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NOTE ON SYMPHYSODON AEQUIFASCIATUS (CICHLIDAE, OSTEICHTHYES)

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Dedicated to Professor Václav Dyk DSc. on the occasion of the 70th anniversary of his birthday

Abstract: 52 specimens (21—121 mm body length) of *Symphysodon aequifasciatus* Pellegrin, 1903 donated by aquarium hobbyists were examined and 10 plastic and 13 meristic characters were studied. This species is supposed to be valid. The hybridization between *Symphysodon discus* Heckel, 1840 and *Symphysodon aequifasciatus* is probable.

INTRODUCTION

Heckel (1840, after Schultz, 1960) described the new genus and species *Symphysodon discus*. He had at his disposal only one specimen from Rio Negro. Pellegrin (1903) described the colour mutation *Symphysodon discus*. var. *aequifasciatus* from Manaos. Schultz (1960) recognized, beside *Symphysodon discus*, three subspecies of the second species within genus *Symphysodon*, *Symphysodon aequifasciatus*, viz., *Symphysodon aequifasciatus* typ., *Symphysodon aequifasciatus axelrodi*, *Symphysodon aequifasciatus haraldi*. After Meinken (1972) four colour mutations of *Symphysodon discus* are called, in the aquaristic slang, "Royal-blue", "Pompadur", "Red discus", "Turquoise discus". *Symphysodon discus* was first brought to Europe in the year 1914 (after Hykeš, 1937) from the vicinity of Manaos, but after Holly, Meinken, Rachow (1943), Glade (1966), Sterba (1977) it was later, in 1921, simultaneously with *Symphysodon aequifasciatus*. For the first time it was reproduced in the aquarium in the U. S. A. in 1934, in Germany in the year 1936 (Hykeš, 1937). After 1945 there are many articles about succesful breeding breeding in captivity in fish hobbyist's literature.

MATERIAL AND METHODS

All measurements were made using dividers with accuracy ± 0.5 mm, only eye diameter, length of snout, width of snout, interorbital distance were measured with the accuracy ± 0.1 mm. The rows of scales and numbers of rays and teeth were counted using binocular microscope. Material preserved at first in formalin was later deposited in 80% spirit.

RESULTS AND DISCUSSION

The body of the examined specimens is flat, discus-shaped, tail short, anal and dorsal fins long, not prolonged into fibres. The membrane of the fin among

spiny rays of the dorsal and anal fins is not continuous but cut off lengthwise along spiny rays. Longest rays of the dorsal and anal fins are close to the end of fins, finally they got became shorter. Pectoral fin small, rounded. Dorsal, anal and caudal fins on the basis covered with small scales, which reach to fin rays. The dorsal fin begins above gill slit, anal below the 4th—5th spiny ray of the dorsal fin. ventral fin in front of the beginning of the pectoral fin below the posterior third of the part of the head. Scales ctenoid. Two incomplete lateral lines are visible. Anterior line reaches from gill cover to the last third of the body and is curved following the outline of the back. Posterior lateral line is direct and reaches from posterior third of the body to the caudal fin. Scales in lateral lines are bigger than the adjoining ones. In about 20% of specimens similar scales with pores were found as in the lateral lines above or below the posterior lateral line on the base of caudal fin (in number 1—4 scales). In about 10% of specimens the difference was found in the number of scales in the lateral lines on the right and left sides of the body. This difference counted ± 1 scale. This was also observed by Holly, Meinken, Rachow (1943). Mounth small in oblique position. Sex differences are not conspicuous. Steindachner (after Hykeš, 1937), after dissection of some specimens of *Symphysodon*, believed that males have ventrals prolonged into fibres. I was unable to solve this problem, most of my specimens had damaged ventrals. I counted 12 teeth on the upper and 12 teeth on the lower jaw. Teeth are conical, small and in bigger specimens with red-brown points. One selected specimen 89 mm of body length had all teeth clean white, another specimen 106 mm of body length had all teeth with dark points. Gill rakers very short. dwarfed. On the outer side of the first gill arch I found 5 gill rakers. The cheek below the eye scaled, opercle, subopercle and interopercle scaled. The whole material was determined after Schulz (1960). Suspecting the aquarium specimens to be hybrids I studied three selected specimens of my material. One specimen (92 mm body length), was coloured as *Symphysodon discus* (3 dark bars across body, D VII/31, A VII/30, P 14, anterior and posterior lateral line 22/12, above lateral line 18, below 30 scales). Vertical scale rows 55. Two specimens (49—51 mm body length) were coloured as *Symphysodon aequifasciatus* (9 dark bars across body about approximate intensity, except first and last, which are a little darker, D IX/29—31, A VIII—IX/25—29, P 14, anterior and posterior lateral line 21—23/10—12, above lateral line 17—20, below 30—31. Number of vertical scale rows in both specimens was 49 (see Fig. 1—2). I believed that the above-mentioned specimens are hybrids and I applied the method of the calculation of the hybrid index of Hubbs and Kuronuma (1942). This method is recommended in case of a small number of hybrids. Average values of the vertical scale rows for *Symphysodon discus* and *Symphysodon aequifasciatus* after Schultz (1960) are the following: *Symphysodon discus* 44—48 scales, ave. 46.26. *Symphysodon aequifasciatus* 50—61 scales, ave 54.80. In the case of *Symphysodon discus* the number of specimens examined by Schultz (1960) is unknown. The numerical values of the vertical scale rows were cited by Schultz (1960 "from literature". I suppose in Schultz's data (1960) the equal number of the specimens concerning *Symphysodon discus* with different number (46—48) vertical scale rows (see Tab. 4). The difference between both weighed averages is 54.80—46.25 = 8.55. I take for my calculations that *Symphysodon discus* = 0, *Symphysodon aequifasciatus* = 100. Then in case of hybridization between *Sym-*

