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**NOTES ON THE AGE AND GROWTH OF THE CHUB (*LEUCISCUS CEPHALUS*),
DACE (*L. LEUCISCUS*) AND ORFE (*L. IDUS*) (PISCES, CYPRINIDAE) IN THE
RIVULET BYSTRICE (NORTHEASTERN BOHEMIA)**

Lubomír HANEL

Received April 28, 1982

Abstract: Age and growth of 76 specimens of the chub, *Leuciscus cephalus* (Linnaeus, 1758), 33 specimens of the dace, *Leuciscus leuciscus* (Linnaeus, 1758) and 17 specimens of the orfe, *Leuciscus idus* (Linnaeus, 1758) from the rivulet Bystřice (north-east Bohemia) was studied using scale method. Length-weight relationship and current absolute and relative indicators of growth were ascertained.

MATERIAL AND METHODS

All studied material was collected by electrofishing and deposited in the Zoological Division of the Regional museum in Hradec Králové. The chub was collected during the years 1960–1972 (from March to October), the dace in 1960–1971 (from May to December), the orfe during the years 1960–1973 (from May to October) in the rivulet Bystřice on localities Obédovice, Kratonohy and Kosičky. The length of this rivulet is about 60 km, its drainage area is about 379 sq. km. Its flows into the river Cidlina near the town Chlumec nad Cidlinou (Northeastern Bohemia).

In all examined specimens (preserved in the formalin and later in alcohol) the body length and total length with the accuracy ± 1 mm were measured. The weight was ascertained with ± 1 g accuracy (in specimens smaller than 100 g with the accuracy ± 0.5 g). 3–5 selected scales were taken from the row below the lateral line above the insertion of ventrals. For scale reading, only one with clearest annuli on the ventrodiagonal scale radius was used (microprojector Lesegerät, Carl Zeiss Jena, magn. 17.5). For back calculation of the length growth was used the method according to R. Lee (1920) with a correction of 18 mm (chub, dace) and 20 mm (orfe). Specific rate of linear growth (C_1) (see Balon, 1964), coefficient of condition (K) (see Holčík, Hensel, 1972) and Ford-Walford theoretical value (L_∞) (see Ricker, 1975), informed on maximal reachable length, was used.

Altogether, 19 fish species were found in the rivulet Bystřice during electrofishing. The most abundant species were: *Blicca bjoerkna*, *Leuciscus cephalus*, *Perca fluviatilis*, *Rutilus rutilus*. The following can be designated as common species: *Alburnus alburnus*, *Anguilla anguilla*, *Carassius carassius*, *Cyprinus carpio*, *Esox lucius*, *Gobio gobio*, *Leucaspis delineatus*, *Leuciscus leuciscus*, *Leuciscus idus*, *Lota lota*, *Tinca tinca*. The following are the additional species: *Cobitis taenia*, *Scardinius erythrophthalmus*, *Noemacheilus barbatulus*, *Misgurnus fossilis*.

RESULTS AND DISCUSSION

Leuciscus cephalus

For review of authors who studied the length growth of the chub see Hanel (1982 b). In the material examined the body/scale relationship is linear (correlation coefficient $r = +0.978$). Calculated correction cannot be used (+27.4 mm) due to the nonhomogenous material. Therefore, the correction of 18 mm based

on actual scale formation was used (see Černý, 1980). Relationship l_1/l_c has been found to be 1.12—1.35 (ave. 1.21), coefficient of condition (K) 1.45—3.77 (ave. 1.98). The equation between conversion factor ($l_1/l_c = y$) and body length ($l_c = x$) was determined as $y = 1.242 - 0.00022x$ (Fig. 1). The theoretical Ford-Walford value L^∞ (Ricker, 1975) was determined as 361 mm of the body

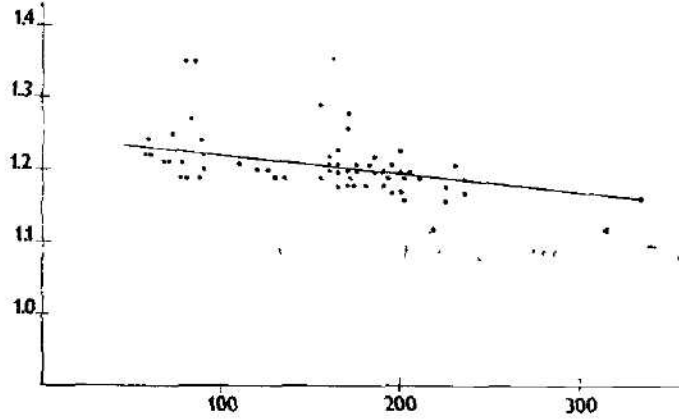


Fig 1 - Relationship between conversion factor ($l_1/l_c = y$) and body length ($l_c = x$) in mm of the chub in the rivulet Bystřice. Abscissa = body length, ordinate = conversion factor.

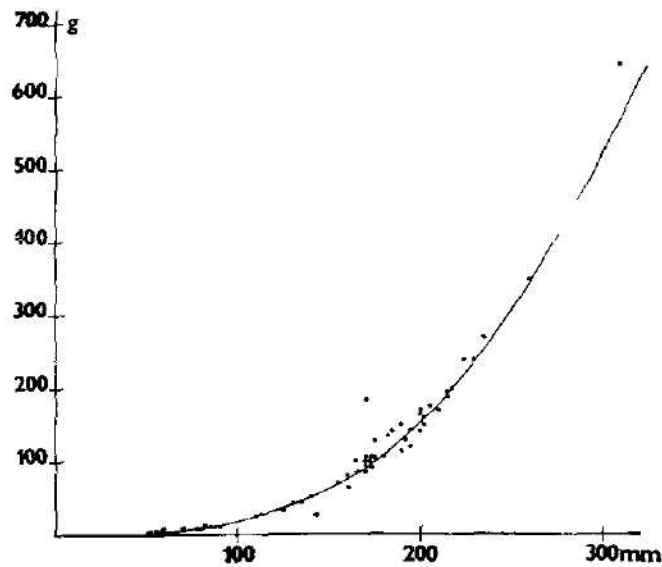


Fig 2 - Relationship between body length in mm and body weight in g of the chub in the rivulet Bystřice. Abscissa = body length, ordinate = body weight.

Table 1. Length growth of the chub, *Leuciscus cephalus*, from the rivulet Bystřice, collected during 1960-1972

Age	No of sp.	Body length in the time of the capture	Average back calculated lengths (in mm), ranges in brackets														
			l_1	l_2	l_3	l_4	l_5	l_6	l_7	l_8							
1+	20	76 (52-120)	50 (41-70)														
2+	3	119 (110-135)	53 (51-55)	96 (92-101)													
3+	9	155 (125-170)	48 (41-60)	92 (77-111)	131 (107-153)												
4+	17	178 (155-218)	50 (37-69)	97 (68-138)	128 (103-184)	160 (134-198)											
5+	12	193 (155-260)	45 (37-59)	88 (77-106)	128 (106-166)	159 (126-226)	182 (145-253)										
6+	5	212 (170-235)	49 (43-55)	91 (77-110)	121 (107-137)	154 (136-172)	174 (157-193)	200 (166-220)									
7+	2	194 (185-202)	49 (47-50)	93 (83-103)	124 (120-127)	141 (131-151)	162 (149-175)	176 (165-187)	187 (176-197)								
8+	1	310	48	89	125	175	211	254	276	295							
		average	49	92	126	158	182	210	232	295							
		annual increments	43	34	32	24	28	22	22	(63)							
		specific rate of linear growth (C_L)	87.8	36.9	25.4	15.2	15.4	10.5	10.5	(27.2)							
		growth characteristics (C_{Ln})	3.09	2.89	2.85	2.23	2.60	2.09	2.09	(5.57)							

length ($l_{t+1} = 47.579 + 0.868 l_t$). The length/weight relationship was determined as $\log w = -4.688131499 + 2.990477518 \log l$ (Fig. 2).

Having for comparison the table of the length growth from some Czechoslovak waters (H a n e l, 1982 b), the growth in the rivulet Bystřice can be designated as the average one.

Leuciscus leuciscus

The growth of this species in Czechoslovak waters was studied by several authors (Tab. 3). The body/scale relationship in the dace from the rivulet Bystřice is linear ($r = +0.965$), but the calculated correction cannot be used (+34.2 mm) due to the nonhomogenous material; Therefore the correction 18 mm was used, following K e n n e d y (1969).

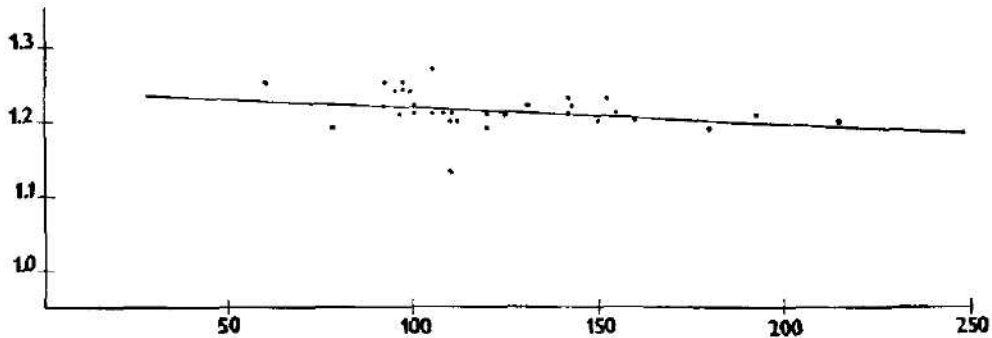


Fig 3 - Relationship between conversion factor ($l_t/l_c = y$) and body length ($l_c = x$) in mm of the dace in the rivulet Bystřice. Abscissa = body length, ordinate = conversion factor

Table 2 Length growth of the dace, *Leuciscus leuciscus*, from the rivulet Bystřice, collected during 1960—1971

Age	No of sp	Body length in the time of the capture	average back calculated lengths (in mm), ranges in brackets						
			l_1	l_2	l_3	l_4	l_5	l_6	
1+	16	95 (78—110)	57 (48—73)						
2+	6	117 (105—131)	53 (49—63)	94 (76—106)					
3+	8	146 (120—160)	52 (43—75)	99 (76—115)	136 (126—153)				
4+	2	187 (180—193)	59 (49—68)	88 (69—106)	117 (95—138)	163 (152—173)			
6+	1	215	50	79	130	164	194	210	
		average annual increments	54	90	128	164	194	210	
		specific rate of linear growth (C_l)	66.7	44.2	38.1	18.3	8.2		
		growth characteristics (C_{ln})	2.76	3.17	3.17	2.76	1.54		

The relationship l_t/l_c was found as 1.13—1.25 (ave. 1.21), coefficient of condition 1.27—1.98 (ave. 1.60). The equation between conversion factor and body length was $y=1.243 - 0.00023 x$ (see Fig. 3). The theoretical value L_∞ is 363 mm ($l_{t+1} = 47.863 + 0.863 l_t$). The length/weight relationship was determined to be $\log w = -5.093029914 + 3.142204459 \log l$ (see Fig. 4).

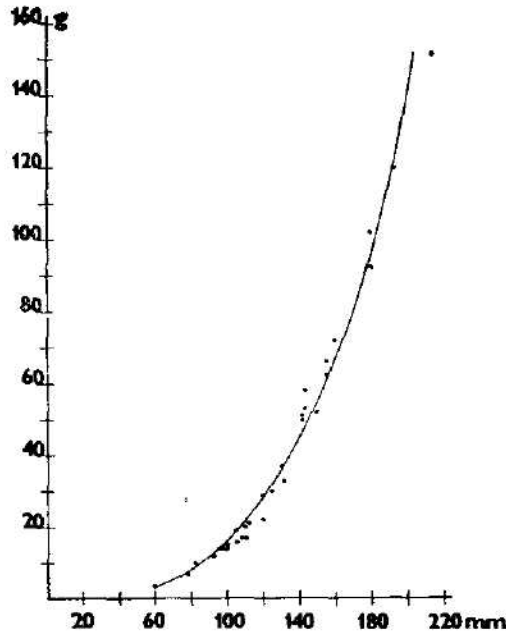


Fig 4 - Relationship between body length in mm and body weight in g of the dace in the rivulet Bystřice. Abscissa = body length, ordinate = body weight.

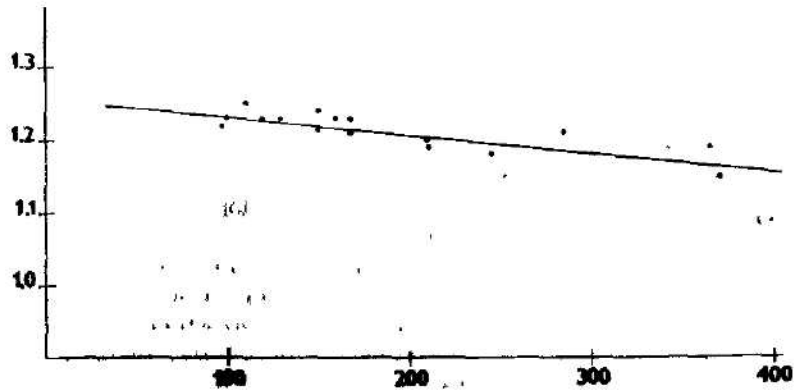


Fig. 5 - Relationship between conversion factor ($l_t/l_c = y$) and body length ($l_c = x$) in mm of the orfe in the rivulet Bystřice. Abscissa = body length, ordinate = conversion factor

Table 3. Comparison of the growth rate (in mm) of the dace, *Leuciscus leuciscus*, from different Czechoslovak localities

Author	No of examined specimens	Locality	l ₁	l ₂	l ₃	l ₄	l ₅	l ₆	l ₇	l ₈	l ₉	l ₁₀	l ₁₁
Leontovyc, 1980	233	the river Vltava, down the Vltava cascade	59	94	129	158	178	195	205	217			
Hanel (in press)	30	the rivulent Trotina, tributary of Labe	59	94	122	146	160	172	181	177	187		
Vostradovský, 1961	108	the reservoir Lipno	54										
own values	33	the rivulent Bystřice	54	90	128	164	194	210					
Leontovyc, 1974	378	the river Želivka	53	74	90	113	141	173					
Krupka, 1969	250	the river Turiec	49	84	114	139	163	185	204	219	237	251	258
Zikmund 1955 (after Krupka, 1969)		the river Moravice	42	77	108	134	158	170	187	203	219		
Losos, Peňáz, Kubičková, 1980	30	the river Jihlava ♂♂	42	72	89	121	143	166	180	186	196		
		♀♀	37	64	87	112	137	156	183	200			

The slowest growth in Czechoslovak localities has been found in the river Jihlava, the fastest growth in the rivulet Bystřice (Tab. 3) From the comparison of the length growth in the rivulet Bystřice with the average growth from the seven mentioned Czechoslovak waters (see Tab. 3), it is evident that the growth in the rivulet is better throughout the whole life of the fish. For details on growth of the dace in some European waters, see Leontovyc (1980)

Leuciscus idus

There are very scarce notes concerning the growth of the orfe in Czechoslovakia (see Tab. 5). Balon and Žitňan (1964) analyzed the age and growth of the xanthoric orfe acclimatized in the Tatra high-mountain Štrba lake in Slovakia. They found here the oldest specimen from the XIIth age class (body length 381 mm). The oldest orfe from Czechoslovak waters was angled in the river Orlice (locality Týniště nad Orlicí) in the year 1977 and was one of the XIIIth age class (body length 422 mm, weight 2000 g) (see Hanel, 1982 a).

The relationship l_t/l_c was 1.15—1.24 (ave. 1.21), coefficient of condition was 1.69—2.89 (ave. 2.15). The equation between conversion factor and body length was $y=1.258 - 0.00026 x$ (Fig. 5). The theoretical value L_∞ was determined as 518 mm ($l_{t+1} = 52.831 + 0.898 l_t$). The length/weight relationship was found to be $\log w = -5.046174346 + 3.166926662 \log l$ (Fig. 6). In our material the body/scale relationship was linear ($r = +0.997$) with the correction 204 mm.

The fastest length growth in Czechoslovak waters was found in the river Malý Dunaj, the slowest growth to the sixth year of life has been found in the river Žitava and Dyje (see Tab. 5). Comparing the length growth from the examined rivulet with the average growth from six mentioned localities (Tab. 5) the growth in the Bystřice has been found to be slower up to the 7th year of life and faster from the 8th year.

Table 4. Length growth of the orfe, *Lepomis albus*, from the rivulet Bystřice, collected during 1960—1973

Age	No. of specimens	Body length in the time of the capture	l_1	l_2	l_3	l_4	l_5	l_6	l_7	l_8	l_9	l_{10}	l_{11}
1+	3	117 (100—130)	63 (59—68)										
2+	5	144 (98—210)	61 (58—68)	107 (88—125)									
3+	3	179 (160—210)	58 (50—63)	113 (106—123)	154 (132—187)								
4+	1	168	68	104	127	163							
5+	1	245	50	104	145	177	217						
6+	1	220	55	79	98	115	165	207					
7+	1	285	52	105	143	177	207	236	274				
8+	1	365	63	93	127	176	224	292	307	318	335		
9+	1	370	67	119	170	226	265	290	308	329	335	345	360
11+	1		60	103	138	172	216	256	296	324	335	345	360
		average											
		annual increments	43	35	34	44	40	40	28	11	10	10	15
		specific rate of linear growth (C_l)	71.7	33.0	24.6	25.6	18.5	15.6	9.5	3.4	2.9	4.3	
		growth characteristics (C_{11})	3.24	3.01	3.04	3.92	3.67	3.72	2.68	1.09	0.99	1.47	

Table 5. Comparison of the growth rate (in mm) of the orfe, *Leuciscus idus*, from different Czechoslovak localities

Author	No. of examined specimens	Locality	l ₁	l ₂	l ₃	l ₄	l ₅	l ₆	l ₇	l ₈	l ₉	l ₁₀	l ₁₁
Balon, 1962	90	the river Malý Dunaj at Kolárovo	70	136	177	233	279	323	346				
Sedlár, 1966	63	the river Žitava	63	117	153	193	224	245	265	295	321	332	
own values	17	the rivulet Bystřice	60	103	138	172	216	256	296	324	335	345	360
Hochman, 1956	36	the river Dyje	59	99	153	201	249	292	330	338	352		
Balon, 1962	49	the river Dunaj at Štúrovo	57	138	201	233	253	270	288	305	327		
Balon, 1962	39	the river Dunaj at Medvedovo	51	119	161	174	217	250					
Peňáz, 1961	151	the river Dyje	51	94	145	184	214	248	285				

Further details concerning the growth of the orfe in some European waters were reported by Balon (1962).

Acknowledgements

Thanks are due to Dr. K. Lohniský, Head of the Zoological Division of the Regional museum in Hradec Králové, for offering kindly all preserved specimens available and details concerning further species in the rivulet Bystřice. Thanks are due to Doc. Dr. O. Oliva, Sen. Lecturer in Vertebrate Zoology, Charles University, Prague for critical reading of the typescript.

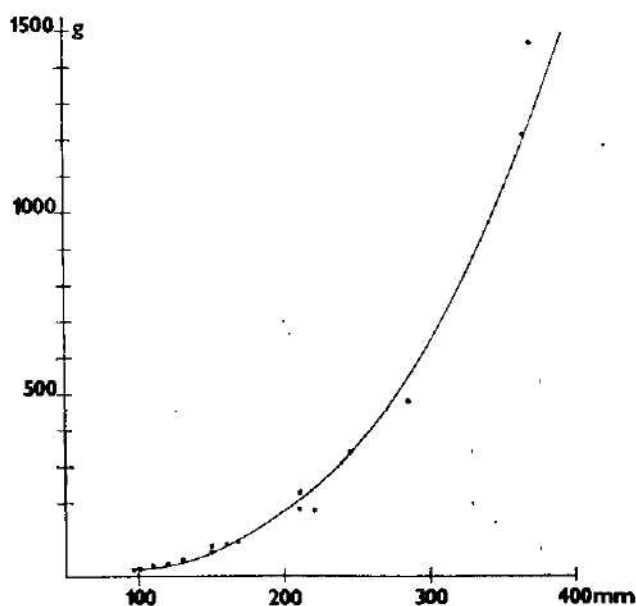


Fig. 6 -- Relationship between body length in mm and body weight in g of the orfe in the rivulet Bystřice. Abscissa = body length, ordinate = body weight.

SUMMARY

This paper describes the age and growth of the chub, dace and orfe from the rivulet Bystrčice. The list of all other species of fishes appearing in this rivulet is given. The chub of 8+ years, the orfe of 11+ years, dace of 6+ years were recorded. The growth rate of the chub has been designated as an average one, in the dace faster and in the orfe in first years of life slower than the Czechoslovak average. The specific rate of linear growth (C_1), growth characteristic (C_{10}) and annual increments decrease with the increase in age in all species examined. The theoretically attainable body length in the chub was determined as 361 mm, in the dace 363 mm and in the orfe as 516 mm.

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**NEW TAXA AND NEW RECORDS OF PALEARCTIC NYCTERIBIIDAE AND
STREBLIDAE (DIPTERA: PUPIPARA)**

Karel HŮRKA

Received January 31, 1983

Abstract: *Phthiridium simile* sp. n. is described from northern Tajikistan and western Kirgizia and separated from *P. orientale* (Hürka et Povolný). *Phthiridium khabilovi* sp. n. from northern Tajikistan, is described and illustrated. New faunistic records are given for 15 species of Nycteribiidae and 2 species of Streblidae; the distribution of species mentioned is stated.

The material described and recorded here resulted from smaller or greater collections in central and southern Europe (Czechoslovakia, France, Roumania, Bulgaria, Yugoslavia), Northwest Africa (Algeria, Tunis) and Southwest and Middle Asia (Georgian SSR, Azerbaijan SSR, Iran, Kirgiz SSR, Tajik SSR). 17 species with 583 specimens of Nycteribiidae and 2 species with 48 specimens of Streblidae were determined.

Family Nycteribiidae

Subfamily Nycteribiinae

Nycteribia (Nycteribia) kolenatii Theodor et Moscona, 1954

Czechoslovakia: Bohemia mer., Bechyně, 20. 1. 1972, *M. bechsteini*, ♀, K. Hürka leg.; Moravia mer., Květnice near Tišnov, 16. 12. 1965, *M. daubentoni*, 2 ♂, J. Gaisler leg., Valtice, 17. 8. 1970, *M. daubentoni*, 2 ♂, ♀, F. Dusbábek leg.; Slov. mer., Gombasek, 12. 7. 1981, *M. daubentoni*, ♂, 2 ♀, K. Hürka leg.

Distribution: Europe — from southern Scotland and southern Scandinavia to northern Portugal, northern Italy, Makedonia and Roumania; eastern limit presently 28–29° E.

Nycteribia (Nycteribia) latreilii (Leach, 1817)

Czechoslovakia: Slovakia mer., Rožňava-kúpele, 17. 2. 1968, *M. myotis*, 2 ♂, K. Hürka leg.; Chvalová near Rimavská Sobota, 10. 7. 1981, *M. myotis*, 2 ♂, K. Hürka leg. — Roumania: Dobrogea, Gura Dobrogei, 6. 7. 1971, *M. blythi oxygnathus*, 5 ♀, K. Hürka leg.; Mt. Sebesului, Ohava Ponor, pest. din Sura Mare, 31. 8. 1981, *M. myotis*, ♀, T. Scholz leg. — Bulgaria: Stara planina, Sukhata pestera near Lakatnik, 10. 2. 1965, *M. myotis*, 4 ♂, 2 ♀, K. Hürka leg.; Stara planina, Karlukovo, 6. 7. 1976, *M. blythi oxygnathus*, ♂, ♀, K. Hürka leg.; Stara planina, pest. Seva dupka near Malko Brestnica, 8. 2. 1965, *M. myotis*, ♂, K. Hürka leg. — Tunis: El Djan near Gobes, 2. 9. 1973, *M. blythi punicus*, 2 ♂, ♀, H. Burda leg. — Tajikistan: Kuraminskij khrebet, Adrasman, 80 km SE Leninabad, 5. 1978, 4. 5. 1979, *M. blythi*, 2 ♂, 4 ♀, T. K. Khabilov leg.; Mogol-Tau mountains, Uč Tepa, 15 km SW Leninabad, 19. 7. 1978, 22. 4. 1980 *M. blythi*, 12 ♂, 17 ♀, T. K. Khabilov leg.; Tagojak, 25 km SW Leninabad, 7. 1979, *M. blythi*, ♀, T. K. Khabilov leg.

Distribution: Continental Europe (northern limit 51–52° N), North Africa, Southwest and Middle Asia eastwards to eastern Kazakhstan.

Nycteribia (Nycteribia) pedicularia Latreille, 1796

Bulgaria: Stara planina, Karlukovo, 7. 2. 1965, *M. capaccinii*, 3 ♂, ♀, K. Húrka leg., Panežka Izvora near Zlatna Panega, 8. 2. 1965, *M. capaccinii*, 29 ♂, 31 ♀, K. Húrka leg. — Yugoslavia: Croatia, Bizek near Zagreb, 7. 8. 1965, *M. capaccinii*, ♂, 4 ♀, J. Gaisler leg. — Algeria: cave near Aokos, 30 km W Bejaia, *M. capaccinii*, 10. 12. 1981, 2 ♂, 2 ♀, 15. 1. 1982, ♂, 2 ♀, J. Gaisler leg.

Distribution (Fig. 1): Mediterranean species of the southern part of Europe (northern limit the Alps and South Carpathians), North Africa (Algeria, Tunis) and Southwest Asia eastwards to Iran.

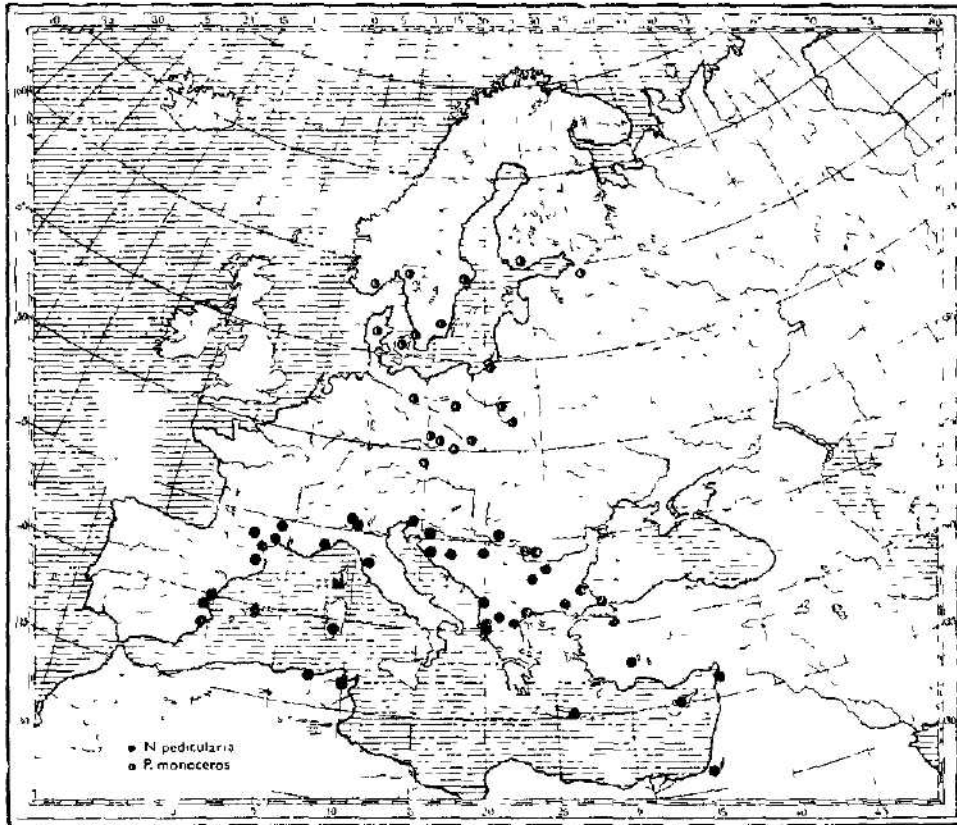


Fig. 1. Distribution of the Mediterranean species *Nycteribia (N.) pedicularia* and the Northpaleartic species *Penicillidia monoceros* in Europe and in the Near East.

