefore, to place the species *Leucochloridiamorpha skrjabini* Chaziev, 1963 in synonymy with the species *L. lutea* (Baer, 1827).

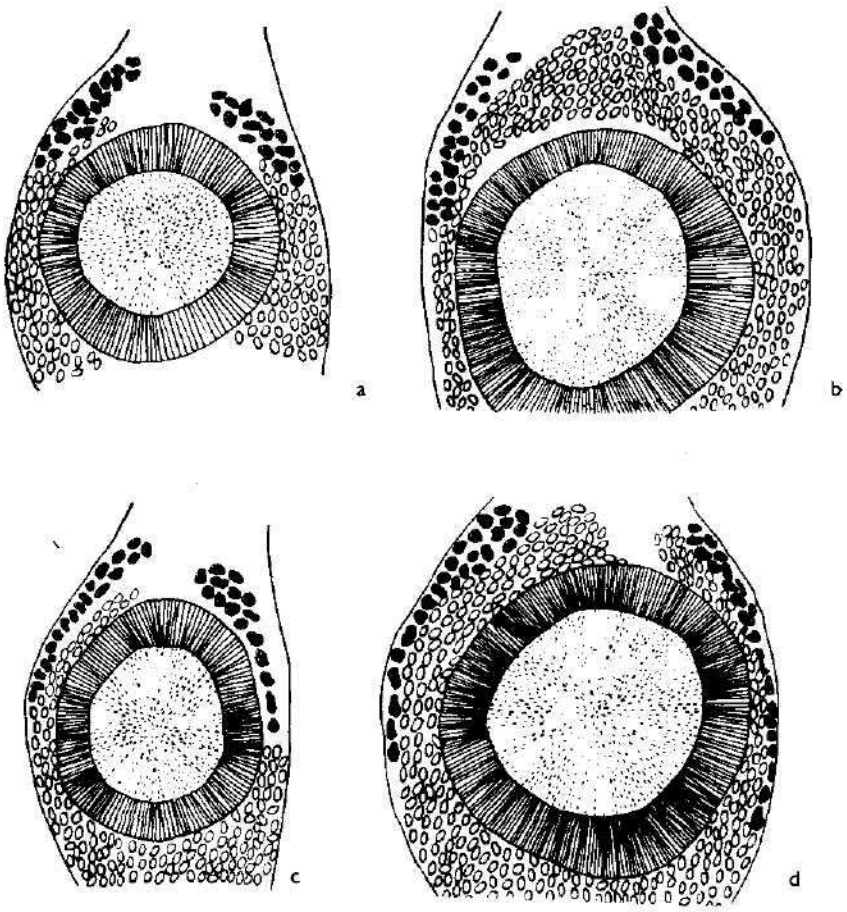

Fig. 1a—d. Variability in the position of the vitellaria; species *Leucochloridiomorpha lutea* (Baer, 1827).

2. *Schistogonimus rarus* (Braun, 1901) — Fig. 4

Host: *Anas platyrhynchos* (L.)
Location: Bursa Fabricii
Locality: Komárno
Geographical distribution: Europe, Asia.

Found in Poland (Sulgostowska, 1956), in the U.S.S.R. (Bychovskaja-Pavlovskaja, 1962), in Central Europe (Lühe, 1909).

Description: Overall length 3.48—4.68 mm, width 3.03—3.24 mm, anteriad conical, posteriad extended and rounded. Cuticle sparsely covered with cuticular spines. Suckers well developed. Ventral sucker situated at approximately the border of the first and second third of the body. Oral sucker 0.435—0.499 mm long and 0.503—0.517 mm wide. Ventral sucker 0.517—0.599 by 0.544—0.612 mm, situated relatively far from the bifurcating caecum. Pharynx muscular, size 0.177—0.313 by 0.218—0.231. Esophagus

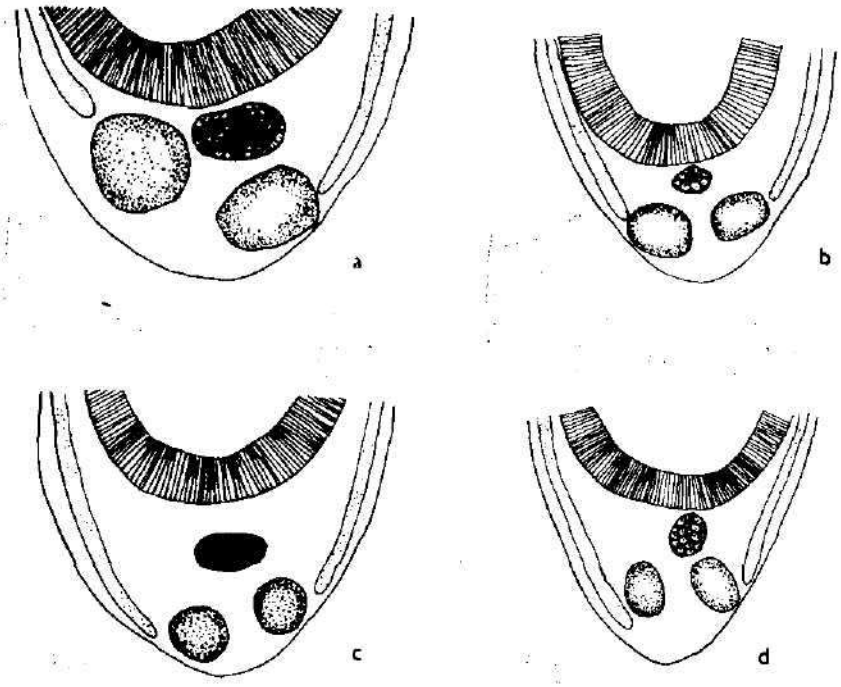

Fig. 2a—d. Variability in the extent of the caecal branches and in the position of the sexual organs species; *Leucochloridiomorpha lutea* (Baer, 1827).