Table 1. Plastic characters in examined specimens (ranges in brackets)

Length group Body length (mm) No. of sp.	I (21—50) 26	II (51—80) 8	III (81—121) 18
In % of body length body depth	(60.8— 77.6) 67.5	(65.5— 73.3) 70.8	(65.2— 86.8) 72.2
In % of body length head length	(30.3— 39.6) 36.4	(30.4— 34.5) 32.5	(28 8— 33.3) 31.1
In % of head length eye diameter	(28.6— 42.2) 35.0	(33.3— 41.5) 36.4	(26.8— 37.0) 31.1
In % of head length mouth width	(12.7— 23.1) 17.3	(15.2— 21.9) 17.7	(11.5— 27.6) 19.6
In % of body length body width	(13.6— 19.1) 15.4	(16.8— 18.9) 18.2	(16.4— 23.5) 19.2
In % of head length snout length	(29.4— 41.3) 33.2	(30.3— 39.1) 35.6	(33.3— 57.1) 42.0
In % of postorbital distance snout length	(82.1—103.2) 94.7	(85.7—104.7) 98.0	(100.0—147.4) 117.6
In % of interorbital distance eye diameter	(78.6—120.0) 92.4	(85.7—104.7) 90.4	(55.3— 81.8) 66.7
In % of head length pectoral fin	(80.0—103.3) 90.9	(82.9—100.0) 90.7	(80.0—104.4) 87.1
In % of head length interorbital distance	(29.1— 46.7) 38.5	(37.5— 43.9) 40 4	(40.4— 55.5) 46.8

physodon discus and *Symphysodon aequifasciatus* the index of hybrids for the first specimen, coloured as *Symphysodon discus* and with 55 vertical scale rows is as follows: 55—46.25 = 8.75; it is 102.3% from 8.55. For the two specimens coloured as *Symphysodon aequifasciatus* and with 49 vertical scale rows the hybrid index is: 49—46.25 = 2.75; it is 32.2% of 8.55. In the first case it seems probable that the specimen is not hybrid, but in the second case the two specimens may represent hybrids between *Symphysodon discus* and *Symphysodon aequifasciatus* possessing 3.1× bigger affinity to *Symphysodon aequifasciatus*.