Nycteribia (Nycteribia) s. schmidlii Schiner, 1853

Czechoslovakia: Slovakia, Devínska Nová ves, 26. 1. 1978, *M. schreibersi*, ♂, ♀. — France: Mersault near Dijon, cave Porée Piarcu, 24. 6. 1965, *M. schreibersi*, ♀, J. Gaisler leg. — Roumania: Mt. Sebesului, Ohava Ponor, pest. din Sura Mare,

1. 9. 1981, *M. schreibersi*, 6 ♂, 7 ♀, T. Scholz leg.; Dobrogea, pest. Gura Dobrogei, 6. 7. 1971, *M. schreibersi*, 6 ♂, ♀, K. Hürka leg. — Bulgaria: Stara planina, Sukhata pestera near Lakatnik, 10. 2. 1965, *M. schreibersi*, ♀, K. Hürka leg.; Karlukova, 4. 7. 1976, *M. schreibersi*, 4 ♂, 12 ♀, K. Hürka leg. — Yugoslavia: Croatia, Bizek near Zagreb, 7. 8. 1965, *M. schreibersi*, 3 ♂, 7 ♀, J. Gaisler leg. — Georgian SSR: Picunda, 18. 7. 1974, *M. schreibersi*, 22 ♂, 21 ♀. — Algeria: cave near Aokos, 30 km W Bejaia, *M. schreibersi*, 30. 4. 1981, ♀, 10. 12. 1981, 3 ♂, 5 ♀, *M. capaccinii*, 15. 1. 1982, ♂, J. Gaisler leg.

Distribution: Southern part of Europe (northern limit central France, Baden, southern Slovakia), North Africa and southwestern Asia, eastwards to Afghanistan.

Nycteribia (Acrocholidia) lindbergi Aellen, 1959

Tajikistan: Kuraminskij khrebet, Adrasman, 80 km SE Leninabad, *M. blythi*, 9. 4. 1978, 3 ♂, ♀, 19. 6. 1978, ♂, 19. 4. 1979, ♂, T. K. Khabilov leg.; Mogol-Tau mountains, Uč Tepa, 15 km SW Leninabad, *M. blythi*, 19. 7. 1978, ♂, ♀, 22. 4. 1980, 3 ♀, T. K. Khabilov leg.

Distribution: eastern Kazakhstan, Kirgizia, southwestern Uzbekistan (Samarkand), Tajikistan, Afghanistan, India (Northwest Himalayas; Darjeeling).

Nycteribia (Acrocholidia) vexata Westwood, 1835

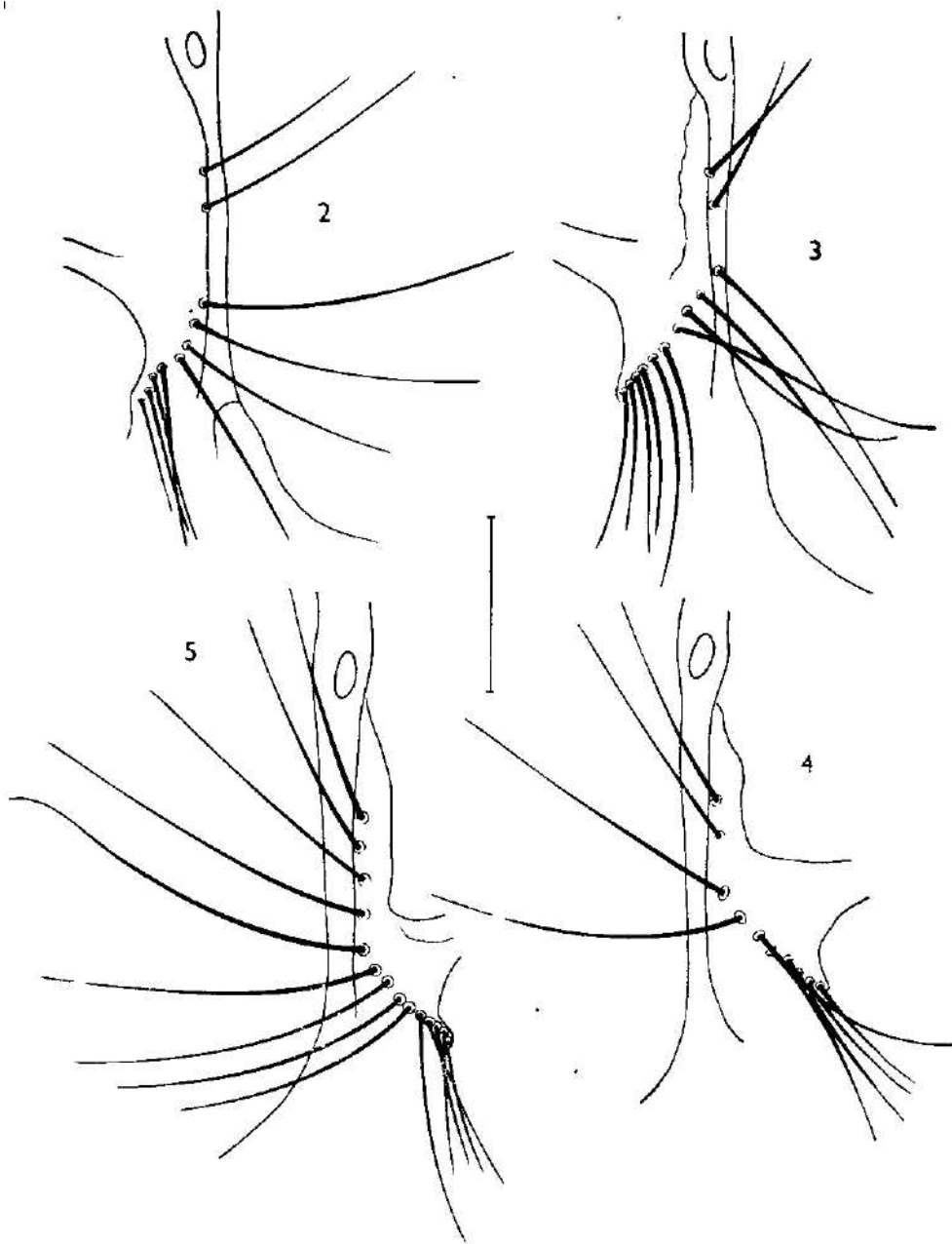
Czechoslovakia: Slovakia, Malá Fatra Mts., Durčíná near Zilina, 13. 2. 1968, *M. myotis*, ♀, K. Hürka leg.; Choč Mts., Lisková near Ružomberok, 14. 2. 1968, *M. myotis*, ♂, ♀, K. Hürka leg.; Nizké Tatry Mts., Janská dolina, Stanišovská cave, 14. 2. 1968, *M. myotis*, ♂, ♀, K. Hürka leg.; Slov. Rudohorie Mts., Červená Skala, Márnikova cave, 14. 2. 1968, *M. myotis*, 3 ♂, ♀, K. Hürka leg.; Rožňava-kúpele, 17. 2. 1968, *M. myotis*, 5 ♀, K. Hürka leg.; Dubník near Košice, 4. 3. 1964, *M. myotis*, 2 ♂, 4 ♀, K. Hürka leg. — Bulgaria: Stara planina, Lakatnik, 10. 2. 1965, K. Hürka leg., *M. myotis*, Temnata dupka cave, 2 ♂, 4 ♀, Sukhata pestera cave, 4 ♂, ♀; Stara planina, Seva dupka cave near Malko Brestnica, 8. 2. 1965, *M. myotis*, 3 ♂, 5 ♀, K. Hürka leg.; Panežka Izvora cave near Zlatna Paneža, 8. 2. 1965, *M. myotis*, ♂, K. Hürka leg.; Rodopi Mts., Staraja pestera cave near Pestera, 4. 2. 1965, *M. myotis*, ♂, ♀, K. Hürka leg.; Rodopi Mts., Snežanka cave near Pestera, 5. 2. 1966, *M. myotis*, 4 ♀, K. Hürka leg. — Georgian SSR: Picunda, 18. 7. 1974, *M. blythi oxygnathus*, 2♂. — Azerbaijan SSR: Semakha, 28. 6. 1979, *M. nattereri*, ♀. — Tunisia: El Djan near Gobes, 2. 9. 1973, *M. bl. punicus*, 2 ♀, H. Burda leg.

Distribution: Continental Europe (northern limit 52—53° N), North Africa and southwestern Asia eastwards to Iran (Elburz Mts) and Turkmenia (Bokhardenskaya cave).

Phthiridium biarticulatum Hermann, 1804

Roumania: Mt. Sebesului Mts., Ohava Ponor, pest. din Gura Frintoanei cave, 31. 8. 1981, *R. ferrumequinum*, 2 ♂, T. Scholz leg. — Bulgaria: Stara planina Mts., Lakatnik, Sukhata pestera cave, 10. 2. 1965, *R. ferrumequinum*, ♂, ♀, K. Hürka leg.; Rodopi Mts., Snežanka cave near Pestera, 5. 2. 1965, *R. ferrumequinum*, ♀, K. Hürka leg. — Algeria: cave near Aokos, 30 km W Bejaia, *R. blasii*, 30. 4. 1981, ♂, *R. euryale*, 1. 10. 1981, ♀, J. Gaisler leg.; Tidolis near Constantine, 20. 11. 1981, *R. mehelyi*, 2 ♂, J. Gaisler leg. — Tajikistan: Mogol-Tau Mts., Uč Tepa, 15 km SW Leninabad, 18. 11. 1979, *R. ferrumequinum*, ♀; Kuraminskij khrebet Mts., Altyn-Tonkan, 100 km SW Leninabad, 17. 12. 1978, *R. bocharicus*, ♀; Kuraminskij khrebet Mts., Gudos, 115 km from Leninabad, 13. 4. 1980, *R. ferrumequinum*, ♀, K. T. Khabilov leg.

Distribution: Southern part of Europe (northern limit — southern Scotland, northern France, Hessen, northern Slovakia), North Africa, Southwest Asia eastwards to Kirgizia, Tajikistan and Afghanistan.



Figs 2-5. Notopleural setae: 2 - *P. khabilovi* (holotype), 3 - *P. simile* (♂, northern Tajikistan), 4 - *P. simile* (♀, Kirgizia), 5 - *P. orientale* (♀, Afghanistan). Scale = 0.2 mm.

The complicated orographic situation in Middle Asia where high mountain massifs of Tian-Shan, Pamir, Hindukush and the Himalayas are contiguous gave rise, at a relatively small area, to several related species of the genus *Phthiridium*. Thus, from the northern part of the western Himalayas *P. nuditerga* and from eastern Afghanistan *P. orientale* have been described. Two new species are now described from Soviet Middle Asia from the Fergana-dell and from southern slopes of the Turkestan ridge (Turkestanskiy khrebet). *P. simile* sp. n. and *P. orientale* (Húrka et Povolný) are closely related, therefore the description of the last species is newly given.

Phthiridium orientale (Húrka et Povolný, 1968)

Stylidia biloba orientalis Húrka et Povolný, 1968

Length ♂ — 2.85 mm, ♀ — 3.00 mm.

Head — anterior margin with 4 long setae. Theca of the proboscis nearly twice longer than labella.

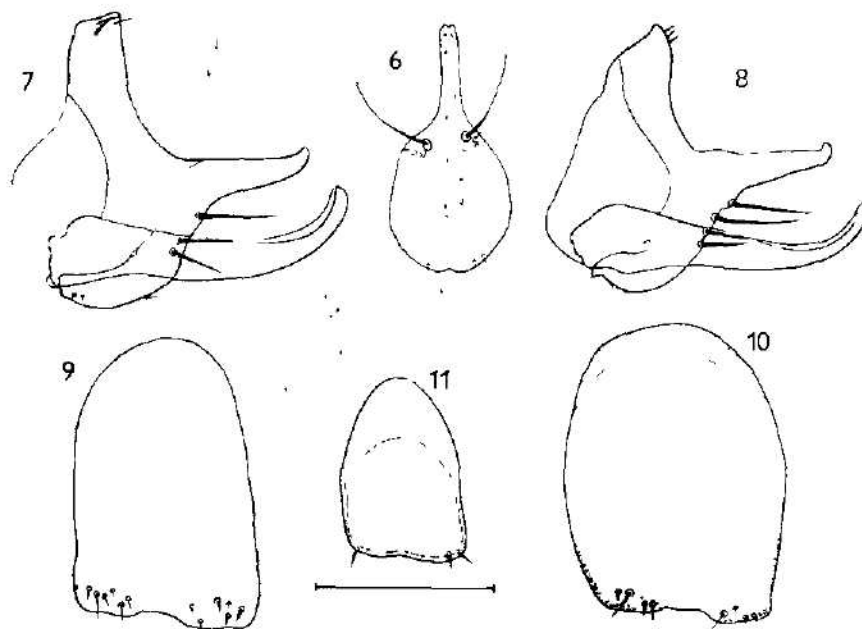
Thorax — as long as wide. Oblique sutures forming an angle of about 75°. 14—17 notopleural setae, there is not a distinct gap between the first two and the remaining setae (Fig. 5). Posterior margin of sternal plate with 4—6 setae at each side, one is longer than the others. Tibiae 5 times as long as wide.

Male abdomen — post-spiracular sclerite with 2—3 setae. Tergite 1 with a marginal row of moderately long setae with a gap in the middle, the surface with few hairs. Tergite 2 large, divided in the middle, with marginal row of moderately long setae and with 4—5 rows of shorter setae on the surface. Tergites 3—6 narrow; tergites 3 and 6 completely divided into 2 lateral sclerites, tergites 4 and 5 undivided, the fifth distinctly narrowed in the middle. Tergites 3 and 4 with short setae on the surface, tergites 5 and 6 bare; 4 long setae in the marginal rows of tergites 5 and 6. Anal segment short, rounded, with convex anterior dorsal margin and with some moderately long setae on the dorsal surface. Abdominal ctenidium with 43 spines. Sternites 3 and 4 with marginal rows of moderately long setae which are longer laterally, sternite 3 with 3—4, sternite 4 with 2 rows of short hairs on the surface. Sternite 5 with a median less strongly sclerotized part and with a deep incision on the posterior margin. Two groups of 18—19 short spines in 3 rows along the sides of the incision, those of the posterior row longer. Some long setae anterior and lateral to the spines.

Genitalia — gonostyles (= claspers) thick, dark, almost straight. One long seta near the base and 2—3 rows of moderately long setae to three-quarters of dorsal surface. Ventral process of aedeagus apodeme (= phallobase) short, fused with the praegonites (= parameres). Aedeagus curved upwards to a rounded tip. Praegonites with long apical process curved upwards to a small tip, the lower part bearing 3 setae which are longer towards the apex, the base with small seta and with some minute spines (Fig. 7).

Female abdomen — tergite 1 with a wider gap in the marginal row as in the male. Tergite 2 large, subdivided in the middle, with 3—5 longitudinal rows of short spines on each half of the tergite and with the marginal row of longer and shorter setae and short spines in the middle. Tergite 6 large, with slightly convex posterior margin, with 15 longer or shorter setae and spines posteriorly and with 1 short spine on the surface (Fig. 13). Connexivum between tergites 2 and 6 bare; short spines on the pleurae. Anal segment short,

conical, with 2 setae at the tip and some short hairs on the dorsal surface. Abdominal ctenidium with 55 spines. Sternites 3 and 4 membranous, each with a marginal row of longer setae and with 2 rows of shorter setae on the surface. Sternites 5 and 6 divided into lateral sclerites which are placed close together, with a marginal row of longer setae and with one row of short setae on the surface. Sternite 7 divided into 2 triangular sclerites with setae posteriorly. Genital plate large, shield-shaped (length:width about 1.6), with more heavily sclerotized anterior margin, posterior corners bear 6 hairs (Fig. 9).



Figs 6-11. 6 - proboscis of *P. simile* (♂, Kirgizia); 7, 8 - praegonites and aedeagus: 7 - *P. orientale* (Afghanistan), 8 - *P. simile* (northern Tajikistan); 9-11 - genital plates: 9 - *P. orientale* (Afghanistan), 10 - *P. simile* (Kirgizia), 11 - *P. khabilovi* (holotype). Scale = 0.2 mm.

Distribution: eastern Afghanistan, Lalanda, host *Rhinolophus ferrumequinum* (♂ holotype); Abdukil near Shigi, host *R. hipposideros midas* (♀ paratype).

Phthiridium simile sp. n.

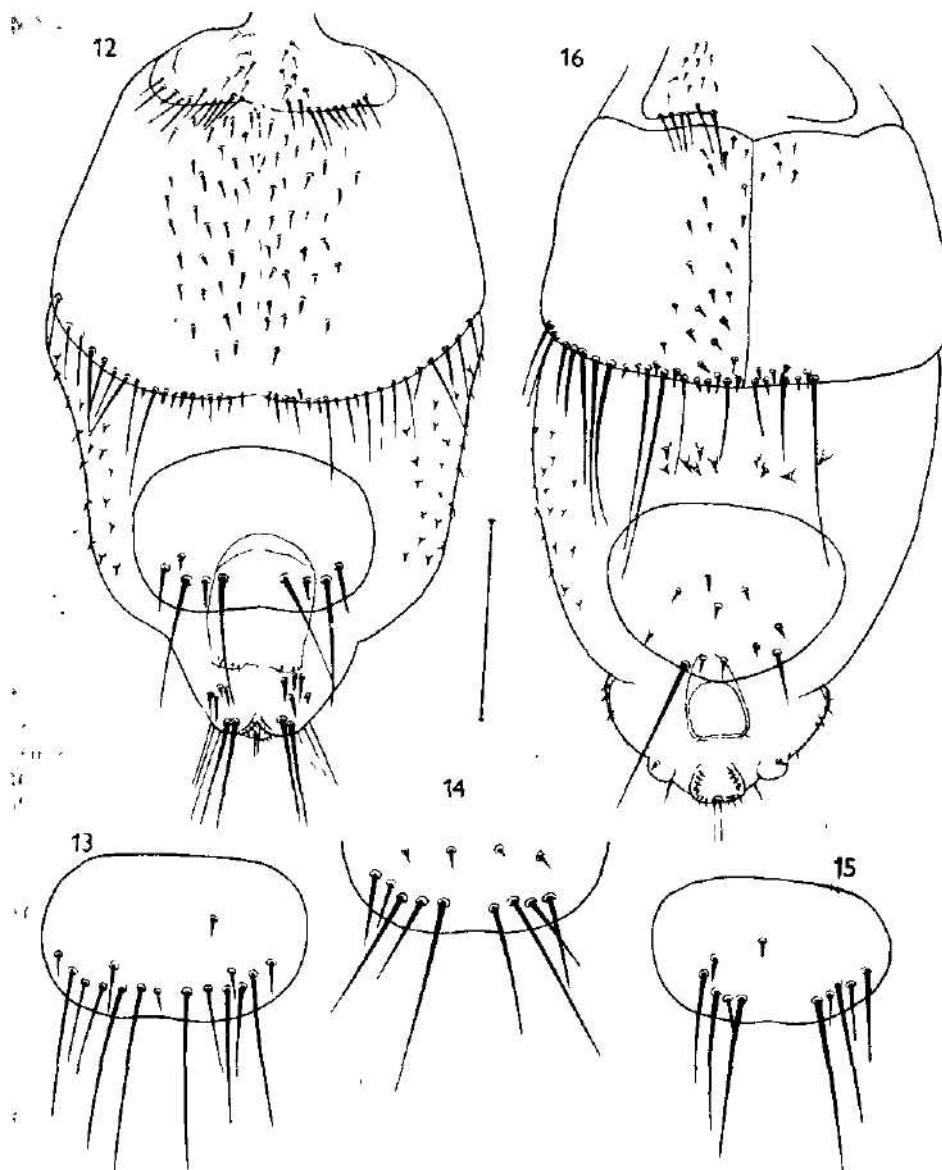
Stylidia orientalis Hürka et Povolný, 1976 nec 1968, pro partim (♂ and ♀ from western Kirgizia).

Length ♂ - 2.5-3.0 mm, ♀ - 2.7-3.0 mm. Colour brown.

Head - anterior margin with 4-8 long setae. Theca of the proboscis less than twice longer than labella (Fig. 6).

Thorax - as in *P. orientale*. 9-14 notopleural setae, there is a more or less distinct gap between the first two and remaining setae (Figs. 3, 4). Posterior margin of sternal plate with 4-7 setae at each side, one is longer than the others. Tibiae 5 times as long as wide.

Male abdomen — post-spiracular sclerite with 3—6 setae. Arrangement of sclerites and chaetotaxy as in *P. orientale*, only tergite 2 with 5—6 rows of setae on the surface. Abdominal ctenidium with 42—51 spines. Two groups of 26—34 spines in 4—5 rows along the sides of the incision on sternite 5.



Figs. 12-16. 12 — female abdomen of *P. simile* dorsal (Kirgizia); 13-15 — female tergite 6: 13 — *P. orientale*, 14, 15 — *P. simile*; 16 — female abdomen of *P. khabilovi* dorsal (holotype). Scale = 0.5 mm.

Genitalia resemble the situation in *P. orientale*, only praegonites with more curved apical process, the lower part bearing ventrally 4–6 setae placed on humps (regularly another number on each side); the base with 2 small setae (Fig. 8).

Female abdomen (Fig. 12) — post-spiracular sclerite with 4–5 setae. Tergite 2 with 2–5 longitudinal rows of short spines on each half of the tergite and with the marginal row of longer and shorter setae laterally and short spines in the middle. Tergite 6 with only 8–10 longer or shorter setae posteriorly and with 0–4 short spines on the surface (Figs. 14, 15). Abdominal ctenidium with 45–53 spines. Genital plate great and wide (length:width about 1.3), with more heavily sclerotized anterior margin, posterior corners with 4–10 hairs (Fig. 10). Other characters as in *P. orientale*.

Holotype: ♀ — northern Tajikistan, Aini, southern slopes of the mountains Turkestanskiy khrebet, 8 August, 1978, from *Rhinolophus hipposideros* (♂), in the author's collection.

Paratypes: 7 ♂, 2 ♀, same data as in holotype; western Kirgizia, Kadam-dzhay, Okhna cave (distr. Osh), 2 February, 1971, ♀, 11 April, 1972, ♂, both from *R. ferrumequinum*.

Phthiridium simile sp. n. belongs to the *P. biarticulata* group and resembles *P. orientale* (Hürka et Povolný) and *P. nuditerga* (Theodor). The differential diagnosis is given in the table.

Characters	<i>P. nuditerga</i>	<i>P. orientale</i>	<i>P. simile</i>
genital plate	length:width = 1.6, basal margin irregular, 3–5 hairs at corners	length:width = 1.6, basal margin regular, 6 hairs at corners	length:width = 1.3, basal margin regular, 4–10 hairs at corners
male sternite groups of spines number of pleural setae	5, about 35 spines in 4 rows, noto-about 12	18–19 spines in 4 rows, 14–17	3, 26–24 spines in 4–5 rows, 9–14

Phthiridium khabilovi sp. n.

Length 3 mm. Color brown.

Head — anterior margin with 6 long setae. Theca of the proboscis at most 1.5 times longer than labella.

Thorax — about as long as wide. Oblique suture forming an angle of about 75°. 9 and 10 notopleural setae, there is a conspicuous gap between the first two and the remaining setae (Fig. 2). Posterior margin of sternal plate with 5 setae at each side, one is longer. Tibiae 5 times as long as wide.

Female abdomen (Fig. 16) — post-spiracular sclerite with 4 setae. Tergite 1 with a marginal row of 6 longer setae on each side, surface with some short setae. Tergite 2 large, subdivided in the middle, with short spines in only 2–3 rows. Connexivum between tergites 2 and 6 with a group of about 10 short spines on raised tubercles; smaller spines on the pleurae. Tergite 6 large with only 2 long setae on the posterior margin and 9 shorter setae on the surface. Anal segment large with 2 small, broad processes bearing one short spine each; some short spines on the lateral sides. Abdominal ctenidium with 47 spines. Sternites 3 and 4 membranous, each with a marginal row of longer setae and with 3–4 rows of shorter setae on the surface of third sternite

and with 2 rows of shorter setae on the surface of fourth sternite. Sternites 5 and 6 divided into lateral sclerites placed close together, with a marginal row of longer setae and with 1—2 rows of shorter setae on the surface. Sternite 7 divided into 2 large triangular sclerites with longer and shorter setae posteriorly. Genital plate shield-shaped, narrow (length : width about 1.55) with heavily sclerotized anterior third and lateral and posterior margins, corners with one or two distinct setae (Fig. 11). There is a small rounded anal sclerite with 2 long setae.

Male unknown.

Holotype: ♀ (gravid), northern Tajikistan, Uč-Tepa, Mogol-Tau mountains, 15 km NW Leninabad, 6 June, 1979, from *Rhinolophus ferrumequinum*; in the author's collection.

The species is named in honor of T. K. Khabilov, Tajik chiropterologist who kindly sent me for study a collection of 84 specimens of Nycteribiidae taken from bats in northern Tajikistan.

Phthiridium khabilovi sp. n. belongs to the *P. biarticulatum* group and differs from other species of the genus in the shape and chaetotaxy of the anal segment.

Basilina nana Theodor et Moscona, 1954

Czechoslovakia (K. Hürka leg.): Bohemia sept., Adršpach, 11. 11. 1975, *M. bechsteini*, ♂, ♀; Slovakia, Juhoslovenský kras, Silická ladnica cave, 18. 2. 1968, *M. nattereri*, 4 ♂, 4 ♀. Milada cave near Silická Brezová, *M. bechsteini*, 2 ♂; Košické Belá near Košice, 3. 3. 1964, *M. myotis*, ♀. — Bulgaria: Stara planina, Karlukova, 6. 8. 1978, *M. bechsteini*, 4 ♂, 2 ♀; Breznica near Blagoevgrad, 14. 7. 1981, *M. mystacinus*, ♀. — Roumania: Mt. Banatului Mts., Socolovac cave, 2. 9. 1982, *M. bechsteini*, 6 ♂, 3 ♀, T. Scholz leg. — Azerbaijan SSR: Semakha, 26. 6. 1979, *M. nattereri*, ♀.

The findings in Bulgaria are presently the most southern in eastern Europe, Semakha in Azerbaijan represents the most easterly locality of the species, found in woody parts of Europe (from southern Great Britain and southern Sweden to northern and eastern Spain, Austria, Switzerland and Bulgaria), in Israel and Azerbaijan.

Basilina italica Theodor, 1954

Czechoslovakia: Slovakia, Dobšiná ice cave, 2. 3. 1964, *M. brandti*, ♀, K. Hürka leg.

Both females from Dobšiná were found on *Myotis brandti* (host of the first female from 1963 was redetermined as *M. brandti*, formerly given as *M. mystacinus* — Hürka, 1964: 205).

Distribution: *B. italica* was described from Italy and found only in France, Switzerland, Czechoslovakia and Poland.

Basilina m. mongolensis Theodor, 1966

Kirgiz SSR: Grigorjevka, north shore of the lake Issyk-kul, 16. 7. 1979, *M. mystacinus*, 3 ♀.

The species was originally described from western Mongolia and found also in eastern Kazakhstan; *Myotis mystacinus* is always given as a host.

Basilina mongolensis nudior Hürka, 1972

Bulgaria: Gorna Breznica, eastern slopes of Maleševska planina Mts. (altitude 500 m), 9. 7. 1983, *Myotis mystacinus*, ♂, ♀, K. Hürka leg.

The subspecies has been described from Croatia (female holotype) and Greece (Thracia, male paratype) and found now in southwestern Bulgaria. The host was preliminary determined as *M. mystacinus*.

The Bulgarian specimens agree with the original description of the subspecies by Hůrka, 1972. They differ slightly only in the number of setae and spines, showing the variability of those chaetotactic characters. Number of notopleural setae 9—11; postspiracular sclerite with 4 short and 1—2 longer bristles; hind margin of abdominal tergite 1 with 17 and 18 setae; posterior processes of tergal plate 2 in female with 3 long and 7—8 shorter setae, tergal plate 3 with 3 setae on each side of the hind margin; abdominal ctenidium with 64 spines in female and 61 spines in male; male sternite 5 with a group of 33 spines in two rows.