0.068—0.163 mm long. Caecal branches extend perpendicular to the edge of the body, along it and past the testes, turning to the median line without reaching the end of the body. Testes very lobate, juxtaposed. Genital pouch narrow, long, with thick walls proceeds close to the pharynx and esophagus and opens into a small lateral elevation next to the oral opening. The female genital pore opens close to the male genital pore on the lateral margin of the body approximately at the level of the posterior end of the oral sucker. Ovary very lobate. Vitellaria, situated mostly on the ventral side of the body, start close above the ventral sucker and end below the testes. Uterus forms numerous loops above the ventral sucker, but these do not reach below the caecal branches. Eggs oval, size 0.0126 by 0.0042 mm.

3. *Leyogonimus polyoon* (Braun, 1902) — Fig. 3

Host: *Fulica atra* (L.)
Locality: Small intestine
Location: Strachotín
Geographical distribution: Europe, Asia

Found in Central Europe (Lühe, 1910), France (Dollfus, 1915), U.S.S.R. (Bychovskaja-Pavlovskaja, 1962).
Description: Small trematodes, overall length 0.95—1.13 mm, width 0.475—0.558 mm. Oral sucker terminal, size 0.060—0.070 by 0.054 to 0.060 mm. Ventral sucker 0.081 by 0.084 mm. Testes oval, 0.243—0.285 mm

long, 0.105—0.135 mm wide. Ovary very lobate, situated above the ventral sucker. Vitellaria, forming a relatively large aggregation above the sucker, do not reach the pharynx. The uterine loops occupy the complete space between the ventral sucker and the posterior end of the body. Eggs 0.024—0.012 mm.

4. *Eucotyle zakharovi* Skrjabin, 1920 — Fig. 10

Host: *Anas platyrhynchos* (L.)
Location: Kidneys
Locality: Napajedla
Geographical distribution: Europe, Asia

Found in Poland (Sulgostowska, 1958), U.S.S.R. (Bychovskaja-Pavlovskaja, 1962).
Description: Overall length 3.23—4.44, width 0.53—0.88 mm. Anterior end of body triangular with rounded edges, separated from the rest of the body by a muscular mound. Width of body at the level of the muscular mound 0.56—0.76 mm. Oral sucker subterminal, spherical, size 0.24—0.30 by 0.18—0.25 mm. Ventral sucker not present. Testes juxtaposed, placed in mid-body, occupy the whole width from one margin to the other, touching on the median line. Pharynx oval, 0.11—0.16 by 0.10—0.15 mm. Esophagus well developed, length 0.34—0.40 mm. Ovary above the testes, size 0.09 by 0.37 mm in length and 0.127—0.141 mm in width. Vitellaria starting at a distance of 0.43—0.73 mm from anterior end, terminate at a distance of 1.70—2.58 mm from anterior end; the termination of the testes never surpasses the margin of the body. The well developed uterus occupies the whole space below the testes. Its anterior portion reaches the muscular mound. Eggs measure 0.033—0.045 by 0.016—0.020 mm.

5. *Cyclocoelum brasilianum* Stossich, 1829 — Fig. 9

Host: *Tringa erythropus* (Pall.)
Location: Air sacs
Locality: Záhlinice
Geographical distribution: Europe, Asia, America

Found in India (Khan, 1935), Japan (Yamaguti, 1958), U.S.A. (Harrah, 1922), Venezuela (Caballero et Diaz-Unguria, 1958), Brasil (Stossich, 1892).
Description: Body anteriad attenuated, posteriad rounded. Overall length 7—9 mm, width 2.57—3.29 mm. Oral and ventral sucker not developed. Oral opening funnel-shaped, subterminal, followed by the muscular pharynx, size 0.193 to 0.252 by 0.252—0.277 mm. Prepharynx moderately developed. Esophagus slightly S-shaped with a distinct musculature. Intestinal branches parallel along the margin of the body, joining below the testes. Testes spherical, almost of equal size. Measurements 0.479—0.655 by 0.420—0.655 mm, situated in posterior portion of the body. The left testis slightly above the right testis. Ovary spherical, sometimes of equal size with the testes, sometimes only half their size. Measurements 0.227—0.487 by 0.210—0.353. Mehlis' gland 0.378 mm long and 0.277 mm wide. Genital pouch present, extending to half the distance between the pharynx and the bifurcation of the caecum. Vitellaria start below this bifurcation, pass along the margin of the body and end below the testes without joining. The well