When I compared my results concerning *Symphysodon aequifasciatus* with meristic characters after Schultz (1960) I found bigger variability in the number of rays in fins and scales in the lateral lines. In the dorsal fin, after Schultz (1960) there are 29—34 soft rays; in my own material 27—33. In the anal fin, after Schultz (l. c), 26—32 soft rays, in my own material 25—33. In the pectoral fin Schultz (1. c.) found (no branched, branched, no branched rays): 2(8—9)3—4; for my own material the values are 2—4(5—8)2—4. The number of scales in the anterior lateral line after Schultz (1. c.) is 10—14, for my own material it is 8—16. The total number of scales in the anterior and posterior lateral lines is 28—36 after Schultz (1. c.), in my own material 23—36 (see Tab. 2—4). When I compared meristic characters concerning number of scales in posterior lateral line with the data of Holly, Meinken, Rachov (1943), I also found differences. According Holly, Meinken, Rachow (1943) the number of scales is 26, while my own values show 8—15 scales. All other authors cited, except Holly, Meinken, Rachow (1. c.), describe 10—14 scales. When I compared plastic characters of the material examined by me with those of Hykeš (1937), Holly, Meinken, Rachow (1943), Pellegrin (1903) the values agreed in most cases. Of

Table 2. Comparison of author's values with Schultz's (1960). Number of fin rays: dorsal and anal fins (spines and branched rays), pectoral fin (unbranched, branched, unbranched rays)

Dorsal fin	VIII	IX	X	27	28	29	30	31	32	33	34	35
S. discus		1						1				
S. aeq. aeq.	1	19	3			1	3	7	7	4	1	
S. aeq. har.		1						1				
S. aeq. axel.	1	20	7				6	14	7			
Author's values	5	35	12	1	1	14	14	13	6	3		

Anal fin	VII	VIII	IX	25	26	27	28	29	30	31	32	33
S. discus	1							1				
S. aeq. aeq.		20	2			2	1	1	10	5	3	
S. aeq. har.		1						1				
S. aeq. axel.	2	21	5		2	1	7	3	9	4	2	
Author's values	12	29	8	1		5	14	14	10	2	3	1

Pectoral fin	II	III	IV	5	6	7	8	9	II	III	IV	V
S. discus	2					2					2	
S. aeq. aeq.	19						12	7		10	9	
S. aeq. har.	2						2				2	
S. aeq. axel.	29						20	9		15	14	
Auttar's	11	12	3	1	4	8	11		2	7	11	4

Toml number of rays in pectoral fin (author's values):				
onu ber of rays	13	14	15	16
hnoof sp.	11	12	1	1

some interest is only the lower value of the body depth in % of the body length. All above- mentioned authors, including Holly, Meinken, Rachow (1943), noted the upper limit 100%, but in my own material this value fluctuated between 60.8—86.8%. This may be caused by different life conditions in aquaria, e. g., keeping the specimens in tanks with a low water level. Interesting is the relative diminishing of the eye diameter in % of interorbital distance in bigger species. While in specimens of 51—80 mm of the body length this value is 85.7—104.7%, in specimens of 81—121 mm of the body length it is 55.3—81.8%. Average values of the eye diameter in % of the head length more or less coincide in all length groups. The agreement of this last character was found when studying the data given by Holly, Meinken, Rachow (1943). Hyke š (1937), Pellegrin (1903). In my own material an interesting feature may be the relative increase of the average value of the snout length in % of postorbital distance in bigger specimens. In the length group of 51—80 mm of the body length the average value was found as 98.0%, in the case of the length group of 81—121 mm of the body length it was 117.6% (see Tab. 1). According to Schultz (1960), in *Symphysodon discus, Symphysodon aequifasciatus aequifasciatus and Symphysodon aequifasciatus haraldi* the row of scales reaches above the dorsal end of the preopercular groove. In *Symphysodon aequifasciatus axelrodi* this row of scales does not reach to the dorsal end of preopercular groove. *Symphysodon aequifasciatus haraldi* and *Symphysodon aequifasciatus aequifasciatus* have in addition a patch of two or three isolated scales behind the eye dorsally almost continuous with the posterior preopercu-

Table 3. Comparison of author's values with Schultz's (1960). Number of scales in lateral lines

Anterior l.l.	15	16	17	18	19	20	21	22	23
S. discus					1				
S. aeq. aeq.				1	4	4	8	4	2
S. aeq. har.						1			
S. aeq. axel.				2	5	8	5	7	2
Author's values	1	2	4	2	5	12	8	3	6