Penicillidia conspicua Speiser, 1901

Czechoslovakia: Slovakia mer., Drienčany near Rim. Sobota, 1968, *M. schreibersi*, 6 ♀, M. Trpiš leg. — Roumania: Mt. Sebesului Mts., pest din Sura Mare, 1. 9. 1981, *M. schreibersi*, ♂, T. Scholtz leg. — Georgian SSR: cape Picunda, 18. 7. 1974, *M. schreibersi*, ♀. — Algeria: cave Aokos, 30 km W Bejaia, 10. 12. 1981, *M. schreibersi*, ♂, Tidohs near Constantine, 20. 11. 1981, *R. mehelyi*, ♂, leg. J. Gaisler.

Distribution: southern parts of Europe (north limit France, Italy, Switzerland, southern Slovakia), North Africa, Southwest Asia eastwards to Turkmenia and Afghanistan.

Penicillidia d. dufourii (Westwood, 1835)

Czechoslovakia: Slovakia mer., Rožňava-kúpele, 17. 2. 1968, *M. myotis*, ♂, 4 ♀, leg. K. Hůrka. — Roumania: Mt. Sebesului Mts., pest din Sura Mare, 31. 8. 1981, *M. myotis*, ♂, ♀, leg. T. Scholtz; Dobrogea, Gura Dobrogei, 6. 7. 1971, *M. schreibersi*, 2 ♀, K. Hůrka leg. — Bulgaria: Stara planina Mts., Lakatnik, *M. myotis*, 10. 2. 1965, Temnata dupka, ♂, ♀, Sukhata pestera, 3 ♂, 3 ♀, K. Hůrka leg.; Stara planina Mts., Karlukovo, 4. 7. 1976, *M. schreibersi*, ♀, *M. blythi oxygnathus*, ♂, 2 ♀, K. Hůrka leg., Rodopi Mts., cave Staraja pestera near Peštera, 4. 2. 1965, *M. myotis*, 2 ♀, cave Snežanka near Peštera, 5. 2. 1965, *M. myotis*, 2 ♂, 2 ♀, K. Hůrka leg. — Yugoslavia: Croatia, Bizek near Zagreb, 7. 8. 1965, *M. capaccini*, 2 ♂, 4 ♀, J. Gaisler leg. — Algeria: cave Aokos, 30 km W Bejaia, *M. myotis*, 30. 4. 1981, ♂, ♀, *M. capaccini*, 18. 9. 1981, 3 ♂, 2 ♀, 10. 12. 1981, 2 ♂, ♀, 15. 1. 1982, ♂, ♀, *R. euryale*, 1. 10. 1981, ♂, J. Gaisler leg., Tidohs near Constantine, 20. 11. 1981, *R. mehelyi*, ♂, ♀, J. Gaisler leg. — Tunis: El Djan near Gomes, 2. 9. 1973, *M. blythi punicus*, 2 ♂, 2 ♀, H. Burda leg. — Georgian SSR: cape Picunda, 18. 7. 1974, *M. blythi oxygnathus*, ♂, *M. schreibersi*, ♂, 3 ♀ — Azerbaijan SSR: Šemakha, 26. 6. 1979, *M. myotis*, ♂ — Tajik SSR: Kuraminskiy khrebet Mts., Adrasman, 80 km SE Leninabad, *M. blythi*, 9. 4. 1978, ♂, ♀, 19. 6. 1978, ♂, 3 ♀, 19. 4. 1979, ♀, T. K. Khabilov leg.; Mogol-Tau Mts., Uč Tepa, 15 km SW Leninabad, *M. blythi*, 19. 7. 1978, ♂, 5 ♀, 22. 4. 1980, ♂, ♀, *M. emarginatus*, 6. 6. 1979, ♀, T. K. Khabilov leg.

Distribution: the nominal subspecies occurs in continental Europe (north limit Netherlands, central GFR, southern GDR, Czechoslovakia, southern Poland), North Africa and in Southwest Asia eastwards to eastern Kazakhstan and West Himalayas.

Penicillidia monoceros Speiser, 1900

Czechoslovakia: Bohemia mer., Ruda near Veselí n. L., *M. daubentoni*, 31. 7. 1980, ♀, 25. 7. 1981, 2 ♂, ♀, K. Hůrka leg.

These findings from the nursing colony of *Myotis daubentoni* confirm the stable occurrence of *P. monoceros* in central Europe.

Distribution (Fig. 1): northern part of Palearctic Region (southern limit Czechoslovakia, Poland, northeastern Kazakhstan, northern Japan).

Subfamily Cyclopodiinae

Eucampsipoda aegyptia (Macquart, 1851)

South Iran: Isin, southern foot of Kuhhay Genu Mts, 27° 19' N, 56° 17' E), 28. 4 – 6. 5. 1977, *Rousettus aegyptiacus*, 55 ♂, 53 ♀, J Ježek leg., collectio National Museum Praha.

Koch and Nader (1979) summarized the present knowledge of the distribution of this fly and her principal host. *E. aegyptia* was found in southern Turkey, Lebanon, Israel, Jordan, northern Egypt, Saudi Arabia and South Yemen.

Family Streblidae

Subfamily Nycteriboscinae

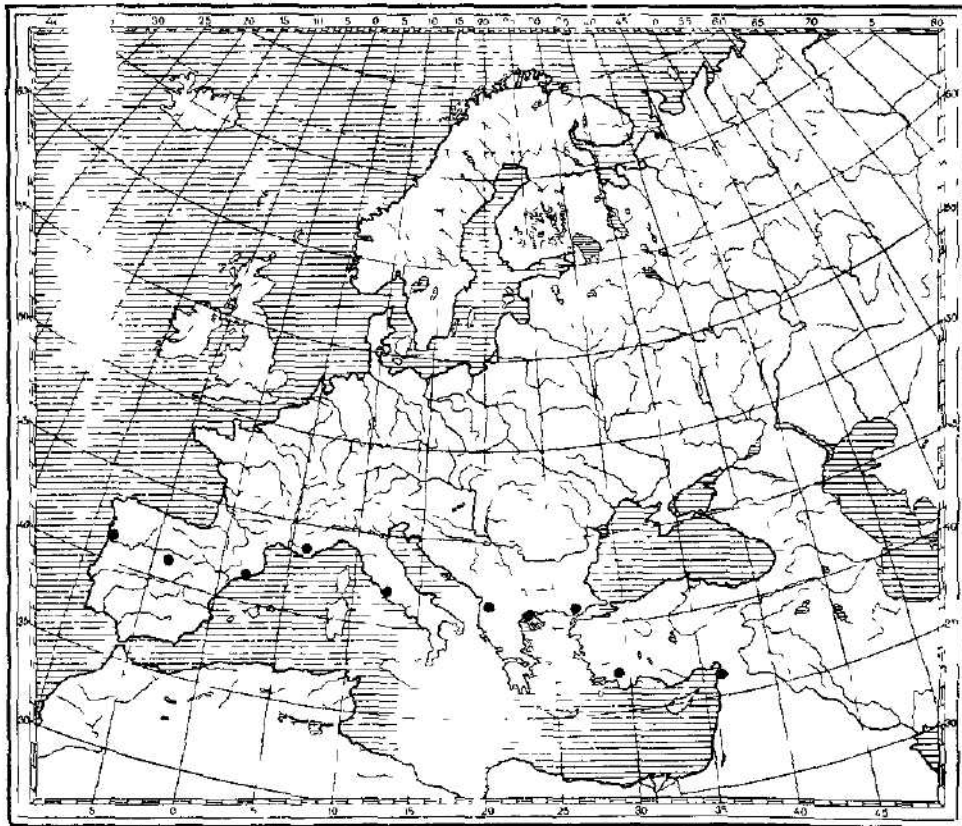


Fig. 17. Northern limit of the distribution of *Brachytarsina flavipennis* in Europe and Turkey.

Brachytarsina flavipennis Macquart, 1851

Algeria: cave near Aokos, 30 km W Bejaia, *R. blasii*, 30. 4. 1981, 2 ♂, 5 ♀. *R. euryale*, 10. 12. 1981, 3 ♀, *R. blasii* and *R. euryale*, 14. 5. 1982, 5 ♂, 12 ♀; Tidolis near Constantine, 20. 11. 1981, *R. mehelya*, 11 ♂, 7 ♀, Setif, 10. 3. 1983, *P. kuhli*, 2 ♀, all leg. J. Gaisler

Distribution: Mediterranean species found in southern Europe (northern limit see Fig. 17), North Africa and Southwest Asia eastwards to Turkmenia and Afghanistan.

Raymondia huberi Frauenfeld, 1855

South Iran: Isin, southern foot of Kuhhaye Genu Mts., 26. 5. 1973, ? *Aselia tridens*, ♀, J. Ježek leg.

In Southwest Asia *R. huberi* was recorded from Israel, Yemen and Afghanistan only; the species is distributed also in Egypt and in East Africa.

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**RESPONSE OF OP-RESISTANT TETRANYCHUS URTICAE (ACARINA) TO
PYRETHROIDS**

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Abstract. Permethrin, cypermethrin, deltamethrin and bioresmethrin showed no acaridal effectiveness against highly OP-resistant strain of *Tetranychus urticae* Koch. Flucythrinate was slightly miticidal. Cypermethrin and bioresmethrin caused the knockdown effect in treated females that partially recovered in 48 hours. Higher concentrations of cypermethrin and deltamethrin were repellent. The sublethal concentrations of all examined pyrethroids caused the increased rate of oviposition in treated females.

INTRODUCTION

Synthetic pyrethroids were introduced into the plant protection during the sixties as a new group of wide-spectral insecticides effective also against some OP-resistant insect populations. Very soon, however, an unfavourable biological impact of pyrethroids was shown, namely speeding of the selection of resistance (Farnham & Sawicki, 1976) and total eradication of natural enemies in biocenosis which often resulted in outbreaks of spider mites (Hoy et al., 1979, Hall, 1979, Riedl & Hoying, 1980).

In Czechoslovakia, pyrethroids have been used in hop gardens against *Phorodon humuli* resistant to many OP-insecticides and carbamates. After 3 treatments of an experimental hop-garden with Decis in 1979, a calamitous outbreak of the OP-resistant two-spotted spider mite occurred, which was attributed to the primary eradication of natural enemies. However, such outbreaks have been reported after the use of pyrethroids also in experiments where no predators were present in check plots (Hall, 1979, Riedl & Hoying, 1980).

In order to evaluate the influence of various factors on spider mite outbreaks connected with pyrethroids we examined the effectiveness of several compounds on the OP-resistant population of the two-spotted spider mites collected during the calamitous outbreak in an experimental hop-garden in Stekník (Central Bohemia) in 1979 (Zelený, Hrdý & Kaluschkov, 1981).

MATERIAL

Two-spotted spider mite *Tetranychus urticae* Koch of two strains was used in experiments:

1. S-strain "Mnichovo Hradiště", a strain susceptible to pesticides
2. OP-R strain "Stekník", which was highly resistant to thiometon, naled, metidathion, mevinphos and vamidothion (Hůrková & Gesner, 1980).

Both strains were bred in the laboratory on *Phaseolus vulgaris* var. *Perlička* at a temperature of 24 ± 2 °C under long photoperiod of 18 hours and relative humidity over 70%.

Pesticides used in experiments were final commercial pyrethroids supplied and examined by the Control and Examining Agricultural Institute in Brno: 1. Ripcord (25% cypermethrin), Shell; 2. Cymbush (10% cypermethrin), ICI; 3. Ambush (25% permethrin), ICI; 4. Decis EC (2.5% deltamethrin), Procida; Isathrin 100 EC (10% bioresmethrin), Procida; Cybolt (10% flucythrinate), Cyanamid. All concentrations given in this paper are those of active ingredients.

METHODS

Assays of acaricidal effect: Standard method of the detection of resistance in spider mites of FAO (Anonymus, 1974) was used discs being treated by spraying in a settling tower instead of dipping. The treated discs were infested by 10–15 migratory females of the examined strain and their mortality was evaluated after 48 hours of exposure.

Assays of ovicidal effect: Females of OP-resistant strain "Steknik" were exposed on leave discs in Petri dishes and removed after 48 hours oviposition. Discs with laid eggs were glued with starch to the bottom of the Petri dish and treated by spraying. Egg-hatching was evaluated on the fifth to sixth day when the untreated control hatching reached 95%. Both acaricidal and ovicidal assays were referred to a statistical evaluation by probit analysis. The regression lines, LC 50 and LC 90 with 95% probability limits were calculated and plotted by Hewlett-Packard 98 – 10 A.

Evaluation of the knock-down effect: Paralysis of the females treated with pyrethroids was counted 2 hours after the exposure and their recovery was evaluated after 48 hours.

Evaluation of the run-off: Percentage of the OP-resistant females that ran off the treated discs was determined in 48 hours after the exposure of females on the treated substrate.

Evaluation of oviposition: The average number of laid eggs per one OP-resistant female exposed on disc treated with the sublethal concentration of pyrethroid was counted in 48 hours. The level of oviposition was compared with that of untreated control females (C=100% oviposition).

RESULTS

Course of poisoning: The ceasing of normal palpating movements which serve to search the feeding was the first response of mites exposed on the substrate treated with pyrethroids. The sensory detectors on the first pair of legs detect danger and some pyrethroids (cypermethrin and deltamethrin) cause the "run-off" at this stage. Females which stay on the treated substrate become intensely excited in 30 minutes, palpating quickly with all legs, running

Tab. 1. Knock-down effect and recover in OP-resistant females of *Tetranychus urticae* Koch 2 and 48 hours after exposure to pyrethroids

Pyrethroid	Conc. a.i.	Total females	Knock-down in 2 hours	Mortality in 48 hours	Recover in 48 hours	% recover
Permethrin	0.01 %	164	48	68	0	0
	0.1 %	200	48	88	0	0
Cypermethrin	0.01 %	208	44	28	16	36.3
	0.1 %	144	118	40	88	68.7
Bioresmethrin	0.1 %	196	148	40	108	72.9
	0.5 %	192	188	60	128	68.0
Deltamethrin	0.01 %	144	56	96	0	0
	0.1 %	140	85	120	0	0

Tab. 2. Acaricidal effectiveness of examined pyrethroids on susceptible and OP-resistant two-spotted spider mites *Tetranychus urticae* Koch

Pyrethroid	Strain	Equation of regression line	LC 50 % a. i.	(95 % probability limits)	LC 90 % a. i.	RF
Flucythrinate	S	$y = 1.72x + 1.67$	0.0008	(0.0006 - 0.0010)	0.0047	—
	R	$y = 1.37x + 2.63$	0.0005	(0.0004 - 0.0007)	0.0044	0.62
Deltamethrin	S	$y = 1.86x + 2.12$	0.0034	(0.0027 - 0.0034)	0.0169	—
	R	$y = 1.10x + 3.08$	0.0054	(0.0039 - 0.0073)	0.0787	1.58
Cypermethrin (Cymbush)	S	$y = 3.24x + 1.47$	0.0122	(0.0106 - 0.0140)	0.0303	—
	R	$y = 2.66x + 1.03$	0.0309	(0.0272 - 0.0350)	0.0937	2.35
Permethrin	S	$y = 3.20x + 0.77$	0.0208	(0.0178 - 0.0234)	0.0529	—
	R	$y = 1.16x + 2.34$	0.1962	(0.1230 - 0.3120)	2.5083	9.42
Cypermethrin (Ripcord)	S	$y = 1.38x + 2.20$	0.0497	(0.0403 - 0.0614)	0.2953	—
	R	$y = 1.64x + 2.07$	0.1229	(0.0940 - 0.1606)	1.0134	2.46
Bioresmethrin	S	$y = 0.80x + 3.37$	0.1060	(0.0627 - 0.1658)	4.1728	—
	R	$y = 0.77x + 2.86$	0.5547	(0.2395 - 1.1262)	24.4450	5.25

from place to place until the locomotion becomes uncoordinated and paralysis begins with the caudal pair of legs. Then the apical legs pull feebly the body for some time and total paralysis of the females occurs in 2 hours after the first contamination. This paralysis was partially reversible with bioresmethrin and cypermethrin (Ripcord) (Tab. 1). The phase of knock-down which precedes the total paralysis is different from that known in flying insects. Knocked-down females of the spider mites do not fall on their back but they remain clinging stiffly to the substrate until they are totally paralysed.

Acaricidal effectiveness (Tab. 2) of permethrin, deltamethrin, cypermethrin and bioresmethrin was very low, characterized by insignificant increase of mortality over the large range of concentrations which is typical of unspecific poisoning (slope $b = 0.77$ to 3.2 , average slope $b = 1.7$). LC 50 varied between 0.0034% to 0.106% in S-strain and between 0.0054% to 0.5547% in R-strain.

Tab. 3. Ovicidal effectiveness of pyrethroids on OP-resistant eggs *Tetranychus urticae* of 0-24 hours of age

Pyrethroid	Conc. a.i.	Number of eggs	Number of unhatched eggs	Effectiveness according to Abbott formula
Untreated control	—	208	4	—
Flucythrinate	0.01	205	4	0
Deltamethrin	0.1	123	6	1.9
	0.05	118	2	0
	0.005	147	2	0
Cypermethrin	0.2	213	18	6.0
	0.1	79	3	1.2
	0.01	92	2	0
Permethrin	1.0	210	65	29.1
	0.1	146	17	9.6
	0.01	79	6	5.1
Bioresmethrin	1.0	165	2	0

Tab. 4. Run-off females of OP-resistant strain *Tetranychus urticae* Koch of the substrate treated with pyrethroids

Pyrethroid	Conc. a.i.	Number of exposed females	Number of run-off in 48 h.	% run-off
Permethrin	0.01	128	51	39.5
	0.001	120	11	9.0
Cypermethrin (Ripcord)	0.1	124	124	100.0
	0.01	120	54	45.0
Cypermethrin (Cymbush)	0.1	119	44	37.0
	0.01	128	38	30.0
Deltamethrin	0.01	126	41	32.5
	0.001	120	0	0
Bioresmethrin	0.1	121	17	14.0
	0.01	128	9	7.0
Flucythrinate	0.01	123	33	26.8
	0.001	121	12	9.9

The resistance factors when based on comparison of LC 50 values were 1.58 to 9.42 proving minimal differences in effectiveness against the susceptible and resistant spider mites. LC 90 for permethrin, cypermethrin (Ripcord) and bioresmethrin in the OP-resistant strain were 1.0%, 4.1% and 24.4% which cannot be applied in practise.

Only flucythrinate (Cybolt) had a miticidal effect (LC 50 = 0.0008% for S-strain and 0.0005% for R-strain) with slightly negatively correlated effectiveness against OP-resistant two-spotted spider mites (resistance level according to LC 50 = 0.62%) (Tab. 2).

Ovicidal effectiveness (Tab. 3) was none in recommended dosages. Only 1% permethrin showed a low ovicidal effect.

Run-off effect (Tab. 4): A significant repellent activity was proved in cypermethrin (Cymbush). In other pyrethroids examined, the run-off was higher in higher concentrations used in experiments.

Oviposition (Tab. 5) was higher in all examined pyrethroids in sublethal concentrations (causing no mortality of the treated females) as compared with the untreated control. Some of those sublethal concentrations were those recommended in practise for the insect pest control.

Tab. 5. Oviposition of OP-R females *Tetranychus urticae* Koch exposed on substrates treated with sublethal dosages of pyrethroids

Pyrethroid	Conc. a.i.	Number of females exposed	Number of eggs laid in 48 h.	Average eggs per 1 female	Ratio to untreated control
Untreated control	—	120	804	6.7	100 %
Permethrin	0.0001	124	1112	8.9	132.8
	0.00001	128	1104	8.6	128.3
Cypermethrin	0.0001	96	704	7.3	108.9
	0.00001	132	924	7.0	104.4
Deltamethrin	0.00001	128	968	7.5	109.5
	0.000005	128	984	7.7	114.6
Bioresmethrin	0.001	128	1008	7.8	117.4
	0.0001	82	632	7.7	114.9

DISCUSSION

Determined toxicity for spider mites of 6 examined pyrethroids with 5 different active ingredients corresponds with the known fact that so-called "classical pyrethroids" (permethrin, cypermethrin, deltamethrin and bioresmethrin) have no miticidal effectiveness, especially in dosages used for insect control.

Unsignificant differences in LC 50 for S- and R-strain prove the unspecific toxic effect. However, Croft & Wagner, 1981 found flat regression lines also in some "acaricidal pyrethroids" and they interpret them as an increased heterogeneity of spider mite populations which facilitates the selection of resistance.

From the view of practical use, we see some handicap of pyrethroids also in fact that the sublethal dosages for OP-resistant spider mites which are recommended for practical insect control (for example against Dampson hop aphid *Phorodon humuli*) caused an increased excitement and activity of treated females and, consequently, higher oviposition rates which speeds the outbreak.

Apart from some interesting theoretical aspects of the mode of pyrethroid poisoning in spider mites (excitation, knock-down, paralysis and recover) we did not find permethrin, cypermethrin, deltamethrin and bioresmethrin as very useful in some integrated plant protection programs, especially due to their unspecific wide-spectral insecticidal activity and their unfavourable side-effect on non-target pests like spider mites in hop-gardens, vineyards, orchards and green-house crops.

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**THE HELMINTH PARASITES FROM AMPHIBIANS OF VANCOUVER ISLAND,
B. C., WESTERN CANADA**

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Abstract: Small samples of two amphibian species, the rough-skinned newt (*Taricha granulosa*) and the red-legged frog (*Rana aurora*), were collected from Vancouver Island, B. C., Canada, and examined for helminths. The parasites recovered included 3 species of digenean trematodes (*Megalodiscus microphagus*, *Glyphelmis californiensis*, *Brachycoelium salamandrae*) and 4 species of nematodes (*Rhabdias joaquinensis*, *Cosmoceroides dukae*, *Megalobatrachonema* sp., *Hedruris androphora*). The occurrence of *H. androphora* and *Megalobatrachonema* sp. represents the first record of these nematodes from North America. All the parasites, which are redescribed and illustrated, are recorded for the first time from western Canada. Some problems concerning the taxonomy and geographical distribution of these helminths are also discussed.

Although there is an extensive literature on helminth parasites of North American amphibians, most reports refer to the territory of the United States. In Canada, attention to these parasites was paid practically in eastern regions only (e. g. Stafford, 1900, 1903; Anderson, 1960; Baker, 1977; Adamson, 1981), and primarily to the parasites of anurans. The present report is the first survey of amphibian helminths from Vancouver Island and apparently from all British Columbia; the closest regions where these parasites have been studied are California and Oregon in the U.S.A. (e. g. Cort, 1919; Harwood, 1932; Ingles, 1936)¹ which have some amphibian species common with Vancouver Island. Regarding the scarcity of published data dealing with the helminth fauna of amphibians of western North America, I consider it useful to present a survey of the helminths found in two species of amphibians from Vancouver Island, British Columbia, during my short visit to Canada in 1979. Occasionally, 10 specimens of the rough-skinned newt (*Taricha granulosa* Skilton) (fam. Salamandridae) and 2 specimens of the red-legged frog (*Rana aurora* Baird et Girard) (fam. Ranidae) were examined;² according to Behler and King (1979) both these species are distributed in North America along the Pacific coast only. The helminth specimens have been deposited in the collection of the Institute of Parasitology, Czechoslovak Academy of Sciences, Prague.

¹) Laboratory facilities for this work were kindly provided by Dr. Leo Margolis, head of the parasitological laboratory, Department of Fisheries and Oceans, Pacific Biological Station, Nanaimo, B. C., to whom my thanks are due.

SURVEY OF HELMINTH SPECIES

Trematoda

Fam. Paramphistomidae Fischeoeder, 1901

1. *Megalodiscus microphagus* Ingles, 1936 (Fig. 1 A—C)

Hosts: *Rana aurora* Baird et Girard, *Taricha granulosa* Skilton.

Location: intestine.

Localities: Nanaimo (29 April 1979) and De Mamiel Creek (a tributary of Sooke River) (7 May 1979), Vancouver Isl., B. C.

Prevalence: in the only *R. aurora* examined from the De Mamiel Creek (3 specimens) and in 3 out of 10 *T. granulosa* from Nanaimo (intensity 1—8 specimens).

Description of specimens from *R. aurora*: Length of body 1.56—1.84 mm, maximum width 0.666—0.884 mm. Oral sucker terminal, 0.163—0.217 mm in diameter, with distinct diverticula 0.090—0.096 mm long. Acetabulum large, ventroterminal, size 0.530—0.707 × 0.503—0.639 mm, being somewhat narrower than body. Length of oesophagus some 0.075 mm, size of oesophageal bulb 0.090—0.105 × 0.060—0.072 mm. Wide undulating caeca extending posteriorly up to anterior margin of acetabulum. Testes large, intracaecal, diagonal; size of anterior testis 0.217—0.245 × 0.163 mm, of posterior testis 0.190—0.272 × 0.150—0.177 mm. Genital pore situated below oesophageal bulb, size of genital bursa 0.081 × 0.060 mm. Ovary almost spherical, size 0.105—0.163 × 0.057—0.109 mm, situated in medial line approximately in mid-way between posterior testis and anterior margin of acetabulum. Vitellaria formed as two lateral groups of 9—10 follicles each, distributed in intracaecal space between testes and acetabulum. Size of eggs 0.096—0.111 × 0.054—0.060 mm.

Description of specimens from *T. granulosa*: Body length of mature specimens 3.22—4.42 mm, maximum width 1.074—1.292 mm. Size of oral sucker 0.313—0.381 × 0.286—0.353 mm. Acetabulum somewhat narrower than body, size 0.870—1.061 × 0.857—0.979 mm. Oesophagus 0.231—0.245 mm long, size of oesophageal bulb 0.123—0.204 × 0.078—0.109 mm; length of diverticula 0.316—0.163 mm. Wide undulating caeca reaching to anterior margin of acetabulum. Testes irregularly oval-shaped, smaller than ovary, situated diagonally; size of anterior testis 0.204—0.245 × 0.136—0.204 mm, of posterior testis 0.150—0.272 × 0.136—0.321 mm. Size of genital bursa 0.121—0.132 × 0.060—0.084 mm. Ovary almost spherical, size 0.190—0.313 × 0.177—0.272 mm. Vitellaria formed as two lateral intracaecal groups of follicles (14 each) situated in space between testes and acetabulum. Size of eggs 0.105—0.135 × 0.057—0.084 mm.

Comments: — According to Yamaguti (1971) this species, originally described from California, has been reported from the hosts *Bufo boreas*, *Dicamptodon ensatus*, *Hyla regilla*, *Rana aurora* and *Taricha granulosa*. This species is, however, very close by its morphology and measurements to another North American species, *M. temperatus* (Stafford, 1905), from which it should differ mainly in having the acetabulum narrower than body; it is probable (see Skrjabin 1949) that further studies will prove identity of both these species. *M. microphagus* has not been hitherto reported from western Canada.

While our specimens from *Rana aurora* are more or less in accordance with species description, two adult specimens from *T. granulosa* differ from it markedly in having their testes smaller than the ovary (testes should be considerably larger than ovary in *M. microphagus*). However, the juvenile trematodes from the same host species possess the testes distinctly larger than the ovary

(Fig. 1C); these were noted for the presence of well demarcated pigmented eye-spots and the body size of the smallest specimen was 0.938×0.340 mm. It is probable that testes become comparatively smaller in old specimens and, therefore, I consider all trematodes from *T. granulosa* to be *M. microphagus*; moreover, *T. granulosa* has been earlier reported as the host for this trematode species.

Fam. Macroderoididae McMullen, 1937

2. *Glypthelmins californiensis* (Cort, 1919) (Fig. 1 D, E)

Host: *Rana aurora* Baird et Girard.

Location: intestine.

Localities: Nanaimo (29 April 1979) and De Mamiel Creek (7 May 1979), Vancouver Isl., B. C.

Prevalence: in the only *R. aurora* examined from Nanaimo (2 specimens) and in the only *R. aurora* from De Mamiel Creek (3 specimens).

Description: Length of body 2.11–4.15 mm, maximum width 0.898–1.156 mm. Cuticle finely spinose. Oral sucker distinctly larger than acetabulum; size of oral sucker $0.231\text{--}0.354 \times 0.258\text{--}0.367$ mm, of acetabulum $0.159\text{--}0.231 \times 0.174\text{--}0.218$ mm. Pharynx muscular, measuring $0.075\text{--}0.135 \times 0.129\text{--}0.171$ mm, length of oesophagus 0.136–0.340 mm. Pharyngeal glands present. Caeca extending posteriorly to approximately $\frac{3}{4}$ of body length. Testes spherical, intracaecal, size $0.299\text{--}0.408 \times 0.218\text{--}0.326$ mm, situated symmetrically at about mid-body length. Genital pore just preacetabular; size of cirrus sac $0.340\text{--}0.476 \times 0.136\text{--}0.163$ mm. Ovary spherical, distinctly smaller ($0.177\text{--}0.299 \times 0.163\text{--}0.231$ mm) than testes, situated intracaecally at level of acetabulum on opposite side to cirrus sac. Uterine loops filling in almost whole space of posterior half of body and that between acetabulum and testes. Size of eggs $0.045\text{--}0.051 \times 0.024\text{--}0.030$ mm. Vitellaria forming two lateral groups of follicles, starting anteriorly at level of posterior margin of pharynx or at half of oesophagus length and extending posteriorly at most to half of testes.