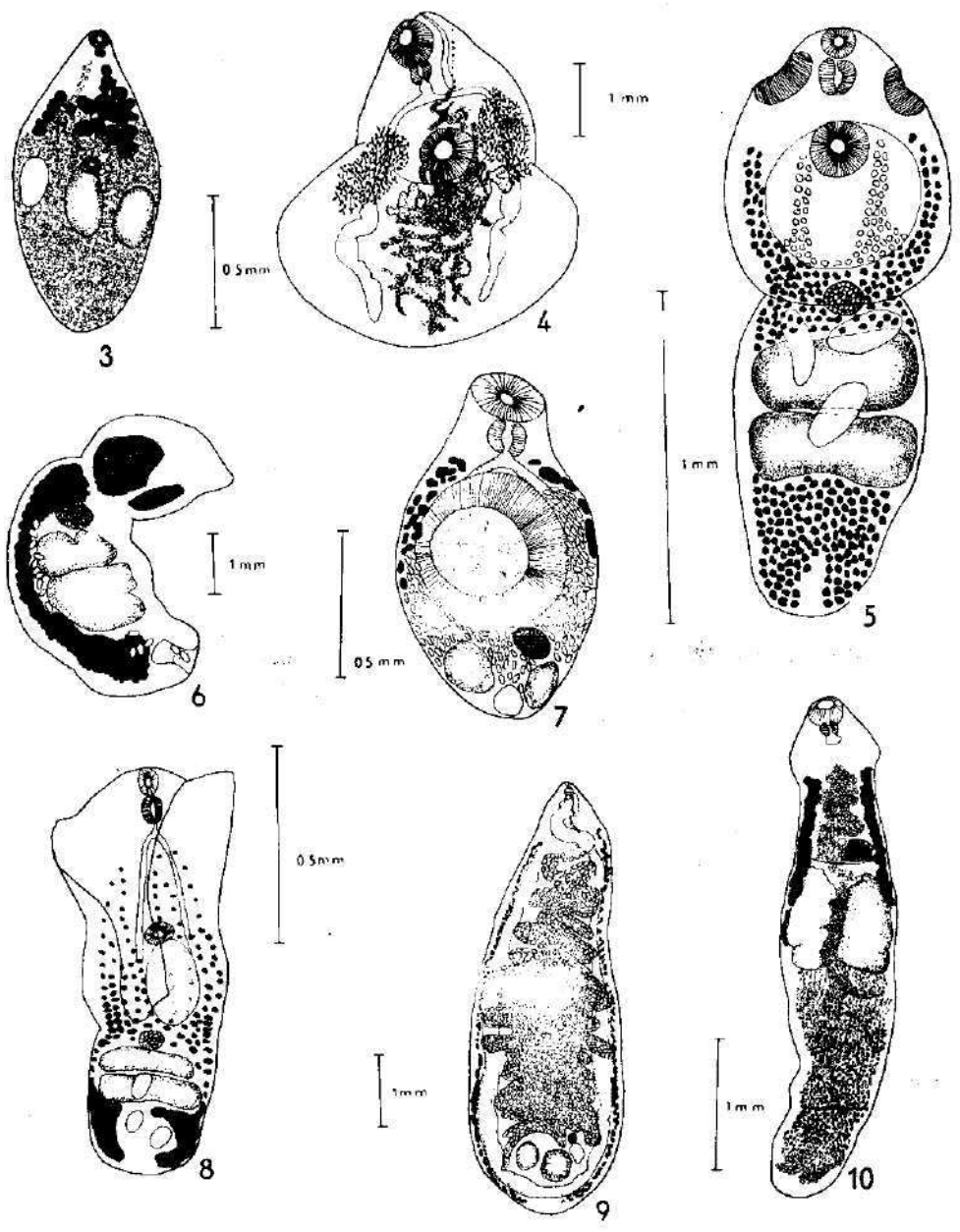

Fig. 3. *Leyogonimus polyoon* (Braun, 1902). **Fig. 4.** *Schistogonimus rarus* (Braun, 1901). **Fig. 5.** *Diplostomum sudarikovi* (Schigin, 1960). **Fig. 6.** *Parastrigea robusta* (Szidat, 1928). **Fig. 7.** *Leucochloridiomorpha lutea* (Baer, 1827). **Fig. 8.** *Neodiplostomum perlatum* (Ciurea, 1911). **Fig. 9.** *Cyclocoelum brasilianum* (Stossich, 1829). **Fig. 10.** *Eucotyle zacharovi* (Skrjabin, 1924).

developed uterus covers partly the vitellaria, starting below the bifurcation of the caecum and extending to about the mid-testes. Eggs oval with thin shells contain a miracidium. Size 0.129—0.148 by 0.067 to 0.077 mm.

6. *Parastrigea robusta* Szidat 1928 — Fig. 6

Host: *Anas platyrhynchos* (L.)
Location: Intestine
Locality: Strachotín
Geographical distribution: Europe, Asia

Found in the U.S.S.R. (Bychovskaja-Pavlovskaja, 1962), Germany (Sprehn, 1930).
Description: Overall length 2.53—3.84 mm. Anterior portion pear-shaped, length 1.05—1.44 mm, width 0.78—1.23 mm. Posterior portion oval, length 1.53—2.40 mm, width 0.75—1.32 mm. Oral sucker, pharynx and ventral sucker not visible on the fixed material. Ovary spherical placed close under the first portion measures 0.155—0.327 mm in length and 0.234—0.409 mm in width. Testes asymmetric, the anterior slightly smaller then the posterior. Measurements of anterior testis 0.409—0.500 mm in length and 0.500—0.637 mm in width, posterior testis 0.318—0.628 by 0.491—0.791 mm. Vitellaria distinctly developed, present in both portions of the body. In the anterior portion they form two large groups that cover completely the oral sucker, pharynx and ventral sucker. In the posterior segment they extend to the end of the body. Eggs small, oval, not numerous, size 0.117 . 0.0819 mm.

7. *Diplostomum sudarikovi* Shigin, 1960 — Fig. 5

Host: *Ardea cinerea* (L.)
Location: Small intestine
Locality: Komárno
Geographical distribution: Europe

Found in the European part of the U.S.S.R. by Shigin (1960) (ex. Skrjabin, 1960).
Description: Overall length of body 0.597—0.920 mm. Body clearly divided into two portions. The anterior longer portion measuring 0.420—0.546 by 0.353—0.469 mm, is leaf-shaped, slightly attenuated towards the anterior end. The posterior portions is shorter or of the same size, mostly oval in shape, measurements 0.200—0.546 by 0.202—0.327 mm. Oral sucker mostly spherical, sometimes oval, size 0.056—0.071 by 0.067—0.078 mm. Pharynx well developed with thick walls, size 0.052 to 0.067 by 0.030—0.056 mm. Ventral sucker placed in the centre of the first portion, slightly larger than the oral sucker, often covered by the holdfast organ. Oral sucker 0.074—0.100 by 0.093—0.100 mm, holdfast organ 0.167—0.278 by 0.189—0.234 mm. Anterior testis oval 0.063—0.088 by 0.218—0.252 mm, posterior testis of the same shape but slightly bigger, 0.089—0.100 by 0.227—0.253 mm. Ovary oval or moderately spherical, situated at the anterior end of the posterior portion slightly laterally from the median line, partly covered by the anterior portion. Measurements 0.067—0.100 by 0.067 mm. Vitellaria well developed, forming 4 cordons above the ventral sucker and concentrating even below the testes in the posterior portion. Eggs not numerous (1—3), size 0.100—0.110 by 0.093 mm.