Posterior l.l.	8	9	10	11	12	13	14	15	16
S. discus					1				
S. aeq. aeq.			1	4	7	9	2		
S. aeq. har.						1			
S. aeq. axel.			4	8	9	8			
Author's values	5	3	4	6	11	9	4	2	1

Total number of scales in l.l.	23	24	25	26	27	28	29	30	31	32	33	34	35	36
									1					
S. aeq. aeq.								1	3	6	4	4	4	1
S. aeq. har.											1			
S. aeq. axel.						1	3	3	10	7	4	1		
Author's values	1	1	2	1		2	3	2	8	4	7	3	2	8

lar row of scales. Never I found this patch of isolated scales. In my material posterior preopercular row of scales ended mostly behind the lower third or fourth part of the eye. There were also specimens where these scales went only to the lower margin of the eye (1 specimen) or where they appeared above the upper margin of the eye (6 specimens). Both specimens that had 49 scales along the body had a posterior preopercular row of scales reaching to lower third part of the eye. One specimen with the coloration of *Symphysodon discus* had these scales above the upper margin of the eye. As regards the coloration of specimens preserved in alcohol, transverse dark bars on the body are well visible. After Meinken (1972), Steindachner observed 1—8, Regan 9 dark transverse bars apparently in preserved specimens, which shows that both had the species *Symphysodon aequifasciatus* at their disposal. Heckel and Kner (after Meinken, 1972) observed three prominent bars on the brownish body. The first across the eye reached the operculum, the second was situated on the base of the caudal fin, and frequently even the third bar was situated across the middle of the body. This character may suggest that these specimens are actually *Symphysodon discus*. Günther (1862) described the coloration of his specimens as brown with three vertical bars. The first one continued from the top of the head to the eye and the operculum, the next one was on the base of the caudal fin, and the third bar could be situated across the middle of the body. This coloration would suggest *Symphysodon discus*, but the number of scales along the body is 52, which is typical for *Symphysodon aequifasciatus* (see Schultz, 1960). Pellegrin (1903) had only three specimens of *Symphysodon discus* with nine dark transverse bars at his disposal and described therefore the color variety of *Symphysodon discus* var. *aequifasciatus*. Besides this "variety" in sensu of Pellegrin (l. c.)

Table 4. Comparison of author's values with Schultz's (1960). Number of vertical scale rows from upper edge of opercular opening in a straight line to base of caudal fin. X – data "from the literature" (after Schultz, 1960)

	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64
S. discus	1		X	X	X																
S. aeq. aeq.									2	1	5	4	3	4	1	1		1			
S. aeq. har.										1											
S. aeq. axel.							2	2	4	2	4	4	4	2	1	2					
Author's values						2	3	3	4	3	4	7	7	4	5	2	2	3		1	2

he also worked with three specimens of "actual" *Symphysodon discus* with three dark bars acros the body. Unfortunately Pellegrin (l. c.) did not distinguish either "forms" according to the number of scales along the body. He described in all specimens only the number of scales along the body (46—56). Holly, Meinken, Rachow (1943) described coloration of preserved specimens as yellow-olive with nine blackish transverse bars, of which the first, fifth and last are the most distinct. They cited two values in the count of scales: number of scales in the middle line along the body (65—70) and in the longitudinal line below the lateral line (50—55). In both cases, according to scales the fish are *Symphysodon aequifasciatus*. Anonymous note (1915) mentioned several specimens as *Symphysodon discus*, with background coloration of the body yellow with nine dark transverse bars more or less distinct. Number of scales along the body being 53—56, this is apparently again the species *Symphysodon aequifasciatus*.