Comments: — *G. californiensis* was originally described from *Rana aurora* and *R. boylei* from California and later it was also recorded from Mexico (Cabalero and Sokoloff, 1934). A detailed comparison of this species with the type species of the genus *Glypthelmins*, *G. quieta* (Stafford, 1900), was carried out by Miller (1930) who concluded that both these species could be distinguished by the presence or absence of pharyngeal glands only. Regarding a considerable variability in the range of vitellaria in *G. quieta*, Miller (op. cit.) did not consider the differences in the vitellaria extent to be a suitable differential character. Our specimens, originating from the same host species from which *G. californiensis* was described, and also from the close geographical area, are noted for the presence of pharyngeal glands like *G. quieta*; this would suggest that *G. quieta* and *G. californiensis* are identical. However, the extent of vitellaria seems to be different in these species. The vitellaria of *G. californiensis* reach posteriorly at most the level of posterior ends of testes according to the original description and only anterior ends of testes according to Cabalero and Sokoloff (1934); in our specimens the vitellaria extend posteriorly at most to mid-testes. In *G. quieta* the vitellaria always surpass the posterior margin of testes and usually extend much more posteriorly (see Stafford, 1900; Miller, 1930; Rankin, 1944). Therefore, for the time being, I consider *G. californiensis* to be a valid species; the definitive solution

of this question will only be possible when more numerous materials are available. *G. californiensis* has not been hitherto reported from Canada.

Fam. Brachycoeliidae (Looss, 1899)

3. *Brachycoelium salamandrae* (Froelich, 1789) (Fig. 2A)

Host: *Taricha granulosa* Skilton.

Location: intestine.

Locality: Nanaimo, Vancouver Isl., B. C. (29 April 1979).

Prevalence: in 3 out of 10 *T. granulosa* examined (intensity 3–5 trematodes per host).

Description: Length of body 1.40–1.93 mm, maximum width 0.530–0.598 mm. Cuticle finely spinose. Oral sucker distinctly larger than acetabulum; size of oral sucker 0.190–0.213 × 0.217–0.225 mm, of acetabulum 0.135 × 0.150 mm. Muscular pharynx measuring 0.054 × 0.060 mm, length of oesophagus 0.090–0.135 mm. Caeca short (length 0.210–0.270 mm), wide, preacetabular. Testes spherical, size 0.153–0.198 × 0.123–0.180 mm, postacetabular, situated approximately at middle of body. Genital pore just preacetabular, size of cirrus sac 0.129–0.144 × 0.060–0.069 mm. Almost spherical ovary somewhat smaller (0.120–0.135 × 0.111–0.102 mm) than testes, situated laterally at acetabulum level on same side as cirrus sac. Uterine loops filling in posterior half of body and space between testes and acetabulum. Size of eggs 0.060–0.066 × 0.030–0.039 mm. Vitellaria forming two lateral groups of follicles starting anteriorly at level of caeca bifurcation and extending posteriorly to level of anterior margin of testes.

Comments: — A number of species of the genus *Brachycoelium* has been described from North American amphibians the validity of which is considerably doubtful mainly because of the great morphological variability of these trematodes. According to the classic study of Rankin (1938) this genus is represented in North America by a single species, *B. salamandrae*. Nevertheless, some authors (e. g. Parker, 1941; Cheng, 1958; Cheng and Chase, 1961; Couch, 1966) do not agree with it, recognizing the existence of as many as 12 North American species of *Brachycoelium*. However, because of variation in so-called specifically valid characters, the distinction of these species is doubtful (Dyer and Brandon, 1973). From these reasons I consider our specimens to be *B. salamandrae*.

B. salamandrae has already been found in *Taricha granulosa* from Oregon in the U.S.A. by Lehmann (see Dyer and Brandon, 1973). This trematode is a parasite of various species of caudate amphibians in Europe and North America; it has not been so far reported from western Canada.

Nematoda

Fam. Rhabdiasidae Railliet, 1961

4. *Rhabdias joaquinensis* Ingles, 1936 (Fig. 2 B–D)

Host: *Rana aurora* Baird et Girard.

Location: lungs.

Locality: Nanaimo, Vancouver Isl., B. C. (29 April 1979).

Prevalence: in the only *R. aurora* examined 2 specimens were found.

Description: Medium sized nematodes. Body covered by thick, loosened undulating cuticle. Body length 8.31–8.91 mm, maximum width 0.476–0.517 mm. Small buccal capsule present, measuring 0.012 × 0.015–0.018 mm. Whole

oesophagus muscular, 0.530—0.571 mm long, somewhat expanded shortly in front of nerve ring and also near its posterior end. Distance of nerve ring from anterior extremity 0.245—0.258 mm. Vulva in both specimens situated 4.28 mm from anterior end of body. Size of embryonated eggs 0.090—0.114 × 0.048—0.057 mm. Tail conical, 0.403—0.406 mm long.

Comments: — This species was described from the same host species from California from the U. S. A. (Ingles, 1936). It has not been reported so far from the territory of Canada.

Fam. Cosmocercidae Travassos, 1925

5. *Cosmocercoides dukae* (Holl, 1928) (Fig. 2 E-I)

Host: *Taricha granulosa* Skilton.

Location: rectum and intestine.

Locality: Nanaimo, Vancouver Isl., B. C. (29 April 1979).

Prevalence: in 5 out of 10 *T. granulosa* examined (intensity 2—6 specimens per host).

Description: Small, whitish nematodes of fusiform body. Oesophagus anteriorly with short pharynx, posteriorly with bulb provided with valvular apparatus. Excretory pore situated slightly below nerve ring level.

Male: Length of body 1.86—4.56 mm, maximum width 0.136—0.340 mm. Length of whole oesophagus 0.489—0.707 mm, of which length of pharynx 0.045—0.075 mm; diameter of bulb 0.069—0.114 mm. Distance of nerve ring from anterior extremity 0.180—0.272 mm, of excretory pore 0.285—0.517 mm. Two spicules, 0.270—0.381 mm long, and gubernaculum, 0.126—0.135 mm long, present. Large complex papillae, each surrounded by small rosette, present in number of 13—16 subventral pairs and 1 lateral pair; last pair of subventral papillae postanal, remaining pairs preanal. Simple papillae of fairly irregular distribution: several preanal pairs and 7—8 postanal pairs present. In addition to paired papillae, small unpaired papilla present on anterior lip of cloaca. Tail conical, 0.126—0.165 mm long, terminating in sharp point.

Female: Body length of gravid females 4.49—5.40 mm, maximum width 0.367—0.408 mm. Length of whole oesophagus 0.612—0.789 mm, of which length of pharynx 0.045—0.060 mm; diameter of bulb 0.090—0.120 mm. Distance of nerve ring from anterior extremity 0.300—0.340 mm, of excretory pore 0.367—0.462 mm. Vulva postequatorial, 1.77—1.95 mm from posterior end of body. Eggs oval-shaped, thin-walled, size 0.063—0.075 × 0.036—0.039 mm. Tail conical, 0.165—0.273 mm long, ending in sharp point.

Comments: — According to Dyer and Brandon (1973) this species is widely distributed in North America where it has been recorded from a number of terrestrial and aquatic amphibians and reptiles from the U. S. A. and Canada; caudate amphibians (*Amblystoma*, *Desmognathus*, *Eurycea*, *Hemidactylium*, *Notophthalmus*, *Plethodon*) are its most frequent hosts. It has also been recorded from members of the genus *Taricha*, namely from *T. torosa* from California and Florida and from *T. granulosa* from Oregon according to Dyer and Brandon (1973). In Canada it has been found by Anderson (1960) in Ontario; it has not been hitherto recorded from western Canada.

Specimens of the present material show considerably greater degree of morphological and metrical variability in *C. dukae* than it has been indicated by available descriptions of this species (Holl, 1928; Harwood, 1930; Ogren, 1953).

Fam. Subulascarididae Freitas et Dobbin, 1957

6. *Megalobatrachonema* sp. (Fig. 3 A—C)

Host: *Taricha granulosa* Skilton.

Location: intestine.

Locality: Nanaimo, Vancouver Isl., B. C. (29 April 1979).

Prevalence: in 1 out of 10 *T. granulosa* examined the only nematode (♀) was found.

Description (female): Medium sized whitish nematode 20.09 mm long and 0.680 mm wide. Mouth surrounded by three little developed lips 0.015 mm long. Three small cone-shaped oesophageal teeth present. Whole oesophagus almost cylindrical, being somewhat expanded near its posterior end only; anterior part of oesophagus forming short pharynx. Length of whole oesophagus 1.50 mm, that of pharynx 0.108 mm. Distance of nerve ring from anterior extremity 0.462 mm, of excretory pore 1.32 mm. Vulva situated at posterior half of body, 6.81 mm from posterior end. Eggs oval-shaped, size 0.099×0.063 mm. Tail conical, 0.911 mm long.

Comments: — So far, there are known only two species in this genus of which *M. terdentatum* (Linstow, 1890) (syn. *M. campanae* Chabaud et Golvan, 1957) is parasitic in European newts and *M. nipponicum* Yamaguti, 1941 in *Megalobatrachus japonicus* in Japan. The female specimen of the present material corresponds by its morphology and measurements exactly to the species *M. terdentatum*, as it was redescribed by e. g. Hartwich (1960) or Baruš and Groschafft (1962), and it is probable that it belongs to this species. However, regarding the fact that this parasite has not been hitherto reported from North America and because no males were available, the nematode found is designated as *Megalobatrachonema* sp. only. It is the first record of a member of the genus *Megalobatrachonema* from North America.

Fam. Hedruridae Railliet, 1916

7. *Hedruris androphora* Nitzsch, 1821 (Fig. 3 D—G)

Host: *Taricha granulosa* Skilton.

Location: stomach and intestine.

Locality: Nanaimo, Vancouver Isl., B. C. (29 April 1979).

Prevalence: in 4 out of 10 *T. granulosa* examined (intensity 2—3 specimens).

Description: Medium sized, whitish nematodes with transversely striated cuticle. Mouth surrounded by 4 large lips (2 lateral and 2 medial) characteristic of genus. Oesophagus not divided into muscular and glandular parts. Excretory pore situated below level of nerve ring.

Male: Length of body 6.47—8.16 mm, maximum width 0.204—0.286 mm. Lips 0.069—0.082 mm long. Length of oesophagus 0.76—1.12 mm. Distance of nerve ring from anterior extremity 0.218—0.258 mm, of excretory pore 0.313—0.354 mm. Posterior end of body spirally coiled. Tail conical, 0.449—0.653 mm long, with rounded tip. Copulatory apparatus of complex structure, consisting of two sclerotized pieces (spicules) 0.180—0.213 mm long, combined between each other by their distal parts; in addition to them, unpaired elongate ventral sclerotized formation 0.075—0.078 mm long present. Caudal papillae: 1 pair of preanals and 8 pairs of postanals present; first pair of postanal papillae may be taken as well for adanal papillae. Well developed longitudinal cuticular ridges present on ventral surface of body at preloacal region.

Female: Length of body 5.74—10.03 mm, maximum width 0.367—0.870 mm (length of gravid females 7.00—10.03 mm, maximum width 0.503—0.870 mm). Lips 0.066—0.090 mm long. Length of oesophagus of smallest female 0.720 mm. Distance of nerve ring from anterior extremity 0.218—0.272 mm, of excretory pore 0.299—0.435 mm. Posterior part of body thickened, posterior end retractile, forming fixative organ; posterior end of body provided with small spike. Distance of anal opening from posterior end of body 0.340—0.381 mm. Vulva situated shortly in front of anus, 0.75—1.29 mm from posterior end of body. Mature eggs embryonated, provided with two small round lateral processes. Size of eggs 0.036—0.051 × 0.018—0.242 mm.

Comments: — The genus *Hedruris* Nitzsch, 1821 includes several morphologically closely related species parasitic mainly in amphibians, less frequently in reptiles or fishes. After Skrjabin and Sobolev (1963) three species are reported from caudate amphibians in North America: *H. siredonis* Baird, 1858, *H. brevis* Walton, 1930 and *H. chandleri* Freitas et Lent, 1941. However, our specimens from *T. granulosa* correspond both in their morphology and measurements to the description of the European species *H. androphora* Nitzsch, 1821, recently redescribed in detail by Petter (1971). It is probable that *H. brevis*, described from North American newts, is a synonym of the latter species from which it differs in somewhat smaller body measurements only. Also the species *H. tiara* Van Cleave et Mueller, 1932, being described from only two specimens found in the stomach of North American fishes (*Esox*, *Erimyzon*), seems to be identical with *H. androphora*; apparently fishes acquired these nematodes accidentally while feeding on current definitive hosts — newts. The finding of *H. androphora* in fishes has been recorded also in Europe (pers. comm. of Dr. E. Kritscher, Austria).

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

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DENDROBAENA BAKSANENSIS SP. N. (OLIGOCHAETA, LUMBRICIDAE), A NEW EARTHWORM FROM CAUCASUS, USSR

Václav PÍŽL

Received March 10, 1983

Abstract: *Dendrobaena baksanensis* sp. n. is described from Caucasus (USSR).

The systematics of the genus *Dendrobaena* Eisen, 1874 is one of the most complex in the family Lumbricidae, a fact which has been illustrated by many authors, e. g. Gates (1979), Perel (1979) and Zicsi (1978).

In a meadow near Djanchoteko have been found seven specimens of a lumbricid of the genus *Dendrobaena* which represents a new species described in this study.

Dendrobaena baksanensis sp. n.

Diagnosis: Length 85—145 mm; setae separated, pigmentation red-purple. Clitellum on the 26.—32. segments, tuberculae pubertatis appear on 29., 30.—32. segments. Two pairs of spermathecae in 9. and 10. segments.

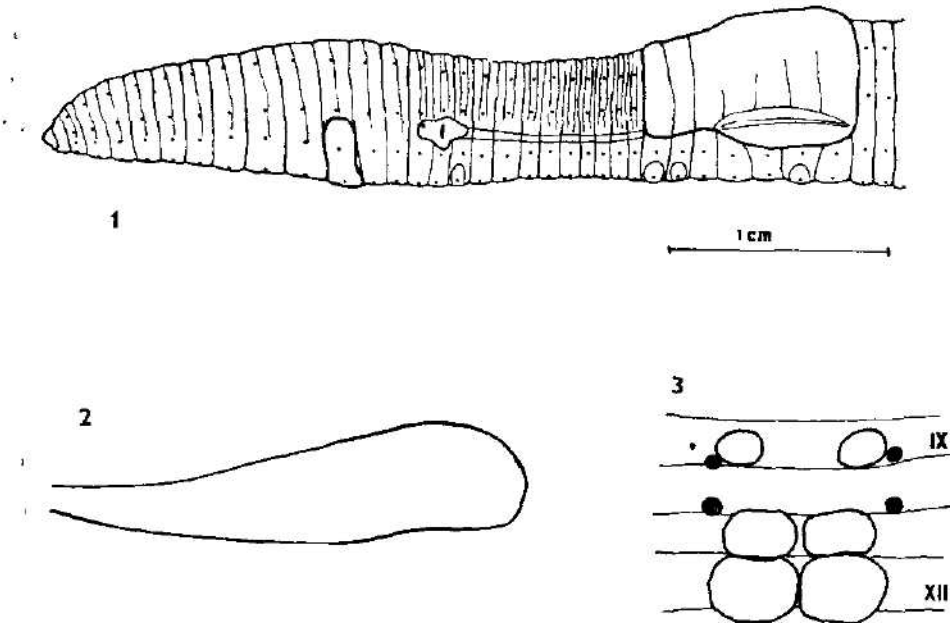
Description

External morphology: Length 85—145 mm, diameter 5—6 mm, number of segments 107—133, weight of fixed specimens 1731—1981 mg. In vivo red-purple with fore-hind and dorsoventral gradient, clitellum pink. After fixing they became more lightly red. During fixation yellowish substance expelled through dorsal pores. Setae separated, with following relative distances in 20. segment: aa: 9,5, ab: 7, bc: 10,4, cd: 11 and dd: 21. Prostomium epilobous open (1/2—3/4). First dorsal pore in intersegmental groove 5/6, well apparent. Nephridial pores at B line level. Spermathecal pores near intersegmental grooves 9/10 and 10/11, at c level. Female pores in 14. segment close to b with little glandular edge. Male pores in segment 15 with developed glandular lips. they extend over 14th and 16th segments.

Clitellum saddle shaped in segments 26—32, where setae and intersegmental grooves badly visible or invisible. Tubercula pubertatis appear on segments 29,30—32, in form of two linear widenings in the ledge of clitellum (Fig. 1). Setae a, b on segment 11 often on large white genital tumescences, on 16., 26., 27. and 31. segments they have little aureolas.

Internal anatomy: Musculature of transitional type. Septa 6/7 and 8/9 broadened. Nephridial bladders sausage-like shaped (Fig. 2). Morren's glands with lamelles in 11th and 12th segments, with no visible extramurals dilatation.

Craw in segments 15 and 16, gizzard in 17 and 18. Three pairs of seminal vesicles in 9, 11 and 12, the first two smaller than the third one (Fig. 3). Two pairs of spermathecae in 9 and 10, roundish, filled with spermatozoa in studied dissected specimens.



figs. 1-3. *Dendrobaena baksanensis* sp. n.: 1 - anterior part of the body (lateral view), 2 - shape of the nephridial bladder (in 18th segment); 3 - repartition of vesiculae seminales and spermathecae.

Affinity: There are some species near to the new one, but all can be differentiated by a set of characters, mainly by the position of clitellum, tuberculae pubertatis and by their internal anatomy. Closest related to *D. baksanensis* is *D. faucium* Michaelsen 1910. The clitellum occupies the same segments in both species, but the position of tuberculae pubertatis and of the genital papillae are different in both species, as well as the number of segments and the length. In *D. faucium* are the tuberculae pubertatis on 31st-32nd segments (in sp. n. on segments 29,30-32), the genital papillae on 10,11 or 12 (in sp. n. on 11, 16, 26, 27 and 31). Length of *D. faucium* is 45-70 mm, number of segments 82-105 (in sp. n. 85-145 and 107-133 respectively).

Locus typicus: USSR, Great Caucasus, Baksan valley, near Djanchoteko, 1100 m a s l., in soil of a wet mountainous meadow (by digging), 24. IX. 1982, 7 specimens leg. J. Obúch

Holotype VPC 41 and six paratypes (three dissected) VPC 4/2-7 in author's collection in Laboratory of Soil Biology, Czechoslovak Academy of Sciences, at Česká Budějovice

Ecological notes: Together with the new species were collected *Dendrobaena rubida tenuis* (Eisen, 1874) and *Eisenia foetida* (Savigny, 1826).

Derivatio nominis: The name is derived from the Locus typicus the valley Baksan.

Acknowledgement

I am very obliged to Dr. J. Obúch (Museum of the Váh-Region, Žilina) for providing the material for study.

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**A STUDY ON PARAMESOTRITON DELOUSTALI IN CAPTIVITY, WITH
DESCRIPTIONS OF THE EGG, THE LARVA, THE JUVENILE AND THE ADULT
(AMPHIBIA: CAUDATA: SALAMANDRIDAE)**

Ivan REHÁK

Received July 21, 1983

Abstract: For six years, studies were made of salamanders of the species *Paramesotriton deloustali* in captivity. Within this period, the animals reproduced twice successfully and both larvae and juveniles were reared. An analysis was made of a number of bionomic phenomena such as daily and seasonal activities, aggressive behaviour, feeding habits, moulting, courtship behaviour, oviposition, larval and juvenile behaviour. In addition, descriptions were given of the individual, developmental stages and of changes during the development. The adult of *P. deloustali* is an aquatic amphibian, it reproduces during the cool season. The male does not grip the female during spermatophore deposition, the female becomes sexually receptive being orientated by the displaying male. Tactile components are an element of the sexual behaviour of both partners. The female, using her hind-feet, wraps the eggs in water plants. The emergence of larvae occurs within 4–7 weeks, the larvae complete their development within 4–12 months. Juveniles are land-bound. Several juveniles have been observed to return to the water at the age of 17 months after the metamorphosis, at a body length of 90–100 mm to live, similar to the adults, in an aquatic environment.

INTRODUCTION

At present, the genus *Paramesotriton* Chang, 1935 has received four species (Bischoff et Böhm 1980), i. e., *P. chinensis* (Gray, 1859), from the Chinese provinces Chekiang and Anhwei, *P. deloustali* (Bourret, 1934) from the montane locality Tam Dao in north Vietnam, *P. hongkongensis* (Myers et Leviton, 1962) from Hongkong, and *P. caudopunctatus* (Hu, Djao et Liu, 1973) from the Chinese province Kweichow. Of these, more complex data on bionomics and reproduction are available for *P. hongkongensis* (Römer 1951). Later, *P. hongkongensis* was repeatedly reproduced in captivity (Freitag 1963). The knowledge available of the reproduction biology of specimens of the species reared in captivity, was reviewed by Rimpf (1978). There is either none or incomplete knowledge of the way of life, the reproduction and the development of larvae of the three remaining species in the genus. Sparreboom (1983) gave an exact description of the courtship behaviour of *P. caudopunctatus* with notes on oviposition. Basic informations about the nature habitation of this species with several notes on bionomics are available in Hu, Djao et Liu (1973) (ex Sparreboom 1981).

So far, knowledge is available only of adult specimens of *P. deloustali* from Tam Dao, its terra typica. Freitag et Petzold (1961, 1978), and Freitag (1962, 1963) gave a detailed description of the morphology of adults of the

species. Fundamental data on the character of Tam Dao, the only known locality of the incidence of the species, complemented with ecological and etological notes, were given by several authors (Bourret 1934, Freytag et Petzold 1961, Freytag 1963, Přivora 1963, Dao van Tien 1965, Felix 1975, Tůma 1980, Jiroušek 1981, Vít et Těšík 1981). Adult specimens were found exclusively in water, in calm sites of a mountain brook in the primeval forest at Tam Dao (in an altitude of approximately 950 m), and in man-made basins fed by the stream. No data are available on either eggs, larvae and juveniles, and nothing is known of their appearance and their mode of life. Observations on the adult of *P. deloustali* in captivity were made by Přivora (1963), Felix (1975), Freytag et Petzold (1978), Tůma (1980), Herper (1981) and Jiroušek (1981).

Live specimens of the salamander *P. deloustali* which the present author received by courtesy of I. Kubát from the Zoological Garden, Prague who had paid repeated visits to Tam Dao, enabled a study on the life of this rare amphibian in captivity. Both in 1981 and 1982, the author succeeded in reproducing and rearing *P. deloustali* in captivity, and obtained a number of as yet unknown data on the bionomics of the species. In 1981, he published a provisional note on the first, successful reproduction of the species (Rehák 1981 b). In the present study, a detailed account is given of the six-year study on adult specimens, of two successful reproductions, and the rearing of larvae and juveniles.

MATERIAL AND METHODS

Adult salamanders were kept in tanks measuring 71×24 cm, 51×30 cm and 41×20 cm respectively, height of the water column from 20 to 40 cm. The bottom of the tank was either bare or covered with pebbles. Dense stands of fern — *Microsorium pteropus*, and broken flower pots were placed in the tanks for hiding places. Summer temperatures ranged from 20–24°C. In the winter, different water temperatures were used (4–8°C, 16–20°C, 20–24°C) within the course of the breeding experiment in order to disclose the most satisfactory temperature regime for a successful reproduction. The salamanders were reared in pairs except in the case of etological studies when either 2 ♂♂ and 1 ♀, or 1 ♂ and 2 ♀♀ were placed together in one tank.

Laid eggs were collected in intervals of several days, and placed in specific glass jars also used for larvae up to their metamorphosis. Land-bound juveniles were kept on a peat substrate intermixed with bits of bark, with a dense stand of various mesophilous plants. A dish filled with water was added to each jar, and a high humidity was retained in order to give the substrate a marshy character.

Biometric measurements given in the paper were made in the following way:

- body length (L) — from the anterior end of the head to the posterior end of the cloaca
- tail length (Lcd) — from the posterior end of the cloaca to the tip of the tail
- head length (Lc) — from the anterior end of the head to the plica gularis
- length of fore-foot (Pa) — from the base to the end of the longest digit
and of hind-foot (Pp)
- distance between — from the posterior side of the base of the fore-foot to
extremities (LiE) the anterior side of the base of the hind-foot
- head width — distance between the corners of the mouth.

Larval measurements:

Distance between the anterior corners of the eyes (1); distance between the nostrils (n), distance from the anterior corner of the eye to the nostril (m), distance between the anterior corner of the eye and the tip of the snout (o).

RESULTS

Adults

Live weight: ♂ (total length 180.4 mm) — 38 g

♀ (total length 212.0 mm) — 45 g

Biometric data: measurements for two ♂♂ (L = 94.0 mm; 97.2 mm)

two ♀♀ (L = 100.0 mm; 101.6 mm)

L/Lcd: ♂♂ 1.17 (1.23) 1.29; ♀♀ 1.08 (second ♀ without tip of tail)

L/Pa: ♂♂ 3.24 (3.26) 3.29; ♀♀ 3.39 (3.43) 3.47

L/Pp: ♂♂ 2.72 (2.90) 3.08; ♀♀ 2.87 (3.05) 3.23

L/LiE: ♂♂ 1.97 (2.13) 2.29; ♀♀ 1.97 (2.04) 2.11

L/Ltc: ♂♂ 4.65 (4.82) 5.00; ♀♀ 4.23 (4.58) 4.93

$\frac{Pa \cdot 100}{LIE}$: ♂♂ 60.0 (65.3) 70.6; ♀♀ 58.1 (59.5) 60.9

$\frac{Pp \cdot 100}{LIE}$: ♂♂ 83.9 (74.0) 84.2; ♀♀ 65.5 (67.0) 68.5

Pa/Pp: ♂♂ 0.84 (0.89) 0.94; ♀♀ 0.85 (0.89) 0.93

$\frac{L - Lc}{Lc}$: ♂♂ 2.45 (2.64) 2.82; ♀♀ 2.91 (3.06) 3.22

Coloration (based on 18 adult specimens imported from the field):

Dorsal side — predominantly almost black, exceptionally brown to reddish brown.

Ventral side — spots in a yellowish orange to reddish colour on a dark background are large and full (type I); smaller spots frequently with a dark centre (type II). Type I characteristic of the male, Type II of the female. An exception was the coloration of a single male that was of Type II. Freshly imported specimens displayed a deeper shade of red on the ventral side than those kept for a prolonged period in captivity (evidently the effect of monotonous food).

Sexual dimorphism: ♂♂ slightly smaller than ♀♀, total length of ♂♂ 160—170 mm (maximum length 180.4 mm), of ♀♀ 180—200 mm (maximum length 212.0 mm). Tail of ♂♂ relatively shorter than that of ♀♀, the former differing in a loaf-shaped cloacal lump. As suggested by biometric data on four specimens, both the extremities and the head of the ♂♂ appeared to be relatively longer than those of the ♀♀. The coloration of the ventral side of the ♂♂ was characteristic of type I. A wide stripe running through the middle of the lateral side of the male's tail changed into a bright, turquoise colour during the reproduction period.

Polydactylia: Observed in one male — a split of the 4th digit on the left hind-foot increased the number of digits to six.

Daytime activity: Adults exclusively water-bound. They never leave their aquatic environment even when given an opportunity. Mostly inert during the day, hiding generally among the plants or under the fragments of flower pots; at night, they leave their hiding places and become more active. Both courtship and oviposition occur mostly at night.