8. *Neodiplostomum perlatum* (Ciurea, 1911) — Fig. 8

Host: *Falco cherrug* (L.)
Location: Small intestine
Locality: Strachotín
Geographical distribution: Europe, Asia

Found in the U.S.S.R. (Bychovskaja-Pavlovskaja, 1962). Description: Overall length 1.451—1.953 mm. The two portions of the body are separated by an indistinct line, which could not exactly be demonstrated. The lateral margin of the anterior portion is turning over at the ventral side and covering part of the holdfast organ. The anterior portion is widest at the level of the pharynx (0.578—0.663 mm) downwards attenuated. The posterior portion is short and almost as wide as long. Measurements 0.378—0.589 mm. It is distinctly shorter than the anterior portion. Oral sucker oval, 0.082—0.111 by 0.070—0.093 mm. Pharynx of approximately the same size as the oral sucker, 0.078—0.111 by 0.052—0.107 millimetres. Holdfast organ elliptic, situated in the posterior half of the anterior portion, size 0.204—0.362 by 0.126—0.200 mm. Ventral sucker smaller than oral sucker, size 0.052—0.078 by 0.070—0.093 mm. Ovary relatively small situated median at the border of both portions. Size 0.152 by 0.241 mm. Vitellaria very fine, starting at the level of the caecal bifurcation and terminating at the end of the posterior portion, being most developed at the border of both portion. Testes widely oval, asymmetric, the posterior slightly larger than the anterior testis, size 0.126 by 0.338—0.367 millimetres. Eggs 0.082—0.096 by 0.056—0.062 mm.

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THE FECUNDITY OF PERCH, PERCA FLUVIATILIS (LINNAEUS, 1758) IN THE KLÍČAVA WATER RESERVOIR

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A b s t r a c t : This work should contribute to recognition of the perch reproduction biology in the water reservoir at Klíčava. The data about fecundity, the period of the sexual maturation as well as data concerning the ripeness coefficient of the sexual glands of males and females are being shown here.

An average absolute fecundity of 14,127 eggs was stated at 61 females taken between April 23rd and May 1st 1964, of body-lenght 115—330 mm, body-weight 40—1,103 g.

INTRODUCTION

To the important questions of the present ichthyology belongs the determining of the common-fish fecundity. This, as a significant quality of species, is one of the indicators of existence conditions of fish population in the reservoir. Good existence conditions make quicker growing possible, which causes earlier sexual maturation and raised fecundity.

The perch is the most numerous component of ichthyofauna in Klíčava waters. In 1963 its population was appraised at 65,043 bodies in the total weight of 2,846.3 kg (H o l č í k, 1967) The Klíčava reservoir lies near the village of Zbečno west from Prague. Its average extension comes to 67.2 ha and its volume is about 9.5 mil. cubic meter of water. The depth is on the most of the places 15—20 m. The most numerous species are the perch *(Perca fluviatilis)*, the roach *(Rutilus rutilus)*, and the rudd *(Scardinius erythrophthalmus)*. More detailed data about the reservoir are to be found in the work by O l i v a and H o l č í k (1965).

MATERIAL AND METHOD

The fecundity of 46 females taken on 23rd of April, 1964 and of 15 females taken on 1st of May, 1964, i.e. of 61 perch females, was determined by the help of the gravimetric method. The values of the gonad ripeness coefficient were acquired by the research of 201 females (out of which 19 had not been sexually matured) and 79 males. The total was captured by a net. The fishes were handled roughly after a month's fixation with the help of 4% solution of formalin. They were weighed with a precision of 0.1 g. To determine their age the scales were taken away from the first row under the side line, oblique to the tail from the first rays of the belly fin. Prepared and preserved gonads were relieved of the superfluous water between the sheets of filtering paper and weighed with a precision of 0.01 g. From the various parts of the ovary 3 samples of eggs were taken away in the weight of 1—2 g. Out of this quantity I got the number of eggs. By the help of this number and of the whole gonad's weight I fixed a proportion serving for calculation of the absolute fecundity. The relative fecundity I expressed in relation of 1g to the total weight of a body. The average size of one egg I obtained by measuring 50 eggs in an iron gutter with fixed scale. I further researched ripeness coefficient values of males and females. The ripeness coefficient I expressed as a relation between the weight of gonad and the total weight of a body percentually to the body-weight.

RESULTS

a) The spawning of perch

The perch is the first fish to spawn soon after the ice melting not to speak of the pike. Its spawning occurs to the end of April and early May. Males secreting milt shoaled on the spawning-places already several days before the very beginning of spawning. A considerable majority of males kept up even in the first days of spawning. Only later in the time of mass spawning the relation between sexes equalled. Young males were thought to spawn first with the old females, on finishing the spawning it was the contrary. The first milted eggs were found on April 23rd at water temperature of 8° C. The temperature was measured 20 cm under the water-level. On May 3rd the spawning was already finishing (water temperature 11° C) and on May 9th altogether outspawned fish were caught. The milted eggs were found near the banks, on the most within 1 m depth. The maximum depth in which eggs were found was about 4 m. But this find was only unique and, moreover, found eggs were evidently unmilted and in decay. The perch preferred quiet, especially leeward waters for spawning. Creamy ribbon-like egg cords were laid mostly on the underwater stumps, but also on stones and aquatic flora. Very often the spawning was carried out over the nets used for catch.

b) The sexual maturation

The perch female is matured in the second year of life when it spawns for the first time. The smallest matured female was 115 mm long and weighed 40 g. The ovary ripeness coefficient was 20.23% and the absolute fecundity 6,993 eggs. The perch male matures already in its first year of life. The smallest sexually matured one-year-old male measured 75 mm, weighed 8.9 g and the testicles ripeness coefficient was 5.94 %. Both bodies were taken on April 23rd.