According to the coloration of my examined preserved material it is possible to divide all specimens into nine groups:

1. Body ochre with nine distinct brown-red bars, the darkest being the first and last. Dorsal and anal fins purplish, pectorals yellowish, ventrals dark purple-brown (5 specimens 22—24 mm of the body length — in all the following data always the body length is cited).
2. Body light ochre without distinct transverse bars. Only the first and last bars distinct. Caudal and pectoral fins colourless, dorsal and anal fins purple-grey (6 specimens 25—51 mm).
3. Body grey-yellow without distinct bars, dark grey bar across the eye and the basis of caudal fin is indicated. Anal and dorsal fins light to dark purple, caudal colourless, the same as pectorals. In one specimen (92 mm) distinct dark grey transverse bars across the middle part of the body. Ventrals grey-purple (12 specimens 20—93 mm).
4. Body grey-yellow, nine transverse dark grey bars of about the same intensity. Dorsal and anal fins dark grey-purple. Mostly distict light spots on caudal, dorsal and anal fins; this is perhaps caused by the short time of its preservation (8 specimens 83—121 mm).
5. Body dark grey-brown, only transverse bars across the eye and on the basis of caudal fin distinct. Dorsal and anal fins black-brown, the same as ventrals. Caudal fin colourless, pectorals yellowish (1 specimen 64 mm).
6. Body dark brown-purple, dorsal, anal, ventrals black-purple. No transverse bars (1 specimen 80 mm).
7. Body brown-purple, chest below the base of the pectoral fins is white, without bars. Transverse dark purple bars not very distinct (4 specimens 40—95 mm).
8. Body light to dark brown-red with nine dark brown bars, out of these the first and last most distinct. Caudal colourless, dorsal and anal fins on the base dark purple-grey, the same as ventrals (10 specimens 23—86 mm).
9. Body dark purple-brown, dorsal and anal fins black-purple, the same as nine distinct transverse bars, most distinct being the first and the last. Caudal colourless, the same as pectorals, ventrals purple-black (4 specimens 39—94 mm, see Fig. 3).

The coloration of the specimens preserved in alcohol is certainly influenced by the duration of the preservation.

SUMMARY

52 preserved specimens from aquaria were examined, which according to keys in Schultz (1960) agree with *Symphysodon aequifasciatus axelrodi*. However, I have found two specimens which cannot be determined after the cited keys. This is perhaps due to hydridization between *Symphysodon discus* and *Symphysodon aequifasciatus* (see Meinken, 1972; Smidt-Focke, 1977; Sterba, 1978) in aquaria. Concerning meristic characters, I found bigger variability than Schultz (l. c.) in the number of rays in the dorsal fin (27—33 soft rays) and the anal fin (25—33 soft rays), in the number of scales in lateral lines (anterior line 15—23, posterior 8—16 scales) and in vertical scale rows (49—64).

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

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SYSTEMATIC STATUS OF TILAPIA MARIAE AND TILAPIA MEEKI (PISCES: CICHLIDAE)

Dedicated to Dr. E. Trewavas DSc.

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Abstract: 50 specimens of *Tilapia mariae* Boulenger, 1899 were studied with regard to 9 plastic and 7 meristic characters. Measurements obtained were compared with Boulenger's (1915) data of *Tilapia mariae* and *Tilapia meeki*. Smaller specimens (to 75 mm standard length) of *Tilapia mariae* differ from bigger ones (over 103 mm standard length) in the coloration, the shape of teeth and in the eye diameter, which are also differences between *Tilapia mariae* and *Tilapia meeki*. The two mentioned species belong probably to one species with the older name *Tilapia mariae*.

INTRODUCTION

There are two colour pattern types of *Tilapia mariae;* one with dark cross bars, the second with dark spots along the body, without cross bars. Specimens of the first colour pattern were described as *Tilapia mariae* Boulenger, 1899, specimens with the second one as *Tilapia meeki* Pellegrin, 1911. According to Whitehead (1962), these two different colour types belong to a single species with the older name *Tilapia mariae* Boulenger, 1899. Specimens of *Tilapia mariae* from West Africa under 150 mm in total length show the "mariae" colour pattern, specimens over 150 mm in total length the "meeki" colour pattern (Whitehead, 1962).

MATERIAL AND METHODS

All 50 specimens of *Tilapia mariae* were originally kept in tanks of Czechoslovak fanciers and after death were preserved in formalin or in alcohol. Measurements of plastic characters were made by use of dividers with the accuracy ± 0.5 mm, except the interorbital width, the mouth width, the length and the depth of the caudal peduncle and the length of dorsal and anal spines, which were measured with the ± 0.1 mm accuracy. Meristic characters were counted using the binocular microscope after Regan (1905).