Annual activities: In animals kept in an unchanged temperature (20—24 °C) throughout the year, the colour of the tail stripe of the ♂♂ intensifies in the autumn (October, November) and becomes turquoise, the animals continue to feed but take up less food than in the summer. No sexual activities were

displayed by a pair kept at 4–8 °C during the winter. The animals were lethargic, stopped feeding, and there were no sexual activities even at the end of the cool period. Most satisfactory, and evidently most similar to field conditions was a decrease in the temperature to 16–20 °C during the winter. In the autumn (November), an intensive courtship coloration was seen in the male, courtship, and later oviposition, occurred in the winter. During the reproduction period, both the male and the female stopped feeding, and the female continued to starve until the end of oviposition; sometimes, close to the end of oviposition, she swallowed a small piece of food. After the courtship period, the male lost quickly its courtship coloration.

Uptake of food: Earthworms were given twice a week to the animals. They also fed on molluscs (*Planorbis*) which they pulled out of their shells. They located immediately, up to a distance of 20–30 cm, the earthworms crawling through the tank, attacked them quickly and devoured them ravenously. If two salamanders got hold of one earthworm, they started to rotate around the longitudinal axis of the body until the prey was halved.

Moulting: The skin rupturing first on the head, is pushed over the fore-legs to the hind-legs by squeezing through the tangle of water plants and rubbing the body on the bottom of the tank. As soon as the skin dangles down from the hind-legs, the salamander catches it with his mouth and pulls it off over the hind legs and the tail. Usually, the skin is swallowed, sometimes it is not. Never is the skin swallowed in the case of the moulting during the reproduction period. Sometimes, the skin is pulled off with the mouth when it hangs either on the tail or on one hind-leg and the tail. The end of the moulting is marked by a wide yawn. Here is an example of the timely sequence of the individual moulting phases:

Start of 1715 hr; the skin reaches the fore-legs at 17.25 hr, it is pushed to the hind-legs at 17.35 hr, pulled off from the tail with the mouth at 17.50 hr, swallowed by the animal at 17.53 hr. However, there is considerable variation in the total duration of the skin-shedding period, and this varies also individually (several specimens need always a longer time to shed their skin than the remaining individuals).

Defence: When disturbed, the animals withdraw rapidly and hide in the tangle of plants or under the fragments of flower pots. The reaction of the animals to being pulled out of the water by hand is passive — most of them become inert, close their eyes and release a sticky substance smelling of parsley root. The secretion produces a burning feeling on abraded, human skin and mucose membranes. When repeatedly hand-handled, the animals do generally not repeat the described behaviour. An animal attacked by a rival, who gets a strong hold on him with his teeth, is again surprizingly passive in its reaction.

Courtship behaviour: The first sexual encounter of a breeding pair was observed on December 30, 1980, at 02.50 hr, at a water temperature of 18.5 °C. The courtship continued each night from 1.00–4.00 hr until January 9, 1981. In the following season, sexual activities started on January 4, 1982 and continued until February 7, 1982, again at night. Other sexual encounters were observed from December 24, 1982 to February 15, 1983. Mating in daytime occurred only once, on January 17, 1982 at 11.00 hr. The course of mating was stimulated by a decrease in the temperature to 16–18 °C from 19–20 °C, i. e., by 1–3 °C.

Courtship of the male is started by fanning the female with the forward folded tail whereby the male positions himself generally in front of the female, sometimes sideways, in parallel direction to the female, but always in agreement with the flow of water in direction to the head of the female. The fanning of the female with the tail of the male is done either from the left or the right side as required by the situation, the number of bouts ranges from 8—15, and increases to 45 when the male is greatly excited. During the display period, the cloaca of the male is surrounded by a bunch of filiform endings of the pericloacal glands. If the female tries to escape, the male pursues her, bumps into her with his head, tries to bar her escape route with his body and presents himself across her line of vision with a full view of his flank. As soon as he attracts the attention of the female, the display enters its next phase. The female moves closer to the male, sometimes biting his head delicately, sometimes nudging the male. At this point, the male turns round and the female trying to follow the male, bumps with her head into his accordion-like folded tail. This promotes the lifting of the male's tail and the deposition of one or several spermatophores. Thereby, the male moves slowly forward and releases the spermatophores in immediate succession. The female follows the male and covers the spermatophores with her body. If the female fails to follow the male, he waits for about one minute with his tail folded accordion-like, then interrupts his posture and starts again with the fanning (previous display phase). Of interest was the behaviour of one male observed on January 11, 1982 at 01.45 during the deposition of the spermatophore. The female covered the spermatophore with her body and then the male nudged the female with his snout about eight times; after about 10 min, he bit her gently five times on the dorsal side of the body and close below the head while he pushed her with his fore-legs. The female, until then pressing her body to the bottom, lifted it with the spermatophore already in her cloaca with its upper portion. The male continued in the courtship for the entire period (about 60 min) during which the female rid herself of the lower part of the spermatophore by rubbing her body on the bottom of the tank.

The transfer of the spermatophore is not always successful. On several occasions the female cannot find it, or it sticks to her leg and is finally lost. Once, the spermatophore got stuck to the bottom jaw of the male while he continued to display by fanning the female. Later, he rubbed it off on plants. Spermatophores are elongately cone-shaped, measuring 7—10 mm in height, and resemble enlarged spermatophores of newts of the genus *Triturus*.

Aggressive behaviour: During the reproduction period, the sexually active male is most unconciliate toward other males. He attacks a weaker male by biting his tail, legs and body. Sometimes, even outside the reproduction period, a stronger male attacks a weaker one, but he is generally less aggressive than during the reproduction period. Sometimes, there is no aggressivity among the males and they tolerate each other. I observed once how an excited male, while in pursuit of his rival, was attacking his own reflection in the glass. Sometimes, one male holds the leg of his rival in his teeth and then both animals become entangled in a ball and remain motionless in this position for as long as from 10—40 min.

The aggressivity of the male during the reproduction period turns sometimes, under certain conditions, against a female. Once, when another female was added to the tank occupied by a sexually active couple, the male attacked

immediately the new arrival, bit her into the legs, the sides of the body, the base and the tip of the tail. When finally succeeding to hold her leg strongly in his teeth, both animals formed a bizarre ball. The female remained passive, with her eyes closed. The male never displayed before the second female but continued to attack her and there were many biting marks on her body. On the other hand, he displayed continuously before the original female in the tank. The frequent attacks of the second female resulted in her death. In the next season, the experiment was repeated with another female. This time, the male courted both females and never attacked any of them. Later, the male was transferred alone to another tank to which the female was placed after several days. He attacked her immediately and bit off part of her tail. No oviposition occurred although she had received the spermatophore during her previous stay with the male while the other female that had never been attacked did lay eggs. However, during the courtship starting on December 24, 1982, the female tried to escape from the displaying male, and was found dead on December 30, 1982, apparently having been killed by the male. It might well be that the male recognizes when a female is not ready for reproduction and drives her away from his territory as he does another male. Aggressive behaviour might also be promoted by fright, it was observed how a male attacked a female after a heavy object had dropped to the floor of the room.

Oviposition: In 1981, oviposition occurred from January 24 to April 18, in 1982 from February 8 to April 17. The total number of eggs laid by the female in the first year was 152, and the number of eggs collected on the individual days were: 8 on January 25, 10 on January 27, 6 on January 30, 18 on February 2, 3 on February 8, 14 on February 12, 24 on February 17, 19 on February 23, 25 on March 1, 17 on March 14, 8 on April 18. The total of eggs laid in 1982 was 256 (20 on February 2, 23 on February 16, 32 on February 20, 28 on February 26, 30 on March 5, 38 on March 12, 34 on March 19, 22 on March 27, 26 on April 6, 3 on April 17).

The eggs were deposited singly on the leaves and roots of the fern *Microsorium pteropus*, and the female was bending the leaves to form a bed for the egg with her hind-legs. During oviposition, the body of the female was hunched, her eyes were closed and, from time to time, the posterior part of her body in the cloacal region was twitching violently. She deposited an occasional egg on the bottom of the tank, or a series of eggs (up to 5) in a chain in which the eggs were connected by sticky, mucose sheaths.

The egg

Eggs with their mucose sheaths are ovoid and measure from 7–8 × 5–6 mm. Without the sheaths, the egg is spherical and measures 3 mm in diameter. The size of the eggs decreases slightly in the course of oviposition. Its animal portion is of a light brown colour, the vegetative portion is white. The colour of the embryo changes from light brown to dark brown during its development.

The development of the egg is completed within 28–48 days at a temperature of about 23 °C fluctuating occasionally within the range from 17–27 °C. The difference in the span of time which the egg needs to complete its development is dependent on two factors: the temperature (larvae emerge earlier in a higher temperature), and on the fact that the developmental stage at which larvae emerge from the eggs is greatly different (see later in the text). The rate of mortality of the eggs is low, it was 3% (5 eggs) in 1981, 13% (34 eggs) in 1982.

Larvae

Biometric data

Age 10 day (n = 10): $L_{total} = 13.5 (15.7) 17.0$ mm $s = 1.2$ mm, $s_x = 0.4$ mm;
 $L/Lcd = 1.12(1.33)1.70$ $s = 0.21$, $s_x = 0.07$

Age 60 days (n = 1): $L_{total} = 35.2$ mm; $L/Lcd = 1.07$; $L/LiE = 2.49$;
 $L/Pa = 3.96$; $L/Pp = 3.31$; $L/Ltc = 4.23$; $\frac{L - Lc}{Lc} = 2.79$; $Pa/Pp =$
 $= 0.84$; $\frac{Pa \cdot 100}{LiE} = 63.0$; $\frac{Pp \cdot 100}{LiE} = 75.3$; $\frac{1}{0} = 1.38$; $\frac{n}{m} = 1.00$

Age 115 days (n = 1): $L_{total} = 37.3$ mm; $L/Lcd = 1.07$; $L/LiE = 2.33$;
 $L/Pa = 3.64$; $L/Pp = 3.51$; $L/Ltc = 4.60$; $\frac{L - Lc}{Lc} = 2.86$; $Pa/Pp =$
 $= 0.96$; $\frac{Pa \cdot 100}{LiE} = 63.8$; $\frac{Pp \cdot 100}{LiE} = 66.3$; $\frac{1}{0} = 1.38$; $\frac{n}{m} = 0.93$

Age 130—210 days (n = 21): $L_{total} = 38.0(50.2)59.2$ mm, $s = 0.18$ mm,
 $s_x = 0.04$ mm; $L/Lcd = 0.96(1.03)1.17$, $s = 0.06$, $s_x = 0.01$; $L/LiE =$
 $= 2.03(2.33)2.58$, $s = 0.12$, $s_x = 0.03$; $L/Pa = 3.04(3.46)4.45$, $s = 0.35$,
 $s_x = 0.08$; $L/Pp = 3.15(3.58)5.00$, $s = 0.50$, $s_x = 0.11$; $L/Ltc = 3.96(4.27)$
 4.73 , $s = 0.23$, $s_x = 0.05$; $\frac{L - Lc}{Lc} = 2.45(3.02)3.48$, $s = 0.27$, $s_x = 0.06$;
 $Pa/Pp = 0.96(1.04)1.16$, $s = 0.07$, $s_x = 0.02$; $\frac{Pa \cdot 100}{LiE} = 51.9(67.8)75.2$,
 $s = 6.2$, $s_x = 1.4$; $\frac{Pp \cdot 100}{LiE} = 46.2(65.9)72.6$, $s = 7.0$, $s_x = 1.6$; $\frac{1}{0} =$
 $= 0.97(1.24)1.47$, $s = 0.16$, $s_x = 0.04$; $\frac{n}{m} = 0.61(0.95)1.07$, $s = 0.18$,
 $s_x = 0.04$

Growth: Emerging larvae measure from 12—16 mm, whereby the larvae emerge at a different developmental stage. E. g., in a larva emerging after 28 days at a length of 12 mm, the digital growth on its fore-feet was in its initial phase, the hind-feet were bud-shaped; in a larva emerging after 35 days (length 14 mm), the hind-feet were still bud-shaped (9.00 mm in length), while four digits were present already on the fore-feet; in a larva emerging after 37 days (length 16 mm), four digits each were present on the well developed fore- and hind-feet.

At the age of 10 days, larval length was 13.5 (15.7) 17.0 mm (n = 10), and there were four digits on each of their hind feet. At the age of one month, the larvae measured 20.0 (24.5) 26.0 mm (n = 17), their hind-legs were already well developed, with five digits; larvae aged three months measured 37.0 (43.0) 53.0 mm (n = 17). Close to their metamorphosis, at the age of 4—7 months, they measured 38.0 (50.2) 59.2 mm (n = 21).

During the initial larval development, one of the most important morphometric changes observed was a positively allometric growth of the tail and the extremities in relation to the body.

Appearance and coloration: Larvae have three well-developed pairs

of clusterlike gills. The tail is bordered with a fin hem. The larval body is black, the upper margin of the tail hem and the posterior part of the bottom margin are white, the gills are pink. The nostrils are white. The eye is prominent, the iris light, the pupil horizontal. Light spots, from a yellowish white to a yellow colour, appear at the age of two months on the ventral side of the larval body. In darkness the black colour of larva changes to grayish, in this case small larvae are transparent with the exception of the contents of digestive tract.

Bionomics: By contrast to the adults, the larvae are active during the day. From time to time, they creep slowly through the tangle of water plants or along the bottom of the tank, but most of the day they hide inert among the plants. They swim exceptionally, mostly when disturbed in that they press their legs to the sides of their body and swim rapidly to their hiding place making wavelike movements with their whole body. They feed ravenously, similar to the adults, on the food offered to them (*Tubifex*, larval *Chaoborus* and *Chironomus*).

Metamorphosis starts within 4—12 months of age, at a size of about 5 cm. First, they lose their clusterlike gills, and usually leave the aquatic environment before the loss is complete (in tanks with a reduced water column, they started to crawl onto floating slabs of polystyrene). Sometimes, regular, respiratory movements of the throat start soon after leaving the water, sometimes they start several days later. In higher water temperatures (from 25 to 30 °C) the larvae need longer to complete their development than they do in temperatures from 20—24 °C.

Mortality: The viability of larvae is considerably high during their development, and mortality is practically nil. Critical is the period of metamorphosis during which 14% of the first batch of larvae reared in captivity died before leaving the water, and 26% of metamorphosed individuals died immediately upon leaving the water.

Juvenile stage

Biometric data obtained shortly after the metamorphosis (n = 24)

$L_{total} = 43.3(51.7)62.5$ mm; $s = 4.5$ mm, $s_x = 0.7$ mm; $L/Lcd = 0.86(1.00)1.13$; $s = 0.06$; $s_x = 0.01$; $L/Lie = 1.99(2.37)2.66$; $s = 0.15$; $s_x = 0.02$; $L/Pa = 2.65(3.14)4.10$; $s = 0.26$; $s_x = 0.04$; $L/Pp = 2.49(3.12)4.10$; $s = 0.26$; $s_x = 0.04$; $L/Ltc = 3.52(4.31)5.02$; $s = 0.23$; $s_x = 0.04$; $\frac{L - Lc}{Lc} = 2.04(2.89)3.55$; $s = 0.30$; $s_x = 0.05$; $Pa/Pp = 0.88(1.00)1.15$; $s = 0.07$; $s_x = 0.01$; $\frac{Pa \cdot 100}{LiE} = 54.8(75.8)97.9$; $s = 7.6$; $s_x = 1.2$; $\frac{Pp \cdot 100}{LiE} = 54.8(76.1)88.9$; $s = 7.1$; $s_x = 1.1$

Growth: Immediately after the metamorphosis, there is either a reduction in body length by about 1 mm or no growth occurs, owing, apparently, to a general reorganisation of the organism and no uptake of food. One month after the metamorphosis, the total length based on measurements of 88 specimens hatched in 1981 was 48 (54) 63 mm, two months after the metamorphosis 45 (54) 64 mm, at three months 46 (56) 64 mm, at four months 47 (57) 67 mm, at five months 48 (59) 70 mm, at six months 49 (60) 73 mm, at 7 months 51 (62) 79 mm,

at eight months 54 (63) 79 mm, at nine months 56 (65) 80 mm. Their length at one year after the metamorphosis was 58 (72) 92 mm ($n = 35$), two years after the metamorphosis it was 68 (83) 138 mm ($n = 30$). The body length of the next generation, after the termination of the metamorphosis, was 44 (52) 63 mm. As evident from a comparison of L/Lcd of the adults and the juveniles, the most remarkable change in juvenile growth was a relative shortening of the tail in relation to the body which is particularly distinct in the male.

Appearance and coloration: Soon after the metamorphosis, the body of the juvenile is plump, the skin relatively smooth. At the age of one to two months, the dorso-lateral and the dorsal ridges gain in prominence, the skin coarsens and becomes verrucose on the dorsal side, the head takes on a more angular shape, and the juvenile starts to resemble the adult in its outer morphology. The dorsal side is of a blackish brown colour, several warts in the dorso-lateral ridge are yellowish orange in colour. A marked, yellow spot appears on the outer side of the insertion of the fore foot (it persists faintly in the adult). In three specimens, a small spot was observed in the nape area. The ventral side is ornamented with ovoid, yellowish orange spots (less reddish in colour than those of the adult). The spots occupy a larger area against the dark background than in metamorphosing larvae, and a smaller area than in the adult. The total area occupied by the spots increases against the dark background as the growth continues. By contrast to the adult, there are never black spots inside the spots. Similar to the adult, the posterior margin of the tail is of a yellowish orange colour.

Bionomics: Juveniles become land-bound as soon as they have completed their metamorphosis. They require a very moist environment and a muddy substrate. They are active at night creeping slowly through the tank, and sleep during the day with their eyes closed, hiding either under bark or in the tangle of plants. They do not enter the water, exceptionally an occasional individual was observed to creep into the dish with water in the tank to remain there for several days or even to moult there. Normally, the animals shed their skin on dry ground in a mode similar to that described for the adult. The first ecdysis starts soon after the metamorphosis. The food consists first of Tubifex and Enchytraeus, later of small earthworms. Their reaction to hand-handling is a complete passivity similar to that described for the adult. It was observed that several juveniles started to return to the water 17 months after their metamorphosis at a body length of 90—100 mm.

Mortality: In the first nine months, the death rate was 8^{0.0} (based on the number of emerged larvae). We did not include animals dying shortly after leaving the water, which generally refused to feed.

DISCUSSION

A comparison of the bionomics of *Paramesotriton deloustali* with those of *P. hongkongensis*, for which Romer (1951), Freytag (1963) and Rimpf (1978) gave detailed data on their biology, showed a considerable similarity to each other in regard to their seasonal activity (they both reproduced during the cool season of the year), their courtship behaviour, the mode of oviposition and the land-bound life of juveniles after the metamorphosis. Similarities were found also in the character of the sexual dimorphism, the look of the egg and the larva, and their development (the female of *P. deloustali* lays more and

slightly bigger eggs, both emerging and metamorphosing larvae are slightly bigger in general, both eggs and larvae need longer to complete their development). The ecologico-etological similarity of the two species, in addition to a similar look of their developmental stages, were in support of suggestions on an anatomico-morphological similarity of the two species. E. g., Freytag (1962) considered *P. deloustali* to be nearer to *P. hongkongensis* than to *P. chinensis*, Bischoff et Böhm (1980) were of a different opinion in that they regarded *P. hongkongensis* to be nearer to *P. chinensis* than to *P. deloustali*. A similar comparison could not be made for the remaining two species in the genus *Paramesotriton* because of a lack of data. Ecologically, *P. chinensis* differs from *P. deloustali* in its terrestrial mode of life outside the reproduction period (Chang 1934—35, Chang et Boring 1935 — ex Freytag 1978; Freytag 1963). The courtship behaviour of *P. deloustali* is very similar to that of *P. caudopunctatus* (see Sparreboom 1983). I did not observe a distinct "retreat display phase" in *P. deloustali*. In both species sexual activity (and refusing of food, especially in males) occurs during the cold part of the year. The differences are in the mode of the oviposition (females of *P. caudopunctatus* deposit eggs in clefts and hollows in or between stones) and in the clutch size which is more numerous in *P. deloustali* (in *P. caudopunctatus* was observed 71 eggs only — Hu, Dja o et Liu 1973, respectively 30 eggs — Sparreboom 1983). In comparison with *P. caudopunctatus*, *P. deloustali* has similar but bigger spermatophores and his eggs (similar in the size without sheaths) have thicker mucose sheaths (maybe in connection with a different mode of the oviposition).

According to Freytag (1963) and Rimp (1978), the courtship behaviour of *P. hongkongensis* resembled that of newts of the genus *Triturus*. However, marked differences were found in the display of the individual species of the genus *Triturus* (Halliday 1977, Rehá k 1979, 1981 a). According to observations made during the present study, the courtship behaviour of *P. deloustali* was simpler than that of species of the genus *Triturus*, and it displayed at night, by contrast to the latter. Features of courtship behaviour common to the members of both genera were the fanning of the female with a forward folded tail; lateral display was confined to a static posture of the male in front of the female. *P. deloustali* did not display laterally in a greatly hunched posture as, e. g., *T. cristatus*. There was also no whipping of the male's tail in front of the female and the phase of retreat of the male in front of the female as observed, e. g., in *T. vulgaris*. Owing to the fact that these components lack also in the sexual behaviour sequence of *T. alpestris* it seemed more appropriate to compare *P. deloustali* with *T. alpestris*. An amplexus between the male and the female were absent in both *P. deloustali* (also in *P. hongkongensis* — cf. Freytag 1963 and *P. caudopunctatus* — cf. Sparreboom 1983) and in members of the genus *Triturus*, but there were differences in their courtship behaviour in that males of the genus *Paramesotriton* in contrast to the genus *Triturus* employed tactile elements such as pushing and nudging the female with the snout and the fore-feet, or exceptionally biting her head gently. The receptive female bumps into the male with her head or bites his head gently. In this, the sexual behaviour of *P. deloustali* is more resemblant of that performed by members of the genus *Cynops*, and their is also a similarity in the mode of spermatophore deposition (cf. Arnold 1977). There has also been suggested an anatomico-morphological nearness between the genera *Cynops* and *Paramesotriton* (Freytag et Petzold 1961). Dao van Tien (1965)

illustrates in his paper an observation made in the field showing a kind of wrapping of the male round the female. According to my own observations, this could not have been a regular element of the reproduction act, or even a form of spermatophore transfer. A similar, bizarre grouping might have arisen from aggressivity because the formation of similar "balls" has been observed also in fighting males whereby the attacking animal holds the leg of his rival tightly in his teeth which is not the case with the pair illustrated by Dao van Tien (1965). In a photograph by Fleck (1981), a male of *P. caudopunctatus* is seen to fold its tail and part of its body around the throat of the female without any sign of aggressivity, and he compares this element with the courtship behaviour of members of the genus *Euproctus*. According to observations given by Sparreboom (1983) this behaviour is not element of the reproduction act in *P. caudopunctatus*. The behaviour is greatly resemblant of that described by Dao van Tien (1965) for *P. deloustali*. A similar behaviour was not observed in *P. hongkongensis* and *P. chinensis* (Fleck 1981, Sparreboom 1983).

Typical of the behaviour of sexually active males of *P. deloustali* is a high aggressivity reflected in attacks of another male. In this, the species differs greatly from members of the genus *Triturus* for which such rivalry is a rare feature (*T. vittatus* — Beljajev 1979), or it is less marked and ritualized (*T. cristatus* — Fretey 1975). In the genus *Paramesotriton* aggressive biting was observed also in *P. caudopunctatus* (Sparreboom 1981, 1983). Another phenomenon in the life cycle of *P. deloustali* receiving attention is the shedding of the skin (Freitag et Petzold 1978, Jiroušek 1981). The authors stated that the skin was shed in pieces and never swallowed. In my opinion, the situation was exceptional and apparently the consequence of unsatisfactory rearing conditions. As observed in the present study, the skin was cast off right down to the end of the body in one piece, then taken in the mouth, pulled off and usually immediately swallowed.

A comparison of several data on water temperatures at Tam Dao suggested that summer temperatures of 23 °C (Dao van Tien 1965), 15 °C (Felix 1975), 21.5—24.5 °C (Jiroušek 1981) were those to which the salamanders responded best in captivity (20—24 °C), with the exception of those given by Felix (1975). On the other hand, a temperature of 11 °C during the cool season (Freitag et Petzold 1961, Dao van Tien 1965, Felix 1975) were below the optimum assessed for a reproduction in captivity (16 to 18 °C). However, it was found of importance to decrease the temperature in the winter in order to induce their readiness for reproduction. Generally, when decreasing the temperature by 1—3 °C, the response of *P. deloustali* was an immediate start of his sexual display. A similar effect was reported also for other newts, e. g., *Pleurodeles waltl*. So far, no information is available on the annual rhythm of juveniles during their terrestrial phase under field conditions where winter temperatures are about 8 °C (with a minimum of 1 °C) and summer temperatures rise up to 30 °C (Jiroušek 1981). Captive animals were active throughout the year, in winter at a temperature of about 20 °C, in summer from 27—30 °C which was well-tolerated. Having regard to a relatively prolonged development of the larvae it might be expected that in the field, at least part of the larval population remains even in winter in the water.

Freitag et Petzold (1961) presented absolute, biometric data for two males and one female of *P. deloustali*. Relative indices calculated from these

data were in agreement with the results obtained in the present study. *P. deloustali* is biggest in size among the members of the genus *Paramesotriton*. The biggest specimen in my material, a female, measured 212 mm in length. Vít et Těšík (1981) reported a similar maximum length. In *P. deloustali*, the proportion of light spots in relation to the dark background on the ventral side of the body is highest among the members of the genus. They dominate frequently in the dark background. Less numerous are spots on the ventral side of *P. hongkongensis*, least numerous on *P. chinensis* (cf. Freytag 1962, 1963). Of a slightly different character is the coloration of the ventral side of *P. caudopunctatus* (cf. Bischoff et Böhme 1980). Dao van Tien (1965) observed a sexual dimorphism in the shade of spots on the ventral side, i. e., pinky orange in the male, yellowish orange in the female. No such thing was observed in my material, on the contrary, the ventral side of several females was of a deeper colour shade than that of the male (a change in the saturation of the colour might be attributed to differences in the food of animals in captivity). However, it occurs with remarkable frequency that the ornamentation on the ventral side of the female is made up of smaller spots that often have a dark centre. Spots on the ventral side of two month old larvae are small dots which increase as the larva and the juvenile grow until they become full spots without difference in their ornamentation upon which the sex of the individual could be determined. According to the literature (Freytag et Petzold 1978, Bischoff et Böhme 1980, Jiroušek 1980, Tůma 1980), the coloration of the ventral side of *P. deloustali* is characterized as a dark mottled or net-like pattern on a light background, from brick red to yellow and orange. With regard to the ontogenetic development it would be better to state that light spots on a dark background ornament the ventral side of the body.

CONCLUSIONS

1. The adult of *Paramesotriton deloustali* is an aquatic amphibian who can live on the land for a short time. Activities of the species are confined to the night. The species reproduces during the cool season, a decrease in the temperature stimulates the development of seasonal, secondary sexual signs and the sexual activity of the animals. In captivity, the actual display was observed from the end of December to the first half of February. The sexual cycle of both males and females is annual.
2. The male does not grip the female while depositing the spermatofore. An element of the courtship behaviour is fanning. The male fans the female with his forward folded tail, touches her head with his snout and fore-feet, sometimes bites her gently. As soon as the female has been "persuaded" by the courting male to participate in the reproduction, she creeps closer and touches the male with her head or bites his head gently.
3. Oviposition occurred from the end of January- or the beginning of February- to the first half of April. Generally, the female sticks her eggs singly to leaves or uncovered roots of water plants with the help of her hind-foot. Exceptionally, she releases several eggs simultaneously, or deposits one egg on the bottom of the tank. The total number of eggs laid by one female was 152 and 256 respectively. The egg surrounded by its gelatinous sheaths is ovoid, its size is $7-8 \times 5-6$ mm, the egg itself is spherical, 3 mm in diameter. The development of the egg lasts from 4-7 weeks.