c) The fecundity

At 61 perch females of body-length 115—330 mm and the body-weight 40—1,103 g, with a minimum of 6,710 and a maximum of 144,000 eggs, was stated an average absolute fecundity of 14,127 eggs. An average relative fecundity was 130 eggs/1 g with a minimum of 91 eggs/1 g and a maximum of 317 eggs/1 g. The highest absolute fecundity of 144,000 eggs was stated at an eight-year-old female of body-length 330 mm and body-weight 1,103 g. The lowest absolute fecundity of 6,710 eggs was stated at four-year-old female of body-length 150 mm, body-weight 73.8 g. This female was simultaneously of the lowest relative fecundity of 91 eggs/1 g. The highest relative fecundity of 317 eggs/1 g was discovered at a two-year-old female of body-length 135 mm, body-weight 58 g. The perch average absolute fecundity values rise with rising length, weight and age (Tab. 1, 2, 3). In the table 2 the high average value of an absolute and relative fecundity at length-group of 131—140 mm is striking. Great individual differences in fecundity were stated at perch females of the same weight, length or age. So for instance at the higher mentioned female with the highest relative fecndity an absolute fecundity of 18,406 eggs was stated. At a female of the same age but larger and heavier (145 mm, 70 g) was stated an absolute fecundity of 8,147 eggs, i.e. less than a half.

Tab. 1. The perch fecundity in relation to the total weight of a body.

The total weight of a body, g	n	The average length of a body, mm	The average weight of a gonade, g	The average coef. of ripeness, %	The size of a egg, mm	The absolute fecundity			The relative fecundity to 1 g		
						min.	max.	the average	min.	max.	the average
1— 50	3	121	9.40	20.15	1.22	6993	11575	9915	175	232	210
51— 100	37	151	21.45	25.11	1.35	6710	18406	10980	91	317	133
101— 150	19	166	31.07	27.29	1.37	9795	24652	13914	95	164	131
151— 200	1	187	46.01	25.06	1.45	—	—	17449	—	—	95
1101—1150	1	330	300	27.20	1.38	—	—	144000	—	—	131

Tab. 2. The perch fecundity in relation to the length of a body.

The length of a body, mm	n	The average weight of a body, g	The average weight of a gonade, g	The average coef. of ripeness, %	The size of a egg, mm	The absolute fecundity			The relative fecundity to 1 g		
						min.	max.	the average	min.	max.	the average
111—120	2	45.0	10.35	22.73	1.22	6993	11575	9284	175	232	204
121—130	4	57.3	10.93	19.38	1.24	9019	11177	9922	155	224	176
131—140	3	67.1	17.62	26.32	1.29	8356	18406	14102	140	317	226
141—150	11	81.4	20.69	25.30	1.33	6710	12156	10106	91	151	124
151—160	23	95.9	25.96	26.90	1.37	7961	16410	11894	94	185	124
161—170	12	109.8	27.59	24.98	1.37	9519	15592	12477	95	142	113
171—180	3	127.2	32.95	25.65	1.37	12548	15326	13537	96	117	107
181—190	2	166.8	47.13	28.62	1.42	17449	24652	21051	95	164	130
321—330	1	1103.0	300.00	27.20	1.38	—	—	144000	—	—	131

Tab. 3. The perch fecundity in relation to the age.

The age group	n	The average length of a body, mm	The average weight a body, g	The average weight of a gonade, g	The average coef. of ripeness, %	The size of a egg, mm	The absolute fecundity			The relative fecundity to 1 g		
							min.	max.	the average	min.	max.	the average
II	7	129	54.6	11.87	21.65	1.24	6993	18406	10622	116	317	197
III	4	145	80.4	20.01	24.51	1.30	9105	12263	10994	126	161	138
IV	28	154	93.1	24.07	25.76	1.36	6710	14831	10969	91	172	119
V	15	167	116.0	31.23	26.82	1.40	9202	24652	13577	95	164	117
VI	1	175	107.0	24.35	22.76	1.24	—	—	12548	—	—	117
VIII	1	330	1103.0	300.00	27.20	1.38	—	—	144000	—	—	131

d) The ovary ripeness coefficient

The perch ovary ripeness coefficient changes characteristically during a year (Tabl. 4). This coefficient reached its highest average value of 26.07% in the second half of April. Before spawning I stated a considerable drop of an average coefficient to a value of 23.46%. Obviously there came to the partial loosing of ripe eggs already before spawning. The average value of the ripeness coefficient of ovary (one was in the fourth-fifth stage of ripeness to the end of April and in the beginning of May) grows higher with the age of the fish (Tab. 5). The highest value of an individual coefficient I stated at a female taken of May 1st, 1964. This female measured 185 mm, weighed 150 g, was 5 years old with a ripeness coefficient of 32.17%. The average coefficient dropped quickly after spawning, similarly to another in-one-lot spawning species. To the end of May the coefficient had an average value of 0.95%. In this time the unspawned eggs were still well visible through a soft, weak and insufficiently transparent ovary wall. In June there came to the resorption of unspawned eggs which, at that time, were considerably small and discoverable only after the ovary was opened. The resorption caused dropping of the June average coefficient value to only 0.90%, i.e. the lowest of the year. Since July the average value began to rise and in October reached 3.14%.

Tab. 4. The perch ovary ripeness coeficient.

Datum (1964)	n	The ovary ripeness coefficient, %		
		min.	max.	the average
26. 2.	11	9.09	21.50	16.85
23.—30. 4.	46	15.00	32.19	26.07
1. 5.	12	16.63	32.17	23.46
28. 5.	5	0.78	1.27	0.95
12.—18. 6.	30	0.65	1.23	0.90
21. 7.	27	0.44	1.90	1.00
*) 21. 7.	19	0.34	0.65	0.46
15. 9.	24	1.06	2.72	1.72
31. 10.	27	0.48	6.45	3.14

*) The sexually unmatured females of the I age-group.

Tab. 5. The perch ovary ripeness coefficient with the ovary in the IV—V stage of ripeness in relation to the age (material from 23. 4—1. 5. 1964).