RESULTS AND DISCUSSION

According to Boulenger (1915) *Tilapia mariae* and *Tilapia meeki* differ in the coloration, in the shape of teeth and in the eye diameter (Table 1). Boulenger's (1915) *Tilapia mariae* had total length 130 mm, *Tilapia meeki* 180 mm. In Boulenger's (1915) key *Tilapia mariae* had "outer teeth with extremely slender shafts, almost setiform", but *Tilapia meeki* possessed "outer teeth moderately slender or rather large". Teeth of our specimens of *Tilapia mariae* with the "mariae" colour pattern (37 and 75 mm standard length) are shown in Fig. 1, teeth of the specimen of the "meeki" colour pattern (143 mm standard length) in Fig. 2. The number of teeth and their rows increases with the body length

and age. In the specimen of 37 mm SL ("mariae") there are 2 (3) rows of teeth in each jaw; 31 teeth in the lower, 37 in the upper jaw; in total 68 teeth. In the specimen of 75 mm SL ("mariae") 3 (4) rows of teeth; 57 teeth in the upper, 68 in the lower jaw; in total 125 teeth. In the specimen of 143 mm SL ("meeki") 4 rows of teeth; 161 teeth in the lower, 302 teeth in the upper jaw; in both jaws 463 teeth in total. Teeth of smaller and younger specimens (37 and 75 mm SL, under 1.5 year) have sharper tips than those of bigger and older specimen (143 mm SL, over 1.5 year). Teeth of all specimens examined are yellowish with reddish brown tips, In bigger specimens the tips are darker than in smaller ones.

Fig.1

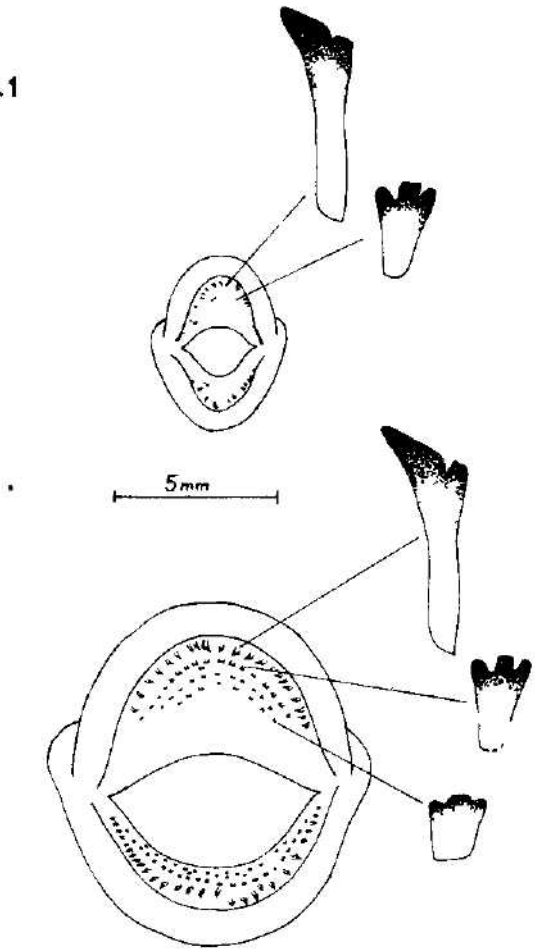

Fig. 1. Teeth of *Tilapia mariae* 37 mm body length of the "mariae" colour pattern (above) and 75 mm body length of the "mariae" colour pattern (below).