4. Larval development lasts from 4—12 months. The larva measures 12—16 mm upon hatching, it metamorphosis at a size of 38.0—59.2 mm. There is generally considerable variation in the degree of larval development upon hatching. The larva is motile immediately upon emergence, a soon start hunting for food. Larvae are active at daytime, they hide in the tangle of plants, mostly creep slowly but when disturbed they swim quickly away with wavelike movements of the whole body. A positive, allometric growth of the tail and the extremities in relation to the body is most prominent during the initial phase of larval development. From the age of two months, light spots appear on the ventral side of the body which increase in size as the larva grows.
5. Towards the end of the metamorphosis, the aquatic environment is abandoned, and juveniles are land-bound. They are active at night. One to two months after the metamorphosis, the dorso-lateral ridges and the dorsal ridge become prominent, and there is a further increase in the area occupied by the light spots on the ventral side of the body. The rate of growth is relatively slow. At the age of 17 months after the metamorphosis, and at a body length of 90—100 mm, several juveniles start to lead an aquatic life.
6. During the reproduction period, sexually active males develop a high degree of aggressivity. They attack other males and sometimes, under certain conditions, their aggressive behaviour turns also against females. The attacking male bites the rival's leg, its body and tail. Sometimes, when the attacking animal gets a tight hold on the rival, both form a ball and remain, in complete immobility, in this posture, sometimes for a prolonged time. The attacked animal reacts passively. The reaction of the salamander to being pulled out of the water is also passivity, immobility and closing of the eyes. In addition, the animal releases in self-defence a considerable quantity of a skin secretion that smells of parsley root.
7. Generally, the old skin is pulled off from the posterior part of the body with the animal's mouth and usually swallowed. This phenomenon has been observed to occur both in juvenile and adult specimens. The first ecdysis of the juveniles follows several days after the termination of the metamorphosis.
8. Sexual dimorphism is considerably marked in the two sexes. Males are smaller in body size than females, their tail is relatively shorter and differs in the loaf-shaped cloacal protruberance. Other differences have been found in the relative length of the extremities and the head, and in the character of the ornamentation on the ventral side of the body. Sexual differences in the shade of coloration of the ventral side have not been observed.

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The plates (Figs. 1–11) will be found at the end of this issue.

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**REDESCRIPTION OF ILYOCRYPTUS SILVAEDUCENSIS (CLADOCERA,
MACROTHRICIDAE)**

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Abstract. *Ilyocryptus silvaeducensis* Romijn, 1919 is redescribed and illustrated. Morphological characters and comparisons with other Palearctic species of the genus *Ilyocryptus* is presented.

INTRODUCTION

In his faunistical work about macrothricids in the Netherlands, Romijn (1917) described the new species *Ilyocryptus silvaeducensis*. A more detailed study appeared later (Romijn, 1919) with a description, key, pictures, its position among other Palearctic species, and relationships to other Palearctic species.

The species was differentiated by the preanal part of postabdomen, a long spine on the second segment of the antennal exopod and basal spines of posterior carapace spines. More recent authors (Šrámek-Hušek, 1962, Manujlova, 1964, Flössner, 1972) have considered this species as a younger synonym of the species *Ilyocryptus sordidus* Liévin, 1848. Prof. Smirnov in his monography (Smirnov, 1976) made this species independent again but only on the basis of literature data.

Comparative material from Holland supports the concept of separate identity of this species as more differential characters were found. None of Romijn's material is deposited in any museum in Holland. The type material is probably lost or destroyed (Dr. Pinkster, Dr. Leentvaar, pers. com.). This is why material from other Dutch habitats is used for the redescription.

MATERIALS AND METHODS

Samples and slides:

1. Holland, Oisterwijkse Vennen, Achterste Choorven, Stat. 3, 16. 11. 1952, coll. De Vries, catalogue number Phyll. 105.003, 2 females in alcohol.
2. Holland, Oisterwijkse Vennen, Achterste Choorven, Stat. 3, 16. 8. 1953, coll. De Vries, catalogue number Phyll. 105.041, 1 female in alcohol.
3. Holland, Oisterwijkse Vennen, Voorste Choorven, Stat. 1, 16. 8. 1953, coll. De Vries, catalogue number Phyll. 105.024, 5 females in alcohol.
4. Holland, Zandput Sib. OV, 5. 7. 1977, coll. E. Notenboom, 2 females on slide.
5. Holland, Ven Rolderveld DR, 21. 7. 1977, coll. E. Notenboom, 3 females on slide.
6. Holland, Speulderveld, 2. 9. 1975, coll. E. Notenboom, 3 females on slide.

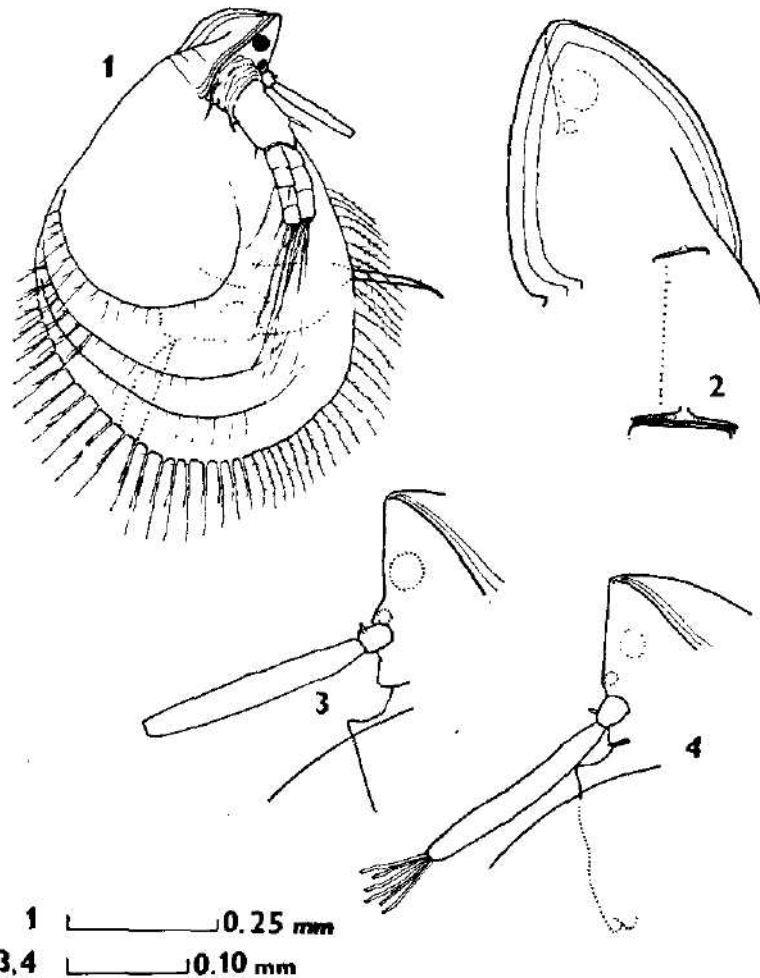
One adult female from the sample No. 1 and three females from the sample No. 3 were stained by lignin pink and chlorazol black and mounted in Canada balsam. Specimens in alcohol and slides (No. 1 - No. 3) are deposited in the collection of Zoologisch Museum, Universiteit van Amsterdam, Instituut voor taxonomische Zoologie, Amsterdam, Holland. Slides (No. 4 - No. 6) are in my personal collection.

REDESCRIPTION

Ilyocryptus silvaeducensis Romijn, 1919

Asexual female

General morphology (Fig. 1): Carapace triangular and wedged-shaped when viewed on cross-section. Dorsal outline slightly convex. Posterior and ventral margin of carapace forming large and continuous curve. Carapace and headshield retained during the moulting. Ventral carapace setae long, direct, with setules. Posterior spines of the last and previous carapaces long, with one short spine near its basis. Posterior spine with maximum of three secondary branches, which are nearly parallel with primary one in the lateral view. Some setules are distally from the last branching (Fig. 6).

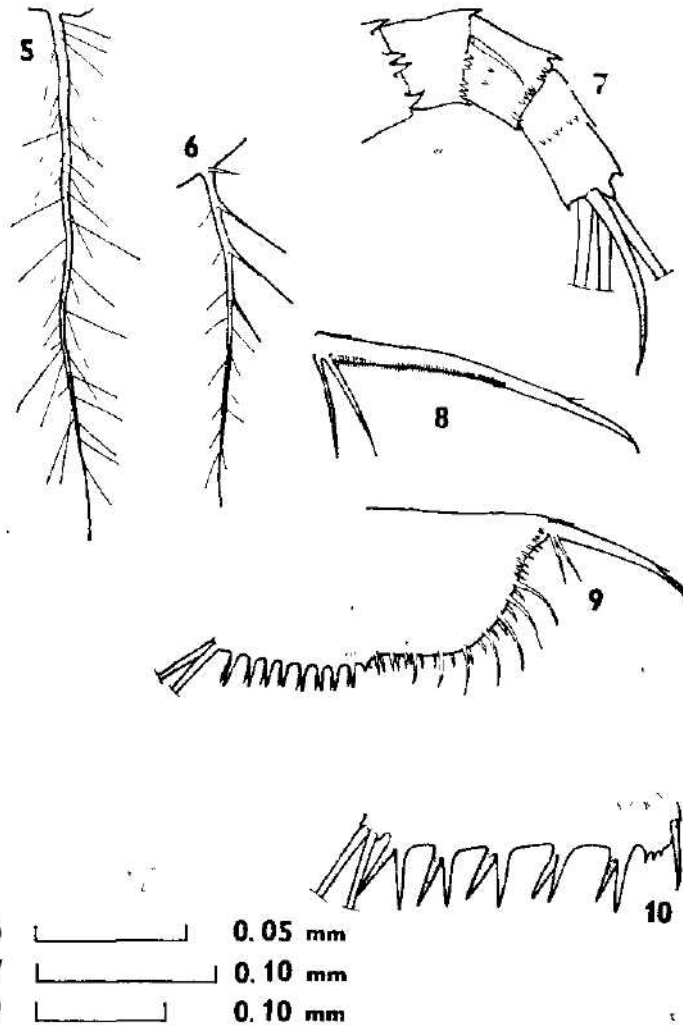


Figs. 1-4. *Ilyocryptus silvaeducensis*, asexual female: 1 - general view, sample 1; 2 - head pore, sample 6; 3, 4 - head with antennula and labrum, sample 3.

Head (Figs. 3—4): Triangular, short, frontal margin straight. Headshield broad, thick, strengthened medially and posteriorly by old exuviae. Head pore in medial line between mandibular articulations (Fig. 2). Small compound eye and ocellus near frontal margin.

Labrum (Figs. 3—4): Anterior part with a prominent corner, ventral margin nearly straight. Posterior part with two lateral lobes.

Antennule (Figs. 1, 3—4): Two segmented. First segment nearly globular with one small finger-shaped tip (sensilla ?) near the basis of distal segment.



Figs. 5—10. *Ilyocryptus silvaeducensis*, asexual female: 5 — seta from ventral shell margin, sample 6; 6 — seta from posterior shell margin, sample 6; 7 — exopod of antenna, sample 6; 8 — postabdominal claw, sample 6; 9 — postabdomen, sample 4; 10 — preanal part of postabdomen, sample 4.

Second segment long, thin, length-width mean ratio: 7.9; n = 6, with sensory setae on the distal top.

Antenna (Figs. 1, 7): Protopod divided into two parts. Proximal part coxal region massive with ring-shaped folds bearing groups of short spines, denticles, setae and posteriorly with one long and one short soft sensory seta. Distal part of protopod is longer than broad with one burrowing spine with setules. One short two-segmented seta situated on the inner side near basis of rami. Endopod and exopod long with swimming setae (0-0-0-3/1-1-3) and spines (0-1-0-1/0-0-1). Spine on the second segment of exposed perspicuously longer than one-half of the third exopodial segment.

Postabdomen (Figs. 9—10): Large, ventral margin nearly straight. Dorsal margin divided by anal opening into two parts. Postanal part longer with two types of spines. Preanal part shorter, nearly straight, with 5—8 doubled spines. Postabdominal setae two-segmented, long, distal segment with sporadic setulation. Groups of short spines are near the basis of terminal claws and near anus.

Postabdominal claws (Figs. 8—9): Long, proximal half nearly straight with bristle of very fine spinules on ventral edge, distal part noticeably curved. On the dorsal margin there is one short spine near the distal tip, two long basal spines situated dorsally and a bristle of thin spines ventrally on the proximal end.

Colour: Living animals according to Romijn (1919) are more lightly coloured than *I. sordidus* which is red-brown. Specimens from the sand bottom are completely colourless.

Differential diagnosis

Preanal part of postabdomen is short, straight with doubled spines. Spine on the second exopodial segment of antenna is perspicuously longer than one-half of next segment length. First segment of antennule with perspicuous finger-shaped tip, second segment long, thin (mean length-width ratio: 7.9). Ventral margin of labrum is nearly straight. Posterior spines of carapace long with one thin spine near the basis and with maximally three secondary branches. The moulting is incomplete, and old cuticles are retained.

Male: unknown.

Sexual female: unknown.

Ecology: *I. silvaeducensis* lives on the upper layer of bottom sediments often together with *I. sordidus*. Carapace is covered with the detritus and mineral particles. The specimens which I was able to study are from acid oligotrophic heatherlakes (vennen). Romijn (1917) has observed the specimens from heath and peat boggs. In a later paper, Romijn (1919) wrote about the type locality: "Zuerst in der Nähe von Herzogenbusch, später jedoch auch bei Valkenswaard und bei Grathem fand ich in Teichen oder Moortümpfen eine Illocryptusart..." p. 535.

RELATIONSHIPS TO THE OTHER PALEARCTIC SPECIES

Romijn (1917, 1919) observed the variability of *I. sordidus* populations from the Netherlands. Based on the different morphology of postabdomen, the length of spine on the second segment of antennal exopod and the type of setae on posterior margin of carapace, *I. silvaeducensis* was described as a new species.

The recent study of Dutch material brought new characteristics for the description of *I. silvaeducensis* (morphology of antennula). In *I. sordidus*, finger-shaped tip on the first antennular segment is imperceptible and second segment is shorter.

I. silvaeducensis is distinctly separated by its external morphology from other species but some characters are similar or the same due to mutual affinity. *I. silvaeducensis* more resembles the species *I. agilis* Kurz, 1878, than to *I. sordidus* with which was synonymized for a long time. Characters in common with *I. agilis* are:

1. Long and perspicuous finger-shaped tip on the first antennular segment.
2. The length of spine on the second segment of antenal exopod.
3. Preanal part of postabdomen shorter than postanal one.
4. Small spine (*I. agilis* has more spines) on the distal part of postabdominal claws.

Incomplete moulting is shared with the species *I. sordidus*. Asexual females of species *I. acutifrons*, *I. vitali* and *I. cornutus* differ markedly from *I. silvaeducensis*: the first two by the morphology of postabdomen, the last by lateral horns on carapace.

It is evident that the situation within the genus *Ilyocryptus* is not simple. It seems that the common European *I. sordidus* is a group of sibling species. Apparently a detailed revision of the whole genus based on rich collection of population samples is necessary.

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TERATOLOGY STRUCTURES IN BONY FISHES

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Abstract. A few abnormalities such as the absence of left eye, premaxillaries, maxillaries and maxillary barbels and dislocation of dentaries along with morphometric measurements in two specimens of *Cyprinus carpio* var. *communis* L., shortening of lower caudal lobe in *Labeo pangusia* (Ham.) and atrophy in the left ventral fin of *Ompok bimaculatus* (Bloch) have been described in the fishes collected from Punjab during 1979-80. Early abnormal development and mechanical injury have been considered plausible factors for such abnormalities.

INTRODUCTION

Teratological structures in fishes have been reported in the past by various workers, viz., Oliva (1950), Gervers (1954), Tandon (1959, 1964), Menon (1973), Chaudhary et al., (1975), Datta and Ghosh (1975), Thakur and Kohli (1976) and Banerji and Singh (1978). Their occurrence is generally attributed to mechanical injury or shock (Tandon and Sharma, 1971; Raghunathan and Jayaram, 1973; Chandrasekran, 1979, Karup and Samuel, 1979) or abnormal early development (Saxena and Tyagi, 1978; Chandrasekran, 1979) or congenital or the result of regeneration (Greenwood, 1972), whereas a few workers did not assign any reason (Hora, 1942; Ovis, 1974; Afsar, 1978). Nevertheless such individuals do manage to survive till they become the victim of an angler or fishermen's net. Though such abnormalities are not of common occurrence in nature a few examples of such abnormalities have been noticed recently while collecting fishes from the districts of Ludhiana and Amritsar of the Punjab State (India).

MATERIAL AND METHODS

Four abnormal specimens viz., *Cyprinus carpio* var. *communis* L (2), *Labeo pangusia* (Ham.) (1) and *Ompok bimaculatus* (Bloch) (1) were collected from the ponds of Ludhiana district and rivers Sutlej and Beas flowing through Amritsar district during routine collection trips during the years 1979-80. The specimens were preserved in 4% formalin and brought to laboratory for further studies. For the sake of convenience, all the body proportions are expressed in the percentage of total length, body length and head length and compared with the normal specimens.

The specimens have been deposited in the Museum of the Department of Zoology, Punjab University, Chandigarh (India).

RESULTS AND DISCUSSION

Two specimens of common carp, *Cyprinus carpio* var. *communis* collected on 8. 9. 80 from a fish pond near Ludhiana exhibit extraordinary abnormalities.

Table 1. Morphometric and meristic characters of abnormal and normal specimens of *Cyprinus carpio* var. *communis*

In the % of	Eye absent		Abnormal mouth		Normal specimen	
	TL	SL	TL	SL	TL	SL
Head length	24.16	30.50	25.58	33.67	27.86	31.50
Head depth	17.44	22.03	17.82	23.46	18.57	25.00
Max. body depth	30.20	38.13	20.15	26.53	26.43	13.47
Min. body depth	10.73	13.55	7.25	10.20	10.00	13.57
Predorsal distance	40.93	51.69	34.88	45.91	40.71	54.81
Postdorsal distance	8.05	10.16	9.30	12.24	9.28	16.35
Length of dorsal fin	34.22	43.22	31.78	41.83	25.71	35.64
Depth of dorsal fin	16.10	20.33	15.50	20.40	13.57	19.76
Length of pectoral	12.75	16.10	17.82	23.46	17.14	23.08
Length of ventral	14.76	18.69	15.50	20.40	15.71	21.15
Length of anal	12.68	15.25	17.05	22.44	7.86	10.57
Depth of anal	15.43	19.49	6.20	8.16	15.00	20.18
P-V distance	15.43	19.49	13.95	18.36	17.85	24.04
V-A distance	21.47	27.11	20.15	26.53	17.14	23.07
Length of caudal peduncle	13.42	16.94	13.18	17.34	12.14	16.35
Length of caudal fin	17.44	22.03	24.80	32.65	23.57	31.73
In the % of head length						
Head length	3.6 cm		3.3 cm		3.9 cm	
Preorbital distance	40.66		27.77		35.89	
Postorbital distance	44.44		48.48		33.33	
Eye diameter	25.00		24.24		25.64	
Head depth	72.22		69.66		66.66	
Meristic characters						
Dorsal fin rays	4 + 17		4 + 21		4 + 18	
Pectoral fin rays	16		16		16	
Anal fin rays	8		8		8	
Ventral fin rays	9		9		9	
Caudal fin rays	19		19		19	
Lateral line scales	35		35		35	
Lateral transverse scales	5½/7½		5½/8½		7½/5½	

The morphometric and meristic characters of these two specimens along with a normal one are given in Table 1.

In one of them the left eye lid is completely closed, thus only right eye is functional. The specimen measures 14.9 cm in total length, 11.8 cm in body length and weighs 45 gm. It is male in the second stage of maturity and the colour is black giving the superficial appearance of *Labeo calbasu*. Some of the morphometric measurements such as maximum body depth, length of dorsal fin, length of anal fin, distance between ventral and anal fins in the percentage of total and body lengths; and preorbital distance, head depth in the percentage of head length show high values when compared with the normal one, whereas a few measurements such as head length, postdorsal distance, length of pectoral fins, distance between pectoral and ventral fins and length of the caudal fin in the percentage of total and standard length show lower values. The rest of the measurements and meristic counts are very near to the normal specimen (Table 1).

In the second specimen of this species the abnormalities appear to be large

from the structure of the mouth to the morphometric measurements. This specimen measures 12.9 cm in total length, 9.8 cm in body length and weights 15 gm and is female in the second stage of maturity. In the mouth the premaxillaries, the maxillaries are absent and the dentaries appear to be dislocated obviously due to injury with the complete loss of maxillary barbels. Some morphometric measurements of this specimen show high values such as length of dorsal fin, depth of dorsal fin, length of anal fin, distance between ventral and anal fins in the percentage of total and standard lengths and postorbital distance in the percentage of head length, whereas a few other measurements show lower values such as head length, head depth, maximum body depth, predorsal distance, distance between pectoral and ventral fins in the percentage of total and standard lengths and preorbital distance in the percentage of head length when compared with normal specimen (Table 1.). The number of dorsal fin ray in the abnormal specimen is 25 as compared to 22 in the normal specimen.

Labeo pangusia (Ham.) which measures 9.8 cm in total length, 7.3 cm in body length, and weighs 15 mg is a male in second stage of maturity. This specimen was collected on Dec. 25, 1979, from the fish pond near Amritsar, it has shortened lower caudal lobe. The male *Ompok bimaculatus* (Bloch) measures 14.1 cm in total length, 12.6 cm in body length, weighs 21 gm having only three short rays in the left ventral fin as against eight rays in the right ventral fin. This specimen was collected on April 7, 1980, from Harike at the confluence of the rivers Sutlej and Beas. In this specimen the left ventral fin has atrophied. In these two specimens all the body measurements are normal.

The extreme-type abnormalities in *Cyprinus carpio* var. *communis* in nature are interesting since this species has been introduced into almost every type of water body for culture purposes because of its fast growth rate. Kaur and Toor (1977) pointed out that the toxicity of Diazinon, Melathiom and Fenitrothion in water caused the deformity in the vertebral column, pericardial sac, circulatory system, coiling of intestine, head region, pectoral fins and and Toor (1977) pointed out that the toxicity of Diazinon, Malathion and due to recent advances in the agricultural sciences, the affluents, insecticides and fungicides are being discharged indiscriminately into water bodies. These may be causing such abnormalities. The abnormalities noticed in case of *Labeo pangusia* and *Ompok bimaculatus* are attributed to mechanical injury during the early stages of development, because all the body proportions are similar to that of normal ones. The present observations confirm the findings of Tandon & Sharma (1971), Menon (1973), Datta and Ghosh (1975), Banerji and Singh (1978) and Karup and Samuel (1979).

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AN ATTEMPT TO STUDY THE EFFECT OF THE WATER VOLUME ON THE FISH GROWTH RATE IN THE BATAK RESERVOIR, BULGARIA

Dedicated to prof. Botyu Botev, Director, Institute of Zoology, and Scientific Secretary of the Bulg. Acad. Sci., on the occasion of his 65th anniversary

Mladen ŽIVKOV & Galerida PETROVA

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Abstract. This study is an attempt to find the pattern and strength of correlation between the average annual (April–November) water volume (V) and the average annual linear increments (t) of various species and age groups of fish. The reasons for this correlation are discussed and it is compared to the correlation between V and the biomass of nutritive organisms.

INTRODUCTION

When studying fish growth rate, authors usually take into consideration the nutritive base, water temperature and fish population density (Oliva, 1955, Frank, 1959, Nikolskij, 1974, Kuznecov, 1978, Welcomme, 1979). No data have been published so far, linking the water volume (level) and the fish growth rate and describing the regularities of this correlation, although it is likely to exist. Some authors established a correlation between the reservoir water volume and the specific composition and abundance of phytoplankton (Dzjuban, 1954, Ertl, 1976, Sais, 1977), zooplankton (Ljudskanova, 1967, Kudrinskaja, 1973, Vranovský, 1974, Najdenov, 1977), benthos (Mejsner, 1952, Micheev, Prochorova, 1952) and fish productivity (Ivanov, 1959, Holčík and Bastl, 1973, 1976, 1977).

BRIEF HYDROLOGICAL AND HYDROBIOLOGICAL CHARACTERISTICS OF THE RESERVOIR

The Batak reservoir was completed in 1958 on the site of the Batak plain and the Batak marsh at 1100 m ab. s. l. The waters of the higher located V Kolarov, Toshkov Chark, Beglika and Široka Polyana reservoirs are carried by a channel to this reservoir. Its total length is 9 km, average width – 23 km, average depth – 14–15 m, maximum depth – 34 m, total area 2107 ha, maximum water volume – 309.216 mill m³, highest and lowest July – August temperature – 24° and 14.3°C, respectively. In winter it is covered with ice. According to Najdenov (1964 a, 1976), Dimitrov (1962), Jošev (1966), Ljudskanova (1967) the average oxygen content varies between 3.8 and 15.8 mg/l with the bottom layers containing in summer only 0.1–2.9 mg/l. The pH is slightly acidous but in bottom layers during stable stratification it reaches 5.2–6.4. The water hardness is low – 1.34–3.03 dH°.

The average annual phytoplankton biomass ranges between 578 and 7077 mg/m³ (Sais, 1975), that of zooplankton between 105.4 and 8192.5 mg/m³ (Najdenov, 1964 b, 1977, Ljudskanova, 1967) and that of benthos between 596.7 and 2991 mg/m² (Dimitrov, 1962, 1967). The total fish catch amounts to 50 t annually.

* Tab. 1. Grouping of average sizes of annual scale rings (S) and the corresponding back calculated body length values (L). $t_1 = L_1$, $t_2 = L_2 - L_1 \dots$ — absolute annual increments. The digits in brackets indicate year of which S, L and t reached the corresponding values

Genera- tion	Age group	Average values of S, L and t at various ages and at the ends of various growth periods					Number of specimens
		1	2	3	4	5	
1981	I(II...)	S ₁ L ₁ t ₁ 8(1981)	(...)				n
1980	II(III...)	S ₁ L ₁ t ₁ (1980)	S ₂ L ₂ t ₂ (1981)	(...)			n
1979	III(IV...)	S ₁ L ₁ t ₁ (1979)	S ₂ L ₂ t ₂ (1980)	S ₃ L ₃ t ₃ (1981)	(...)		n
1978	IV(V...)	S ₁ L ₁ t ₁ (1978)	S ₂ L ₂ t ₂ (1979)	S ₃ L ₃ t ₃ (1980)	S ₄ L ₄ t ₄ (1981)	(...)	n
1977	V(VI...)	S ₁ L ₁ t ₁ (1977)	S ₂ L ₂ t ₂ (1978)	S ₃ L ₃ t ₃ (1979)	S ₄ L ₄ t ₄ (1980)	S ₅ L ₅ t ₅ (1981)	n
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MATERIAL AND METHODS

Materials were collected in 1970 through 1981 using nets measuring 400 by 12 m. A total of 1300 individuals of carp (*Cyprinus carpio*), 1100 — of goldfish (*Carassius auratus gibelio*), 1050 — of chub (*Leuciscus cephalus*), 2500 — of roach (*Rutilus rutilus*) and 550 — of bleak (*Alburnus alburnus*) were examined. The body length (L) was measured along the scale cover. Scales were used for age determination. The diagonal (carp and chub) oral (goldfish) and caudal (roach and bleak) radii (S) of scales were measured. The S values of each species were arranged according to Table 1, aiming at revealing the growth rate of various species, generations and age groups in various growth periods. The L values found in these tables were obtained from the S values by the previously described (Živkov, 1980, 1982) modified back calculation method. The absolute annual increments (t) computed from the L values were used as growth rate indices (Živkov, 1972, 1982) by the following manner: the t values of tables similar to table 1 (not published for technical reasons) from one and the same growth period (year, digits in brackets) occupying one and the same diagonal row were arranged in a horizontal row in tables similar to table 2 (a separate table for each species) opposite the corresponding V values from the same year. Thus each vertical row of the latter tables contains t values of various age to as age groups as well. To eliminate the age-dependent growth rate differences groups (generations) and are relevant to the time when they were at one and the same age. For this reason the vertical rows of tables similar to table 2 will be referred the water volume effect on the growth rate was studied separately for each age by regressing the V against the corresponding t values of each vertical row of tables similar to table 2. The correlation and regression analysis was done by standard methods (Lakin, 1981).