The age group	n	The average length of a body, mm	The average weight of a body, g	The average weight of a gonade, g	The average coef. of ripeness, %
II	7	129	54.6	11.87	21.65
III	4	145	80.4	20.01	24.51
IV	28	156	93.1	24.08	25.84
V	15	167	116.0	31.23	26.82
VI	1	175	107.0	24.35	22.76
VIII	1	330	1103.0	300.00	27.20

e) The testicles ripeness coefficient

The perch testicles ripeness coefficient reaches considerably lower values during a year than the ovary ripeness coefficient. It reached its highest average value of 6.55% to the end of April. The average ripeness coefficient values of testicles (in the IV—V stage of ripeness at that time) rise with the age (Tab. 7). The highest coefficient value of 10.18% had been discovered at a four-year-old male 137 mm long and 57.5 g heavy. From May and June no material was beforehand. In July the average ripeness coefficient was 0.34%, in October it was already 4.31%. This high October value shows that the sexual glads' products maturing of perch males is very quick.

Tab. 6. The perch testicles ripeness coefficient.

Datum	n	The testicles ripeness coefficient, %		
(1964)		min.	max.	the average
23. 4.	31	3.11	10.18	6.55
21. 7.	42	0.07	3.13	0.34
31. 10.	6	2.41	5.56	4.31

Tab. 7. The perch testicles ripeness coefficient with the testicles in the IV—V stage of ripeness in relation to the age (material from 23. 4.—1. 5. 1964).

The age group	n	The average length of body, mm	The average weight of a body, g	The average weight of a gonade, g	The average coefficient of ripeness, %
I	11	84	12.3	0.62	4.99
II	11	120	39.2	2.81	7.10
IV	8	152	79.9	6.11	7.73
V	1	153	79.2	6.51	8.23

DISCUSSION

The spawning of perch at Klíčava was carried out from the end of April to the beginning of May after the water reached 8° C of temperature. This season corresponds to the majority of statements in literature. The stating of water temperature during the spawning season is more truthful than the stating of the spawning season itself. The water temperature, and its rising (at species spawning in spring) or dropping (at species spawning in autumn), worsk as a stimulator of the spawning start. But all this mechanism is not yet fully known. The main paper belongs probably to the neurohumoral reactions. The measured water temperature at Klíčava during the spawning season is answering to the literary statements. E.g. Drenski (1951) and Nikolskij (1950) agreed on the water temperature of 7—8° C, Berg and others (1949) speak of 8—15° C, Drjagin (1949) of 8° C, Gladkij and Něvjadomskaja (1964) of 10° C. Quite unique is the affirmation

of Veber and others (1962) that the spawning had been carried out at temperature of 4.2—12° C.

Typical for the perch is its modesty to the substrate over which it spawns. After Kryžanovsky's ecologic characterization of fresh-water fish the perch belongs to the group of indifferent species. Perch's modesty and adaptibility make its reproduction possible in ecologically variable or small or thickly planted reservoirs. Gladkij and Něvjadomskaja (1964) said that in the lake Naroč old females came first into spawning with males milting for the first time. Similar conditions were observed at perch spawning in the reservoir of Klíčava.

The maturing season concerning statements differ at individual authors. Evidently it is caused by the fact that the perch settles the waters with various conditions which affect its maturing time. The majority of authors agree that the males are sexually matured a year before females. Dyk (1938) called attention to the one-year-old males with solidly developed testicles. These males were in majority. This discovering acknowledged Kříženecká-Pulánková (1952) too. She found considerably developed testicles at males up from 4 cm of length. She judged that these small males didn't milt in their first year only because they couldn't find adequate spawnable females. It is necessary to say that at Klíčava these one-year-old males milted in mass. Otherwise the time of sexual maturing and the spawning of one-year-old males at Klíčava is unique.

The perch from Klíčava is maturing very early in comparison with the others, after the statements made in literature, but its absolute fecundity is not very high. It is evident at first sight (Tab. 1, 2, 3) that the average values of absolute fecundity are rising with the weight, length and age of the fish. But this increase is not very outstanding. This is perceptible namely of the table 3 where the females of age-groups II and III and IV are shewing nearly equal average fecundity. We shall not find much higher fecundity at females of age-groups V and VI either. A considerable increase of fecundity can be found in age group VIII only. I found only several statements of the average fecundity. Letičevskij (1946) stated an average fecundity of 20,800 eggs at 3—6 year-old females from the southern part of the Aral sea. He found it low. The average absolute fecundity of the perch females in Klíčava (being of the same age) is considerably lower. Veber and others (1962) stated a considerably higher average fecundity (68,800) of the perch from Sjamozero than that of Klíčava. But, after him females older than six years were in majority. Jevtjuchova-Rekstin (1962) stated an average fecundity of about 18,000 eggs at the Bajkal perch. This figure comes near to that of Klíčava. Gladkij (1964) as well found a higher average fecundity (about 36,000 eggs) at the Naroč-sea perch. The fecundity of the Klíčava perch is higher at two- and three-year-old females only. As a whole we can say of the Klíčava perch — in comparison with the statements in literature — that its maturity comes earlier and its fecundity is higher in its first years. But since it reaches the fourth year its fecundtiy is comparatively lower than that of the other perch populations, as it is known from the authors. The average values of the ovary ripeness coefficient coincide in the base with the values shown by Mejen (1927). The differences appear between the values from July and October. The evolution of the new eggs generation is running slower at the Klíčava perch. The

average value of the ovary ripeness coefficient 0.46% which I stated at 19 females of the age group I responds to the Drjagin's statement (1952) who wrote that the sexually unmatured individuals had the ripeness coefficient lower than 1%. The average testicles ripeness coefficient responds to the values shown by Kulajev (1927).

SUMMARY

The average absolute fecundity of 14,127 eggs (min. 6,710, max. 144,000 eggs) was stated at 61 perch females from the Klíčava water reservoir. They were 115—330 mm long, weighed 40—1,103 g. Their average relative fecundity was 130 eggs/1 g (min. 91 eggs/1 g, max. 317 eggs/1 g). The average values of absolute fecundity of females rise with the weight, length and age. The perch males of Klíčava mature and spawn for the first time already in their first year of life, the females in their second year.