Table 1. Plastic characters of *Tilapia mariae*

	Authors' data			Boulenger (1915)	
	Tilapia mariae	*Tilapia mariae*	alltogether	*Tilapia mariae*	*Tilapia meeki*
n	44	6	50	13	
Total length in mm	33–95	126–181	33–181	130	180
Body depth in % of total length	35 (30– 38)	33 (29– 38)	35 (29– 38)	42– 56	50–57
Head length in % of total length	26 (23– 29)	25 (24– 26)	26 (23– 29)	33– 36	33–36
Eye diameter in % of head length	32 (28– 36)	25 (23– 27)	31 (23– 36)	30– 36	25–29
Eye diameter in % of interorbital width	81 (60– 90)	53 (49– 57)	78 (49–90)	67–100	60–75
Length of last dorsal spine in % of head length	48 (35– 65)	52 (50– 53)	48 (35– 65)	50– 67	about 50
Length of third anal spine in % of length of last dorsal spine	92 (60–122)	88 (73– 94)	92 (60–122)	100 and less	a litlle less than 100
Length of pectoral fin in % of head length	89 (74–104)	96 (90–102)	90 (74–104)	100	nearly 100
Length of caudal peduncle in % of its depth	61 (53– 77)	74 (52– 83)	63 (52– 83)	less than 100	more less than 100
Snouth length in % of postorbital part of head	86 (70–100)	102 (79–111)	88 (70–111)	100 and less	–

Table 2. Meristic characters of *Tilapia mariae*

	Authors' data			Boulenger (1815)		Pelegrin (1903–1904)
	Tilapia mariae "mariae" colour pattern	*Tilapia mariae* "meeki" colour pattern	alltogether	*Tilapia mariae*	*Tilapia meeki*	*Tilapia mariae*
Rays in dorsal fin	XVI/13 (XVI–XVII/ /12–15)	XVI/13 (XVI/13–14)	XVI/13 (XVI–XVII) 12–15	XV–XVI/12–13	XV/14	XVI/12
Rays in anal fin	III/11 (III/11–12)	III/11 (III/10–11)	III/11 (III/10–12)	III/10–11	III/10–11	III/10
Scales in lateral line	18/12 (16–21/10–15)	22/15 (20–23/14–15)	18/12 (16–23/10–15)	19–21/10–16	21/11–12	21/14–15
Scales above lateral line	4 (3– 5)	4 (3– 4)	4 (3– 5)	3– 3.5	3.5	3.5
Scales below lateral line	11 (10–12)	11 (10–12)	11 (10–12)	11–12	11	12
Scales in longitudinal row	27 (26–28)	28 (27–29)	27 (26–29)	29–31	30	30–31
Gill rakers on lower part of anterior arch	13 (12–15)	14 (13–14)	13 (12–15)	13–15	14	13
Gill rakers total on anterior arch	16 (15–19)	18 (17–18)	16 (15–19)	–	–	–

Table 3. Frequency of dorsal spines and rays of *Tilapia mariae*

	The "meeki" colour pattern						
	spines				rays		
	XV	XVI	11	12	13	14	15
Whitehead (1962)	2	51	1	13	36	2	1
Trewavas	7	3	—	1	—	2	7
Our data	—	6	—	—	5	1	—
Total	9	60	1	14	41	5	8

	The "mariae" colour pattern						
	spines				rays		
	XV	XVI	XVII	12	13	14	15
Whitehead (1962)	—	17	—	5	12	—	—
Trewavaas	1	11	—	4	4	4	—
Our data	—	42	2	7	28	8	1
Total	1	70	2	16	44	12	1

Coloration of our preserved specimens of the "meeki" colour pattern of *Tilapia mariae* is yellowish-brown with 5 or 6 dark blotches along the middle of the side, fins are greyish to brownish (Fig. 3). The coloration of the "mariae" colour pattern of preserved specimens of the same species is yellowish 7—8 dark vertical bars, fins are greyish to brownish (Fig. 4).

Plastic and meristic characters of both colour patterns of *Tilapia mariae* as compared with published data of *Tilapia mariae* and *Tilapia meeki* are given in Table 1 and 2. Our measurements of the specimens of *Tilapia mariae* of the "mariae" colour pattern agree with Boulenger's (1915) data of *Tilapia mariae*, our data of specimens of "meeki" colour pattern of *Tilapia mariae* also agree with those of *Tilapia meeki* given by Boulenger (1915). Differences between the two colour types examined by us are found only in the eye diameter, which corresponds to the differences between *Tilapia mariae* and *Tilapia meeki* and, simultaneously, to bigger eyes in smaller and younger specimens of *Tilapia mariae* as compared with larger ones (see Table 1). Some interesting differences are found in head length and body depth in % of total length, but Boulenger (1915) does not inform of his method of the total length measurements. Table 3 shows the comparison of the dorsal spines and the number of rays of both colour patterns of *Tilapia mariae*. Between our specimens and the specimens examined by Whitehead (1962) and Trewavas (in Whitehead, 1962) no remarkable differences were found. The total highest frequency of dorsal spines was found to be XVI in both colour patterns, of dorsal rays 13.