RESULTS

As shown in Table 2, carps at one and the same age had different annual increments in different growth periods. The comparison between the V and the corresponding t values reveals regularities. For example the two-year-olds (Fig. 1 II) had the largest average annual increments at average annual volumes of 60 and 260 mill.m³ and the smallest increments — at 190 mill.m³. From 60 to 190 mill.m³ the increments were diminishing and above 190 mill.m³ they were growing. In other words the average annual increments (t) vary depending on the average volumes (V) and the curve describing this variation has the

shape of a third order parabole. This correlation coefficient is high ($r=0.708$) and statistically significant (Fig. 1 II, Table 3). The pattern of this relatively complex curve can be further illustrated if the V and t values from Fig. 1 II are grouped by volume classes (intervals) and their average values are analysed again. Fig. 1 II A shows an almost functional correlation ($r=0.97$). The second type curves of the other species are shown only. The data of the first type are shown in tables (Tab. 4—7) and by formulas (Tab. 3). The V, t correlation was studied in the second age group only, because some of the carp yearlings were stocked, i. e. they did not grow in the reservoir. The samples of other age groups were not representative enough (Tab. 2).

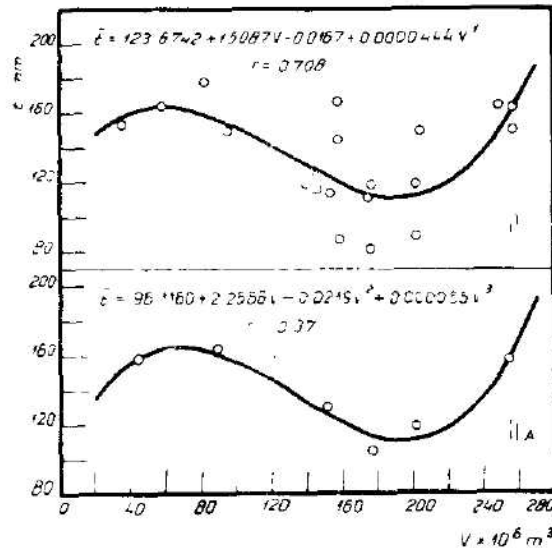


Fig. 1. II — Correlation between average (April to November) water volumes (V) in different years and corresponding absolute annual increments (t) of two years old carps. II_A — Correlation between average v values in different volume classes (intervals) and corresponding average t values of two years old carps.

The V, t correlation of the goldfish is of the same type (Tab. 4, Fig. 2). When data on fish increments at smallest volumes are available, the correlation is of the third order parable pattern (Fig. 2, I and IV). In all other cases the parable is of the second order (Fig. 2 II, III, V). The highest increments were observed at V about 80 mill. m^3 . From 80 to 140—170 mill. m^3 they diminished and grew beyond this limit. The V, t correlation coefficient of the first age is very high ($r=0.999$, Fig. 2 I and $r=0.84$, Tab. 3) and those of the other age groups were very high, too ($r=0.79$ — 0.89 , Fig. 2 II, III, V) but statistically insignificant because of small n values. The r values in Table 3 are somewhat smaller.

The chub growth rate is shown in Table 5. The V, t correlation patterns are more diverse (fig. 3). Nevertheless the third order parable is the best fitting curve in two age groups (Fig. 3 II, III). The highest t values were observed

Tab. 3. Parameters of equations which approximate the correlation between average water volumes (April through November) (V , 10^6 , m^3) and the average annual increments of fish (t , mm)

Species	Age group	Function	Correlation coefficient	t-test	t-tabl.	P	Number of years
Carp	II	$t = 123.6742 + 1.5087V - 0.0167V^2 + 0.0000444V^3$	0.708	$4.25 >$	3.92	0.001	20
	I	$t = 103.2487 - 0.6692V + 0.0041V^2 - 0.0000058V^3$	0.839	$4.87 >$	4.59	0.001	12
Goldfish	II	$t = 298.4236 + 7.3518V - 0.0495V^2 + 0.00011V^3$	0.520	1.83	2.26	0.05	11
	III	$t = 52.0950 - 0.1691V + 0.000825V^2$	0.414	$1.37 <$	2.26	0.05	11
	IV	$t = 58.7014 - 1.0623V + 0.0069V^2 - 0.0000127V^3$	0.612	$2.19 <$	2.31	0.05	10
	V	$t = 50.0425 - 0.3994V + 0.0012915V^2$	0.456	$1.25 <$	2.45	0.05	10
	I	$t = 106.0739 - 0.0713V$	-0.301	$1.05 <$	2.20	0.05	13
Chub	II	$t = -33.2832 + 3.2221V - 0.0277V^2 + 0.0000704V^3$	0.706	$3.15 >$	2.23	0.05	12
	III	$t = -0.8349 + 4.5390V - 0.0429V^2 + 0.0001233V^3$	0.796	$3.94 >$	3.25	0.01	11
	IV	$t = 27.9344 - 0.0759V + 0.0015V^2$	0.684	$2.65 >$	2.31	0.05	10
	I	$t = 96.3186 - 0.5023V + 0.0016633V^2$	0.665	$3.21 >$	3.01	0.01	15
Roach	II	$t = 93.4432 - 0.5855V + 0.0015862V^2$	0.528	$2.24 >$	2.16	0.05	16
	III	$t = 115.6163 - 1.1933V + 0.0035428V^2$	0.825	$4.84 >$	4.49	0.001	13
	IV	$t = 69.1319 - 0.5750V + 0.0016105V^2$	0.456	$1.70 <$	2.20	0.05	13
	V	$t = -5.5630 + 0.1083V - 0.0000471V^2$	0.459	$1.55 <$	2.26	0.05	11
	I	$t = -33.1762 + 2.6931V - 0.0178V^2 + 0.0000367V^3$	0.586	$2.40 >$	2.20	0.05	13
Bleak	II	$t = -32.9255 + 1.2921V - 0.0097V^2 + 0.0000226V^3$	0.698	$6.12 >$	4.78	0.001	11

Tab. 5. Average water volumes (April through November) and the corresponding average annual increment- (t. mm) of the cfub

Growth period (year)	Average water volume (m ³)		Average annual increments at various ages												
	t	n	1		2		3		4		5		6		
	t	n	t	n	t	n	t	n	t	n	t	n	t	n	
1975	145	559	370	116.0	1	65.5	3	47.0	12	59.0	29	41.0	14	37.6	29
1974	101	340	260	110.5	3	69.6	12	77.6	29	43.8	16	62.0	36	23.5	4
1973	201	827	640	100.0	12	70.0	29	85.6	16	50.4	14	57.7	4		
1972	175	678	930	81.0	29	46.4	16	59.0	14	82.4	68	37.7	4		
1971	176	669	500	95.2	16	60.8	14	39.8	221	77.2	4	36.8	32	25.4	12
1970	158	745	090	98.8	14	58.6	653	51.4	38	37.0	47	32.2	14	8.9	3
1969	94	258	650	78.4	363	77.2	38	69.6	47	29.8	14	32.2	3	11.8	6
1968	56	039	700	107.0	38	88.8	47	56.0	14	30.6	3	30.0	6	8.0	1
1967	145	202	100	102.8	47	88.0	14	45.4	3	28.4	6	34.0	1		
1966	111	969	070	103.0	14	76.6	3	36.6	6	30.0	1				
1965	140	016	950	86.0	3	70.6	6	39.0	1						
1964	34	756	537	98.4	6	41.4									
1963	201	061	250	77.6	1										

at V around 80 mill.m³. From 80 up to 150—170 mill.m³ they were diminishing and beyond this limit they were growing once again. The first age group increments diminished with the volume increase (Fig. 3 I). This diminishing was very slow, though, because the proportion coefficient (0,0826) of the linear

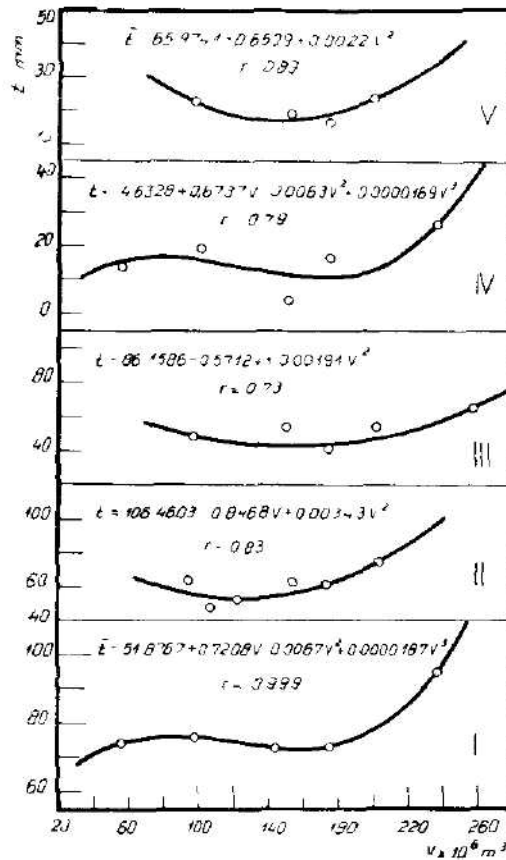


Fig. 2 Correlation between V and t of the goldfish (conventional signs same as those in Fig. 1 II_A).

equation $t = 107.3611 - 0.0826 V$ describing the V and t relation is real small, i. e. the slope of the line in fig. 3 I is not steep. This indicates that the water volume variations do not alter considerably the growth rate of chub yearlings. The 4th age group exhibited a reversed trend (Fig. 3 IV). With the increase of V the t values showed an almost exponential growth. The V, t correlation of all age groups (see the 1st one in Table 3) is strong and statistically significant (Tab. 3 and Fig. 3).

The roach average annual increments also showed considerable variations in different growth periods (Tab. 6). But followed a well defined uniform correlation with V in all age groups. The t values diminished with the increase of V up to 150—180 mill.m³ and grew rapidly beyond this limit (Fig. 4). The

Tab. 6. Average water volumes (April through November) and the corresponding annual increments (t, mm) of the roach

Growth period (year)	Average water volume (m ³)		Average annual increments at various ages																	
	t	n	1		2		3		4		5		6							
			t	n	t	n	t	n	t	n	t	n	t	n	t	n	t	n		
1981	156	899	620		50.0	76	4.5	2	35.0	3	28.0	15	26.5	10						
1980	249	779	750	82	47.0	2	41.5	7	34.0	30	27.2	24	30.3	1						
1979	157	872	000	2	50.3	7	26.0	20	29.5	24	6.0	1	24.0	1						
1978	176	156	590	7	37.7	63	27.0	45	22.5	2	12.0	2	26.4	12						
1977	256	624	160	63	54.0	57	21.0	1	24.5	2	16.3	18	21.8	34						
1976	204	417	820	57	36.5	2	19.9	3	15.4	22	6.9	44	5.8	29						
1975	145	559	370	2	45.2	33	20.3	59	12.7	85	2.3	79	18.0	258						
1974	101	827	640	32	37.7	61	22.1	105	16.2	94	2.2	281	11.6	331						
1973	201	827	640	61	35.4	150	17.0	115	13.2	319	5.9	421								
1972	175	078	990	150	26.8	135	4.0	357	6.1	453										
1971	176	089	500	139	26.2	465	6.9	572	11.8	7	12.6	2	4.7	8						
1970	158	745	090	465	26.8	572	16.9	7	19.9	2	16.8	3								
1969	94	258	650	572	58.5	7	52.5	2	36.0	3										
1968	56	039	700	7	62.5	2	53.7	3												
1967	145	702	100	2	71.8	3														
1966	111	969	070	3	68.5															

correlation is of the second order parable pattern and the correlation coefficient is high ($r=0.80-0.98$, Fig. 4) and statistically significant in the first three age groups (Tab. 3 and Fig. 4). The last two age groups showed a moderate and insignificant V, t correlation mostly because of small sample sizes (Tab. 3).

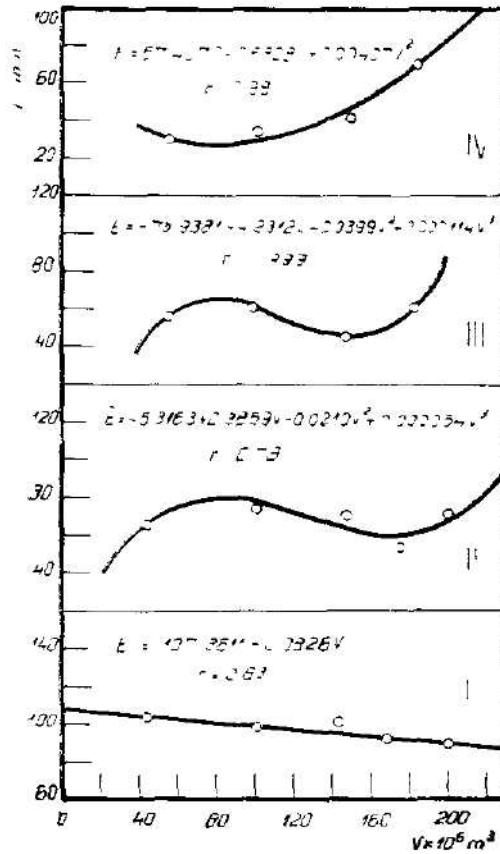


Fig. 3. Correlation between V and t of the chub (conventional signs same as those in Fig. 1 II_A).

Because of large samples of the first two bleak age groups (Tab. 7), the V, t correlation is of the third order parable pattern (Fig. 5). It is worth noting that the curve peaks are not as well shaped and are considerably shifted to the right (100—110 mill.m³). The further increase of V leads towards a considerable increase of t values. The V, t correlation coefficients of both groups are high and statistically significant (Tab. 3 and Fig. 5).

DISCUSSION

As shown on Figs. 1—5 and Tab. 3, the V, t correlations follow the third order parable pattern either in full or are parts of this curve (the thick curves

Tab. 7. Average water volumes (April through November) and the corresponding average annual increments (t, mm) of the bleak

Growth period (year)	Average water volume (m ³)	Average annual increments at various ages														
		1			2			3			4			5		
		t	n	t	n	t	n	t	n	t	n	t	n	t	n	
1981	166	100.0	28	24.0	28	16.5	6	10.5	1							
1980	249	104.5	28	35.5	6	15.0	1									
1979	167	872	8	14.5	2											
1978	176	160	1													
1977	268	624	1			14.5	1									
1976	204	417	820	40.5	1											
1975	145	559	370	21.5	27	15.7	31	23.8	9							
1974	101	340	250	23.2	141	11.2	42	16.2	22							
1973	201	827	640	21.5	52	17.9	22	16.2	17							
1972	175	078	930	13.5	22	9.0	19	11.9	16							
1971	176	069	500	77.8	25	0.4	35	11.0	7							
1970	158	745	090	86.0	63	16.7	105	15.0	17							
1969	94	258	650	76.5	105	20.5	17	11.9	1							
1968	56	039	700	74.5	17	13.1	1									
1967	145	202	100	112.5	1											

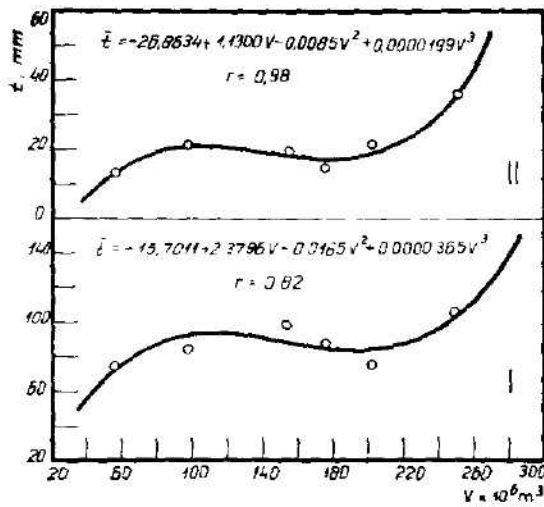
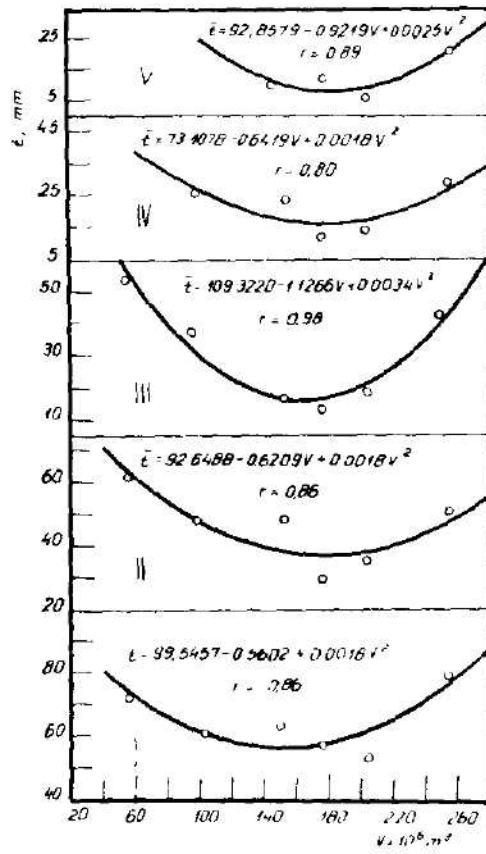


Fig. 4. Correlation between V and t of the roach (conventional signs same as those in Fig. 1 II_A).
 Fig. 5. Correlation between V and t of the bleak (conventional signs same as those in Fig. 1 II_A).

of Fig. 6). In the former case the curve contains all parts of a third order parabole, namely: a well shaped left (ascending) slope, a maximum, a descending slope, a minimum and an ascending right slope. Usually the correlation follows this pattern when sufficient V records and the corresponding t values are available within their entire ranges of variation (Fig. 3 II, III, Fig. 5). Whenever the number of years with lowest V values is not sufficient, the left ascending slope of the third order parabole is either ill defined (Fig. 6, 4, Fig. 1, Fig. 2 I, IV) or completely missing (Fig. 6, 5, Fig. 4), i. e. the parabole is of the second order.

These are the most common cases. The 4th chub age group correlation pattern (the last one in Fig. 6 and Fig. 3 IV) is somewhat different due to the effects of other factors that will be discussed later.

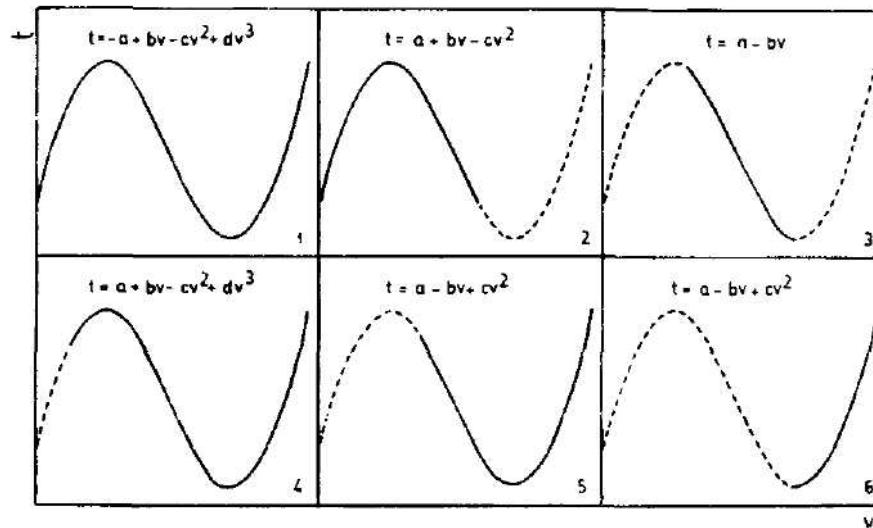


Fig. 6. Type of correlation between the water volume (V) and the absolute annual linear increments (t) of different species and age groups. With solid lines — really estimated types of correlation between V and t and their correspondent equations (1-6). With dotted lines — assumed alteration of t by V.

Generally, the V, t correlation patterns of various species and age groups within species show both similarities and differences. Naturally the nutrition base of the reservoir should be first considered among the reasons for the similarities and differences in the growth rates among various phenological years. The zooplankton is considered of great significance as nutrition basis of fish (Najdenov, 1977). It has been studied for years. Its abundance variations were studied by Najdenov (1964 a, b, c, 1976, 1977) and Ljudskanova (1967). Our correlation and regression analysis showed that the correlation between average water volumes (V) and average annual (April — May) zooplankton biomass (Z) also followed the third order parabole pattern (Fig. 7 II). The Z values were growing up to 80—100 mill.m³, declining up to 200—220 mill.m³, and growing once again beyond this limit ($r=0.614$, $t=2.2 < t_{tab.}=2.31$, $P=0.05$). The reason for the relative low value of r and its statistical insignificance is the varying correlation between V and Z in different seasons. At the

beginning of the growth period (in spring) the average Z values show little or no correlation with V and the coefficient is low and insignificant ($r=0.283$, $t=0.835 < t_{tab.}=2.31$, $P=0.05$). While in summer it is high and significant (Fig. 8, I $r=0.782$, $t=3.55 > t_{tab.}=3.36$, $P=0.01$). As shown on the graph, the highest Z values occurred at V around 100 mill.m³, i. e. 1/3 of the reservoir capacity, and the lowest — at V around 220 mill.m³ (2/3 of the capacity). Beyond this limit the Z values grew again. The fall data (Fig. 9 II) resembled the summer ones.

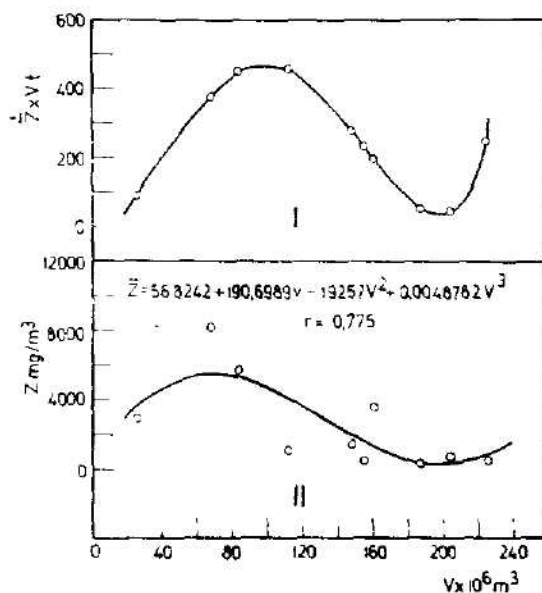


Fig. 7 Alteration of average values of the biomass of zooplankton (Z mg/m³) (II) from April till November and the product ($Z \cdot V$, tons) (I) in correlation with the corresponding average reservoir volume (V mill. m³) during different years.

The total reservoir zooplankton biomass (the product of the average annual zooplankton biomass and the average water volumes — $Z \cdot V$, tons) followed the same pattern of variation (Fig. 7 I, 8 I A, 9 I).

The reasons for this relatively complex plankton variation pattern are beyond the aims of this study. However it has been found that the size, depth, hydrology and hydrochemistry affect the biological components of a reservoir. It is assumed that the large water volume variations in the reservoir studied do affect its biota. For example Mejsner (1952), Micheev and Prohorova (1952) point out the water volume variations and particularly the flooding of previously dry banks (strongly increasing the abundance of nutritive species) as one of the most important factors affecting the living conditions of fish. It is known also that the smaller and shallower a reservoir, the higher its secondary productivity.

Having in mind these principles we can point out that at a volume of 100 mill.m³ the water covers the relatively flat surface of the Batak plain and does not reach the steep banks. The bays of Kostandovski, Studenets and Sv. Georgi

particularly contribute to the extending of the shallow waters. The maximum zooplankton biomass occurs at this volume (Figs. 7, 8, 9). The further elevation of the water level increases the share of deep sections and coincides with the decline in Z values (Figs. 7, 8, 9). The northern banks (especially those at 3—4 km from the dam) get steeper and the large central parts of the reservoir get deeper. At 200—220 mill.m³ the broad southern part of the Batak plain is flooded thus increasing the share of shallow waters. The plain is normally used as a naturally and artificially fertilized pasture and is rarely flooded. For this reason the zooplankton biomass there is the highest (Najdenov, 1964 b).

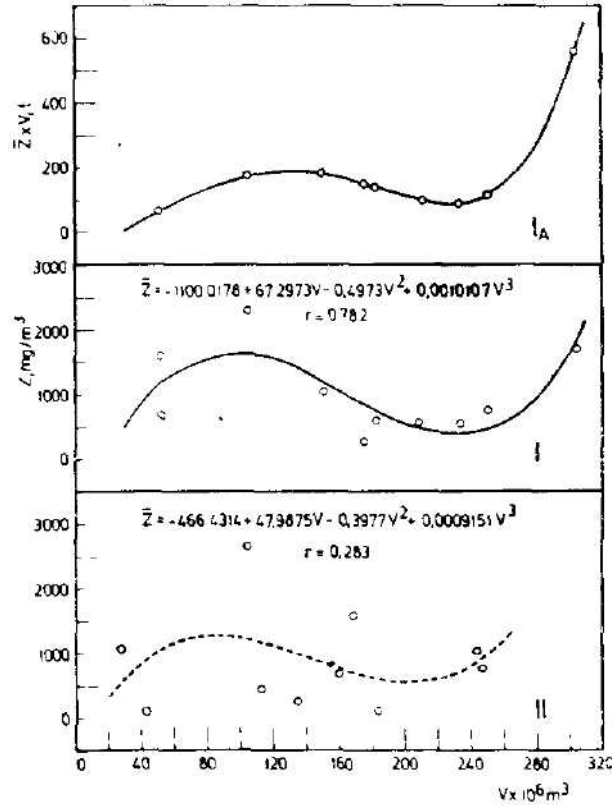


Fig 8. Alteration of average summer (I) and average spring (II) values of the biomass of zooplankton ($Z \text{ mg m}^{-3}$) as well as the product ($Z \cdot V$, tons) in summer (IA) in correlation with the average water volumes ($V \text{ mill.m}^3$) during the respective seasons in different years

When studying the phytoplankton dynamics of the reservoir over a period of 3 years Sais (1977) found an inverse relation between its abundance and the water volume. However, longer studies may show that this relation follows a more complex pattern. As shown by Najdenov (1964 c) phytoplankton is of importance for fish nutrition.

The benthos biomass and abundance and its significance for fish nutrition were

studied in 1958—1963 by Dimitrov (1962, 1967). He listed the carp and the goldfish as benthos consumers. We found though that the chub and the roach had benthic components in their diets, too. It is generally accepted that in this reservoir benthos is much less abundant and insignificant for fish nutrition (Dimitrov, 1962, 1967, Najdenov, 1964 b, 1977).

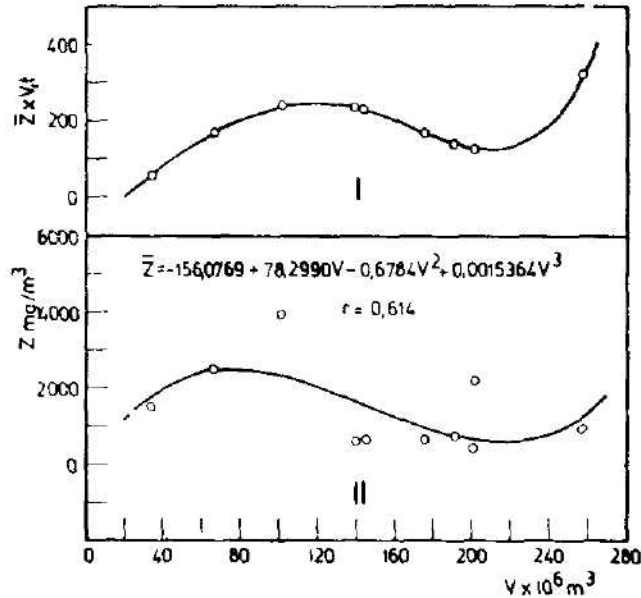


Fig. 9. Alteration of average autumn values of the biomass of zooplankton ($Z, \text{mg}/\text{m}^3$ (II) and the product ($Z \cdot V$, tons) (I) in correlation with the average water volumes (V , mill. m^3) during autumn in different years

The data on benthos biomass (B) are insufficient to establish a significant correlation with the water volume. Having different aims Dimitrov located his benthos sampling sites along a transverse line and thus did not take into account the effect of temporarily flooded, previously dry areas on the benthos biomass. Nevertheless some examples indicate that at high water levels B values grow: at $212.142 \text{ mill. m}^3$ the average summer B value is $596.7 \text{ mg}/\text{m}^2$, at $253.146 \text{ mill. m}^3$ — $1035 \text{ mg}/\text{m}^2$, and at $304.743 \text{ mill. m}^3$ — $1715 \text{ mg}/\text{m}^2$. This is similar to the effect of the initial water build up. We observed that in such cases benthic organisms were of significance for the fish nutrition. Besides this the land vegetation of flooded pastures contributes to the diet of the chub, roach, carp and goldfish. Thus the flooding of previously dry areas largely determines the second peak (in many cases higher than the first one) of the growth rate curves of these species (see the curve patterns in Figs. 1—4 at volumes over 160 — 190 mill. m^3).