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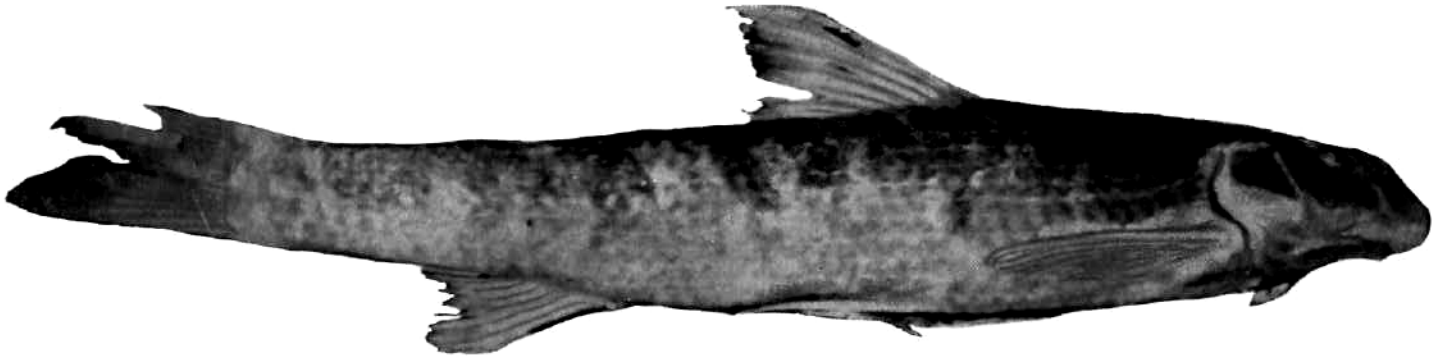


Plate I.

Fig. 1. *Rhinogobio nasutus* (Kessler). Type specimen. Z.I.A.N. 2481.

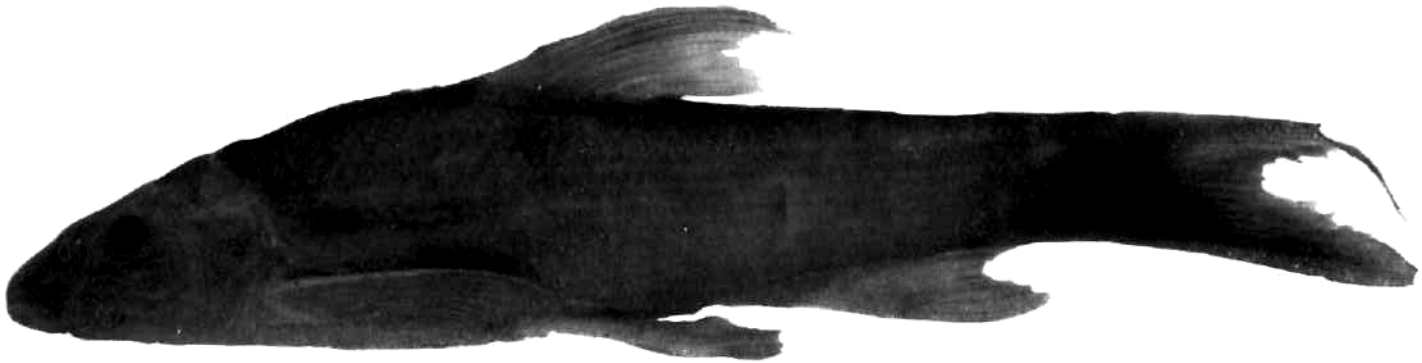
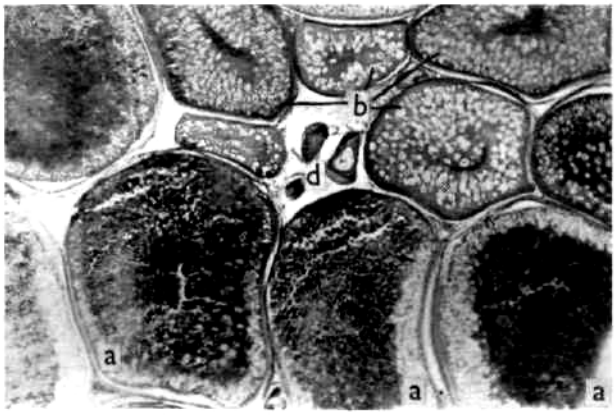


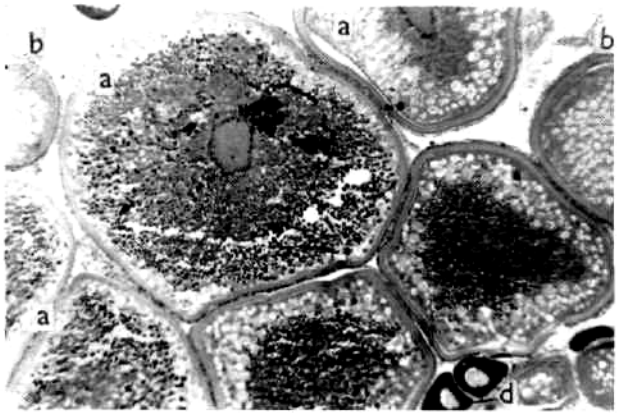
Plate II.

Fig. 2. *Rhinogobio ventralis* Sauvage & Dabry. Type specimen of *Gobio longipinnis* Nichols, A.M.N.H. 8419.

Mihai Papadopol: Recherches sur la biologie de la reproduction du carassin (Carassius carassius (L.)) dans le bassin inférieur du Danube.



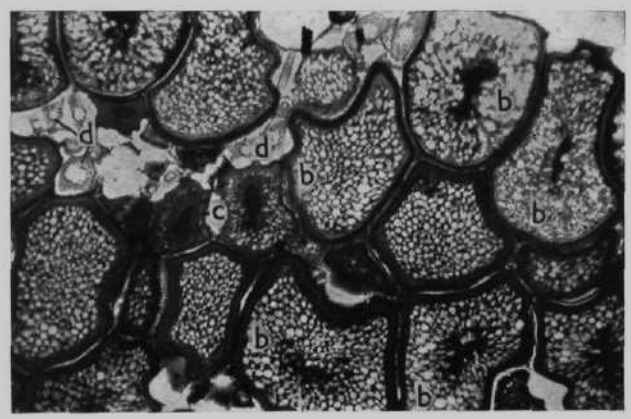
1



2

Figure 1 — Structure histologique de l'ovaire (au début du IV-e stade de maturation) de *Carassius carassius* sexuellement mûr, pêché avant l'époque de reproduction (avril 1959) dans le lac Rosu: a) ovules presque mûrs avec vitelus; b) ovocytes à cytoplasma vacuolaires; c) ovocytes à vacuoles luisantes en 1—2 rangées périphériques; d) ovocytes jeunes avec cytoplasma intensément basophiles (ob. 6×, oc. 6×, microphoto M. Papadopol).

Figure 2 — Structure histologique de l'ovaire de carassin en IV-e stade de maturation pêché au début de la reproduction (mai 1961) dans le lac Jijila: a) ovules mûrs; b), c) et d) ovocytes en divers stades de développement (ob. 6×, oc. 6×, microphoto M. Papadopol).



3

Figure 3 — Structure histologique de l'ovaire de carassin (en III-e stade de maturation) pêché après la reproduction (sept. 1961) dans le Delta du Danube: b), c), d) — ovocytes en divers stades de développement (ob. 6×, oc. 6×, microphoto M. Papadopol).

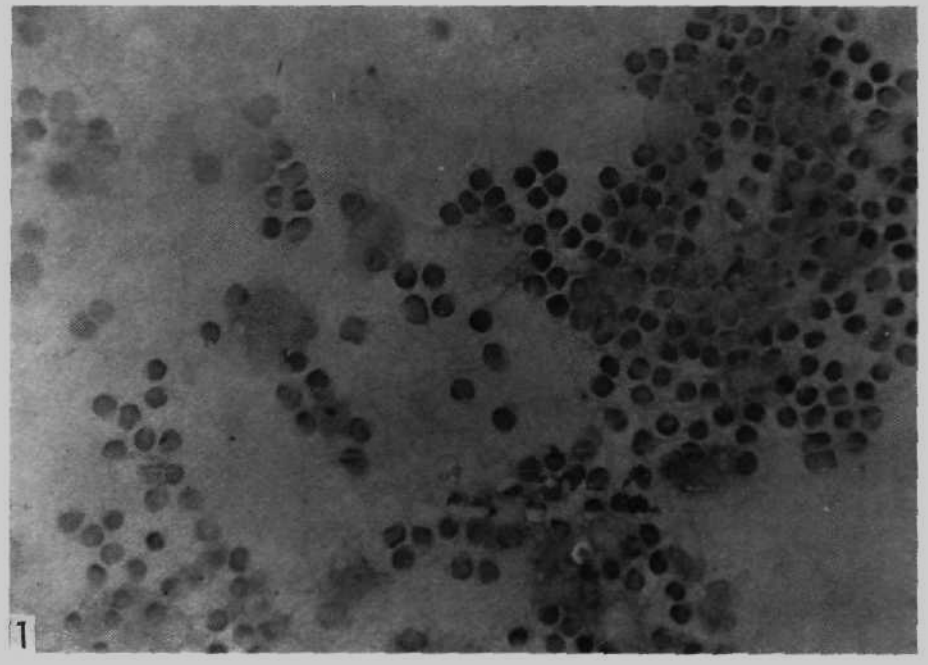


Fig. I. Sperm smears of the chub, Leuciscus cephalus. Both smears Brendan T. Farelly staining. Magnification about 1000×. Natural length of the head 4—5 μm, of the tail 25 μm, total length 29—30 μm. — Male No 3 from May.

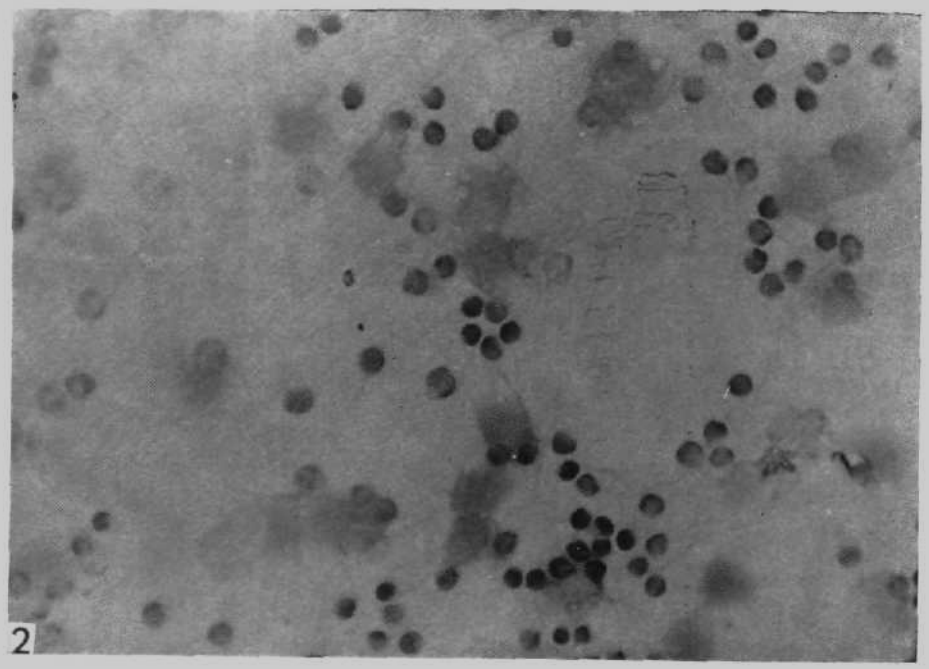


Fig. 2 — Male No 2 from June.