The V, t correlation curves of various species and age groups generally resemble the V, Z correlation curve pattern and differ from it by some parameters determining the position of maxima and minima, steepness of slopes, i. e. rate of variation of t and Z as affected by V , etc.

The first age groups showed a great diversity in the variation of t as affected by V . As the chub reproduction season is prolonged and the spawning is in portions (Živkov, 1980), the annual chub yearlings' increment depends much more on the number of spawnings and duration of periods between them and not so much — on the nutrition base and the water volume variations. The maximum of the bleak yearlings' t curve is shifted far to the right (at 100–120 mill.m³, fig. 5 I). This is due to the delayed reproduction of this species in the Batak reservoir (early summer, Živkov, 1980) leading to a considerable dependance of the growth rate of newly hatched fish on the zooplankton summer curve (compare Fig. 5 I and Fig. 8 I). This curve considerably affects the growth rate curve of two-year-old bleaks as they start intensive feeding in early summer only the spawning (Živkov, 1980).

The V , t correlation curve of the 4th chub age group differs considerably from the zooplankton curve (compare Fig. 3 IV and Figs. 7, 8, 9) indicating a limited dependence of higher chub age groups' growth rate on zooplankton dynamics. After the third year of age this species starts feeding on fish (there was no predator fish population in the reservoir during the period of investigations on this species, Živkov, 1974).

The large numerical variations of different species and age groups affect the corresponding annual increments. For example at one and the same volume of 160 mill m³ the increments of two-year-old carps in different years vary within a wide range — from 86.4 mm in 1970 to 167.5 mm in 1981, (Fig. 1 II and Tab 2) because of varying number of fish in different years. The 1969 and 1970 roach generations were so numerous that accounted for over 80 % of the commercial catch during the next 10 years. The 1969 carp generation accounted for almost 90 % of the carp catch over the following several years (Živkov, 1975). On the other hand, in 1981 and generally during the recent years the fish abundance declined because of intensive fishing, insufficient stocking and predator pressure of the already abundant population of the pike perch (*Stizostedion lucioperca*). Regardless of the large variations of annual increments the correlation of average V , t values generally follows the third order parabolé pattern (for ex. see Fig. 1 II A).

CONCLUSION

The water volume variations in different years and seasons are an important ecological factor in the Batak reservoir. They strongly affect the growth rate of fish. The following general trends of variation of annual linear increments (t) were established: a slight increase with the volume increase up to 1/3 and the total capacity; a decline between 1/3 and 2/3 and a rapid increase beyond 2/3. The function describing the V , t correlation is a third order parabolé or parts of it. In most cases this correlation is strong and significant. The correlation between V and the biomass (Z) of zooplankton, being the basic fish diet component, follows the same pattern and is strong and significant, except for the beginning of the growth period in spring.

The V , t and V , Z correlation curves are similar in shape but differ in their parameters. The reasons for this difference are both formal (lack of data on all possible water volumes) and biological (differences in diets, abundance, timing of reproduction and intensive feeding of various species and age groups, increased participation of benthos and submerged pasture vegetation in the diet at high water levels, predation, etc.).

Acknowledgements

The authors thank Asst. Professor O. Oliva for the review of the manuscript and encouragements.

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REVIEWS — RECENSE

Overrein L. N., Seip H. M. & Tollan A., 1982: *Acid precipitation — effect on forest and fish*. Final report of the SNSF-project 1972–1980. 175 pp., Reclamo, Oslo.

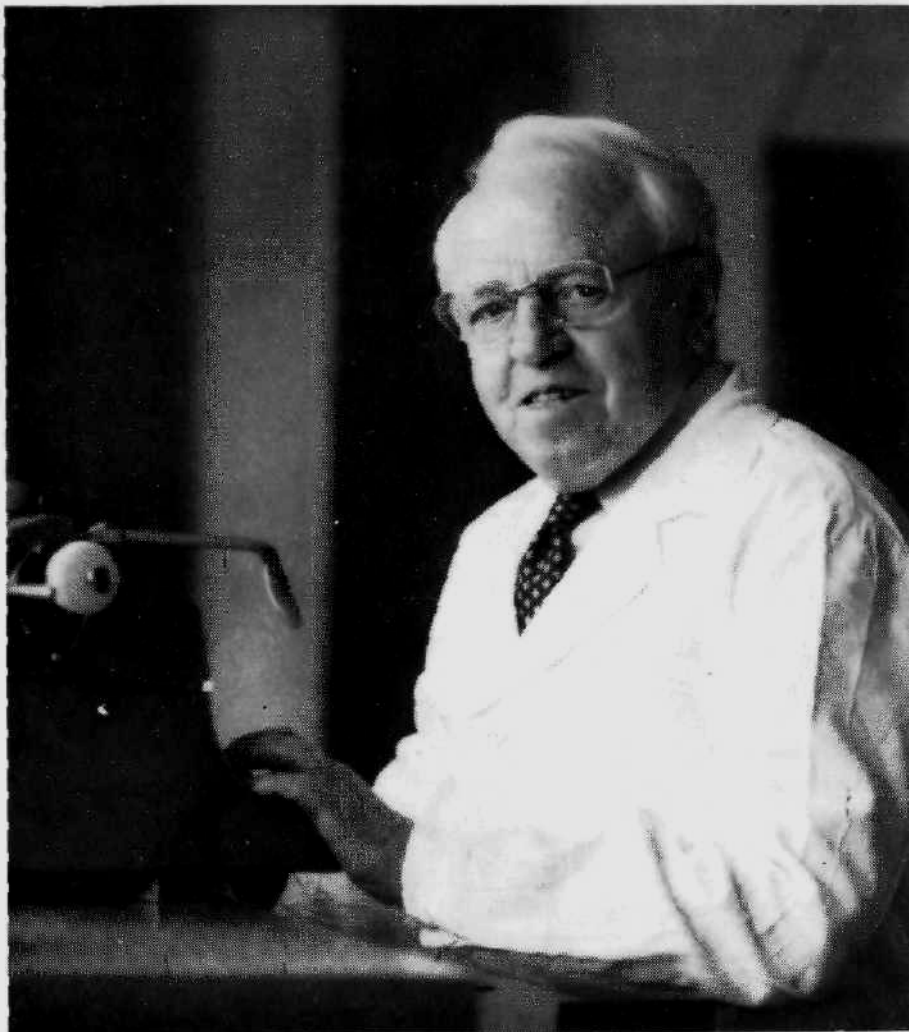
The running water acidification has become a serious problem of recent hydrology, hydrobiology and nature conservation especially in North America and Scandinavia. This book represents results of the Norwegian interdisciplinary research programme (SNSF—project) for the period of 1972–1980. The main objectives of this programme have been: (1) establish as precisely as possible the effects of acid precipitation on forest and freshwater fish and (2) investigate the effects of air pollutants on soil vegetation and water, required to satisfy point 1.

Eleven chapters are included in this book. As it is apparent from the headings of individual chapters the acidification is studied from really complex point of view. First part of the book deals with physico-chemical background of acidification (emissions and transport, atmospheric deposits, status and trends of acidification, chemical modification of precipitation in contact with soil and vegetation, snow and melt etc.).

More than a third of the book content deals with the effects of acidification on animal and plant growth. This book actually represents one of the first attempts to summarize effect of acidic precipitation on aquatic invertebrates and fish in Europe. Direct effects of acidification are manifested by mucous deposits between gill lamellae of fish leading to a serious mortality and reduction of fish standing crop. Most of fish (e. g. perch, charr or trout) are not able to tolerate acidity of water below pH=4.5. Recently, lakes in more than 13 000 km² of Norway are devoid of fish and in additional 20 000 km² are with reduced fish stocks. Although aquatic ecosystems under acidification show both reduced production and decomposition, and all trophic levels are affected; the fish in acid waters does not disappear by lack of food. Although also the invertebrate fauna shows reduced species diversity during the acidification, invertebrates in general are able to tolerate acidic water better than fish. There are also indirect effect of acidification on invertebrates (ceasing of food uptake, behavioral changes etc.). The simplifications of invertebrate biocoenoses (drastically reduced diversity) make the ecosystem more vulnerable to changing and, consequently, represent an additional stress also on the top-predators. Moreover, there is a considerable increase of toxicity of some metals in connection with acid episodes (e. g. the Al-toxicity depends on water pH and possesses maximum around pH=5.0). This phenomenon represents one of the main cause of massive fish kills.

The acidification of both running and standing water represents a serious problem also in Central Europe. Unfortunately, such a comprehensive study on both biotic and abiotic changes connected with the acidification is yet to be expected in our country.

T. Soldán and V. Landa



Předseda Československé společnosti zoologické při ČSAV a přední československý zoolog akademik Josef Kratochvíl se dožil 6. ledna 1984 v plné svěžesti 75 let. Členové Československé společnosti zoologické při ČSAV mu k tomuto významnému jubileu přeji mnoho zdraví a úspěchů v další práci.

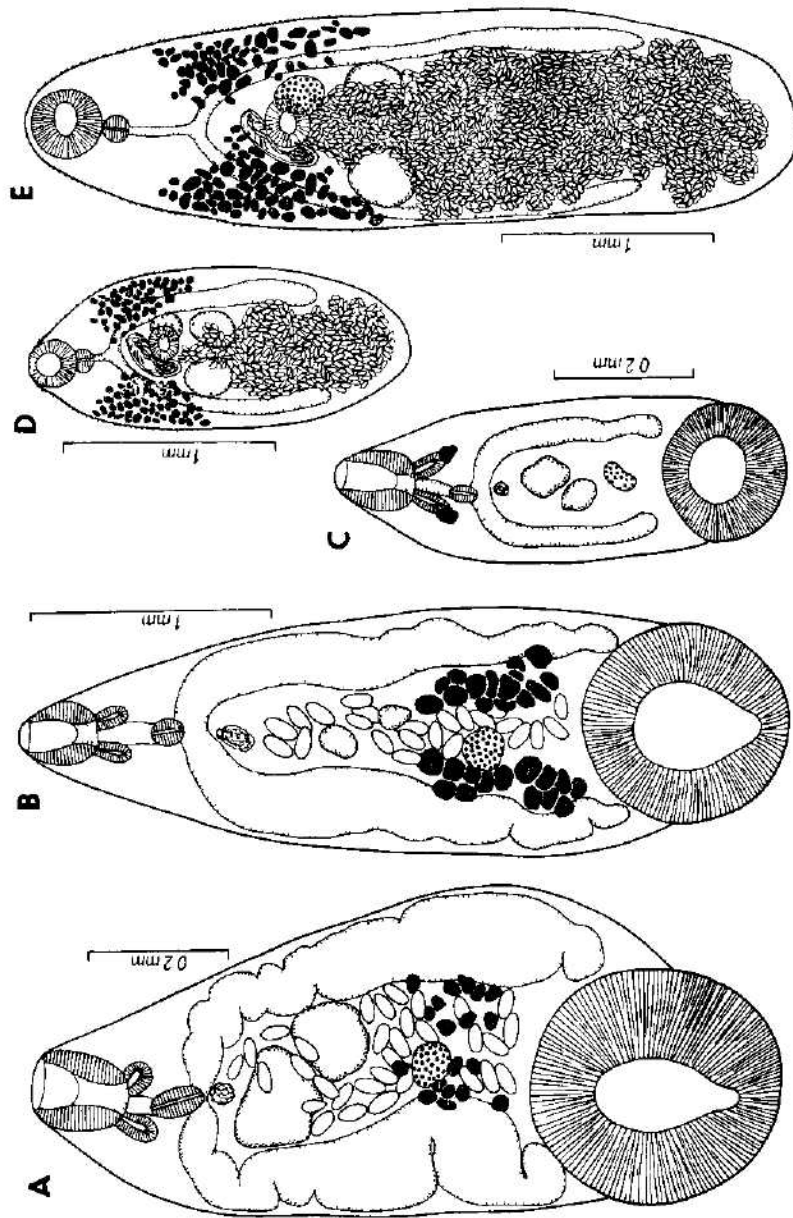


Fig 1 A-C - *Megalodiscus microphagus* Ingles, 1936 (A - from *R. aurora*, B - from *T. granulosa*, C - juvenile specimen from *T. granulosa*), D-E - *Glyphihelminus californiensis* (Cort, 1919) (two specimens of different size of body)

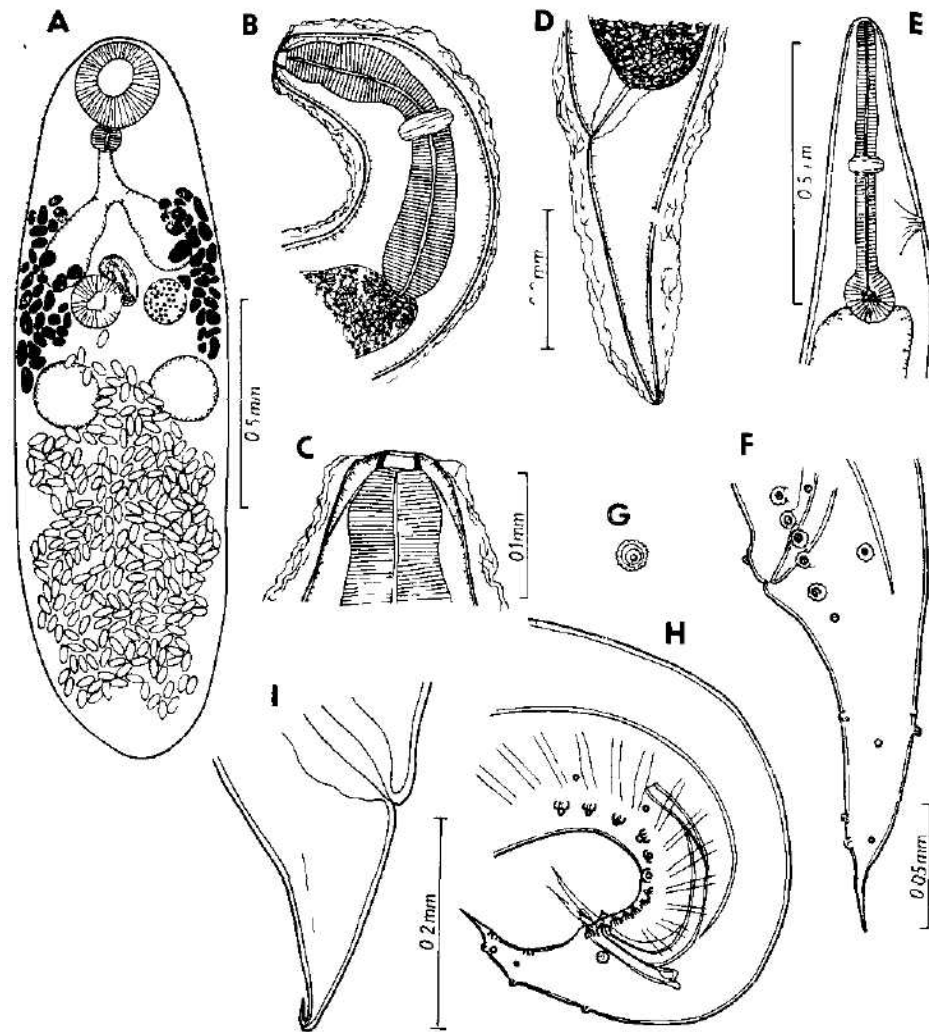


Fig 2 A - *Brachycoelum salamandrae* (Froelich, 1789), B-D - *Rhabdias joaquinesis* Ingles, 1936 (B, C - anterior end of body, D - tail), E-I - *Cosmocercoides dukae* (Holl, 1928) (E - anterior end of female, F - tail of young male, G - ornamented caudal papilla, H - posterior end of male, I - tail of female)

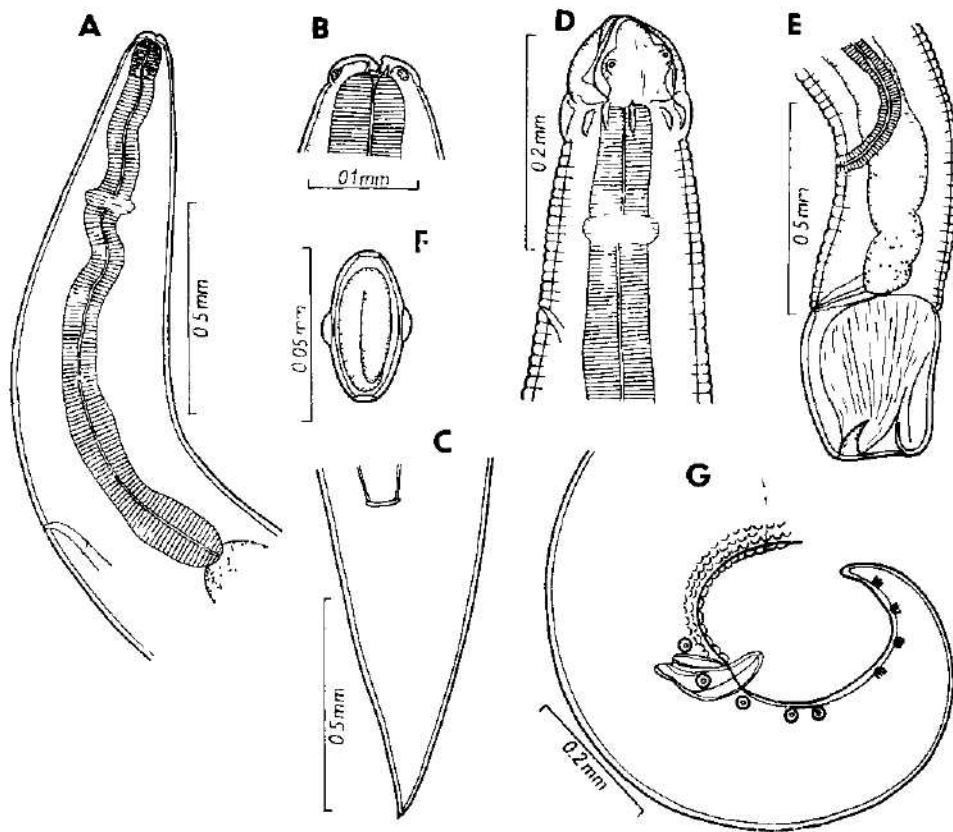
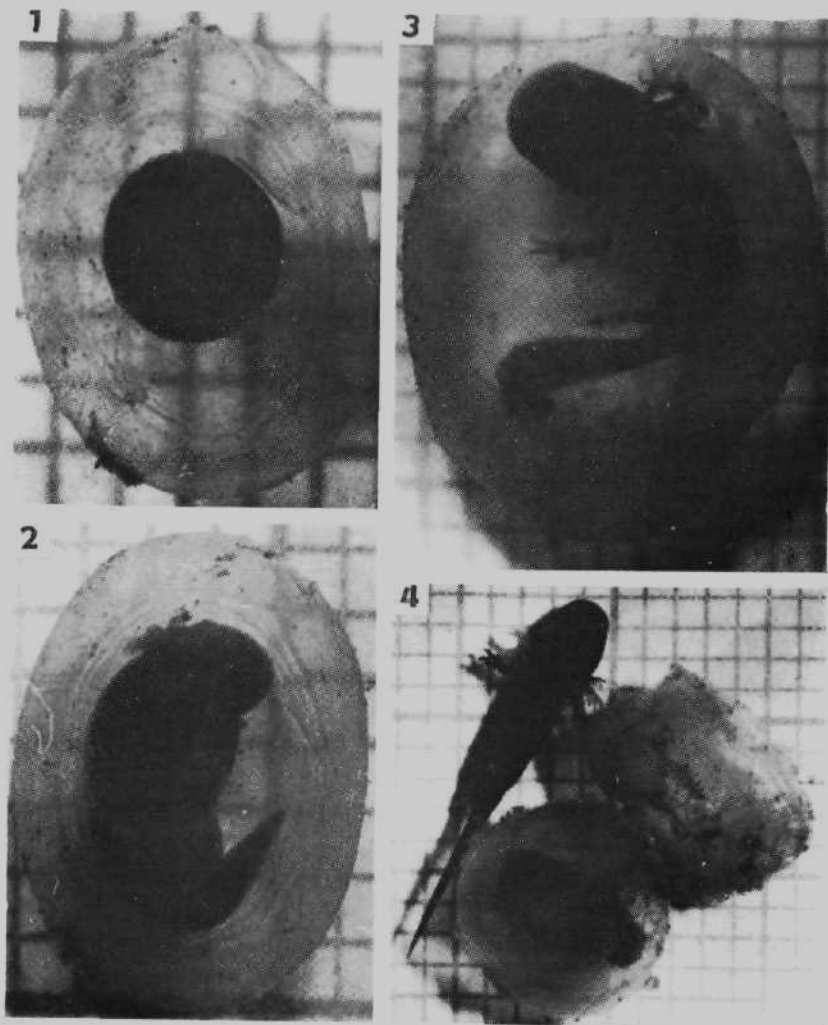


Fig. 3 A-C — *Megalobatrachonema* sp. (female) (A — anterior end of body, B — mouth region, C — tail); D-G — *Hedruris androphora* Nitzsch, 1821 (D — anterior end of female, E — posterior end of young female, F — egg, G — posterior end of male)

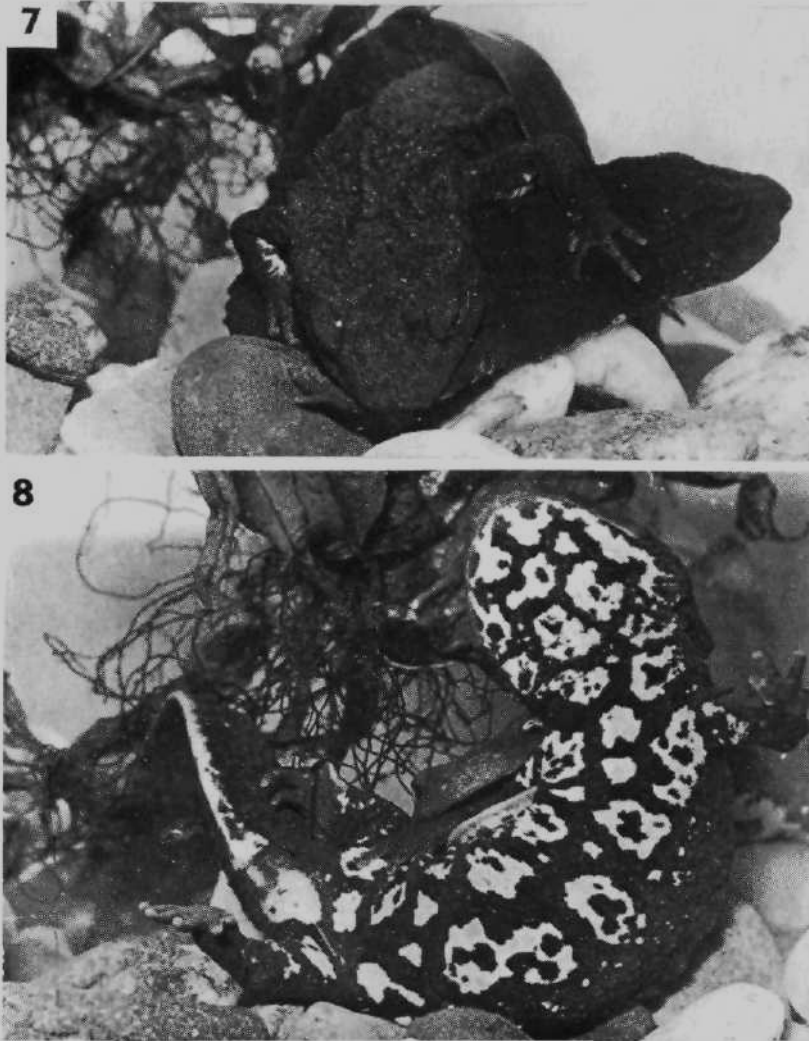
Rehák I.: A study on Paramesotriton deloustali in captivity



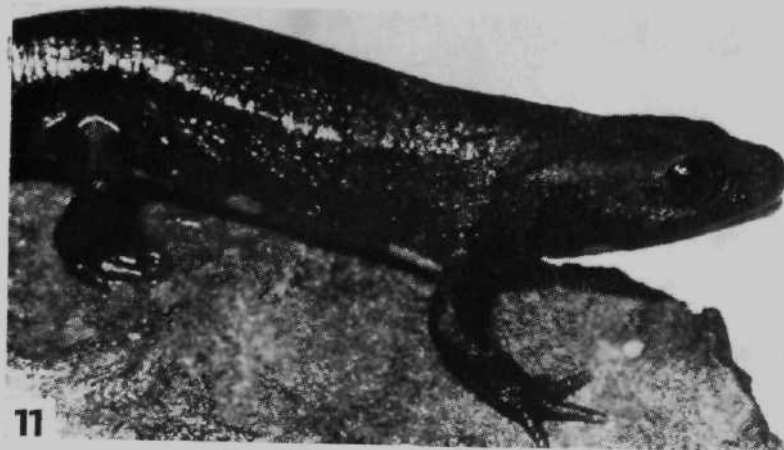
Figs. 1-4. *Paramesotriton deloustali*: 1 — the egg immediately after the oviposition; 2 — the egg 15 days after the oviposition; 3 — the egg 42 days after the oviposition (before the hatching); 4 — the hatching.



Figs. 5, 6, *Paramesotriton deloustali*: 5 — the larva aged two months; 6 — the larvae aged three months.



Figs. 7, 8. *Paramesotriton deloustali*, aggressive behavior: 7 — the immobile tangle of fighting salamanders (the male holding the female's extremity, the female passive with eyes closed); 8 — the male biting the female. The ventral side of the female.



Figs. 9–11. *Paramesotriton deloustali*: 9 – aggressive behavior – the male attacking the female; 10 – the ventral side of the male; 11 – the juvenile immediately after the metamorphosis.

POKYNY PRO AUTORY

Věstník Československé společnosti zoologické uveřejňuje původní vědecké práce členů společnosti v rozsahu nejvýše 30 stran rukopisu, napsané v některé z kongresových řečí, a dále články, hodnotící životní dílo našich zoologů, vyžádané redakcí. Práce autorů, kteří nejsou členy společnosti, budou přijímány jen výjimečně.

Formální úprava prací:

Rukopis (originál a 1 kopie) musí být psán na stroji s většími typy obřádek, na stránce 30 řádek, řádky po 60 úhozech, bez větších oprav. Rukopisy, které by neodpovídaly těmto formálním požadavkům, budou vráceny k přepsání.

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

Vlastní práce: 1. Velmi stručný abstrakt, v rozsahu nejvýše 15 řádek, v angličtině. 2. Úvod do problematiky (stručně). 3. Materiál a metodika (u známých metod pouze odkaz). 4. Vlastní část experimentální nebo popisná. 5. Diskuse. 6. Závěr. 7. Seznam citované literatury (nikoliv bibliografie!). 8. Adresa autora. 9. Tabulky, texty k obrázkům a grafům. Celý rukopis je průběžně stránkovan.

Citace prací proveďte podle jednotného vzoru: autor, rok, název, časopis (mezinárodními bibliografickými zkratkami), ročník, sešit pouze v případě, že ročník není průběžně stránkovaný, stránky. U knižních titulů nakladatel a místo vydání. Např.: Hrabě S., 1975: Second contribution to the knowledge of marine Tubificidae (Oligochaeta) from the Adriatic Sea. *Věst. čs. Společ. zool.*, 39: 111–119.

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

Obrázky a grafy kreslete černou tuší na kladívkový nebo pausovací papír v poměru 1:1 až maximálně 1:2, u taxonomických prací musí mít obrázky měřítko. Obrázky kreslete pokud možno tak, aby mohly být všechny stejným způsobem zmenšeny. Fotografie musí být ostré, kontrastní, na lesklém papíře. Obrázky sestavte do tabulí, které by bylo možno reprodukovat na šíři strany (126 mm), nebo s textem na celé zrcadlo (126 × 188 mm). Obrázky nebo obrazové tabule průběžně číslujte a v rukopise vyznačte místo, kam mají být zalomeny.

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

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

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

Práce zasílejte na adresu: Doc. Dr. K. Hůrka, CSc., výkonný redaktor Věstníku čs. Společ. zool., Viničná 7, 128 44 Praha 2.

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