Whitehead (1962) reports the "mariae" colour pattern in aquarium in young specimens, the "meeki" colour pattern in older ones. We have observed the same in our aquaria. Young specimens (in first 12—18 month of their life) are coloured in "mariae" pattern; in 60—80 mm standard length the "meeki" colour pattern is formed. Dark cross bars disappear, each dark blotch is formed in the area between two neighbouring bars. But in the group of specimens of *Tilapia mariae* the "mariae" colour pattern appears often in the weakest specimen, even though it is larger than 80 mm SL. Whitehead (1962) showed A III/10—11; gill rakers on the lower part of the anterior arch 13—15 in both

colour patterns. Daget (1951) found D XV/12—13; A III/10 in two specimens of *Tilapia meeki* (90—118 mm) caught in Cote d'Ivoire near Abidjan. Sterba (1977) used Boulenger's (1915) data.

SUMMARY

The problem of species designation of *Tilapia mariae* Boulenger, 1899 and *Tilapia meeki* Pellegrin, 1911 was studied. For this purpose only aquarium specimens were used. Specimens of the two mentioned types differ from each other only in the coloration, the body length, the eye diameter and the shape and the number of teeth and the number of their rows. The "mariae" colour pattern was found in young specimens (under 1.5 year of life, under 60—80 mm SL) and in weakest specimens (of the group kept in aquaria), even though they are bigger than 80 mm SL (about 90 mm SL). Bigger and older specimens (over 1.5 year and 80 mm SL) have the "meeki" coloration. With the increase of the body length also the number of teeth and their rows increases; tips of the teeth become less sharp. Differences found between the ""mariae" and "meeki" colour pattern of *Tilapia mariae* are the same as between *Tilapia mariae* and *Tilapia meeki*. *Tilapia mariae* and *Tilapia meeki* thus probably belong to one species which must take the older name *Tilapia mariae* Boulenger, 1899. Whitehead (1962) made similar observations and conclusions in natural conditions.

Acknowledgements

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Figs. 2—4 will be found at the end of this issue.

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DIAGNOSIS AND BIONOMY OF UNKNOWN AGONUM, BATENUS, EUROPHILUS AND IDIOCHROMA LARVAE (COL., CARABIDAE, PLATYNUS)

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Abstract: The larvae of *Platynus (Agonum) ericeti* (Panzer) (L I, L II, L III), *P. (A.) sexpunctatus* (L.) (L I, L II, L III), *P. (Batenus) livens* (Gyll.) (L I, L II), *P. (Europhilus) fuliginosus* (Panzer) (L I, L II, L III), *P. (Europhilus) gracilis* (Strum) (L I ,L II, L III), *P. (E.) micans* (Nicolai) (L I, L II, L III) and *P. (Idiochroma) dorsalis* (Pontop) (L I, L II, L III) are described and illustrated. The larval diagnoses of *Agonum* Bon., *Batenus* Motsch., *Europhilus* Chaud., *Idiochroma* Bedel and *Limodromus* Motsch. are briefly given, the subgenera are keyed in all larval instars. The results of rearing and the duration of individual developmental stages under laboratory conditions are mentioned. All the species belong to the breeding type without the larval diapause.

The tribe Platynini (= Agonini), under the supertribe Pterostichitae (sensu Kryzhanovskij, 1976), is separable in the larval stage from both Pterostichini and Zabrini in the absence of a distinct membranous area on the lateral aspect of the stipes. Under the genera of Platynini only *Platynus* Bon. s. l. and *Olisthopus* Dej. have well developed lacinia (*Olisthopus* Dej. possesses a distinctly protruding clypeus).

The division of the genus *Platynus* Bonelli in the subgera is not uniform; the larval characters are not employed. Thus all new knowledge from the larval taxonomy is valuable.

MATERIAL AND METHODS

The larvae studied were reared during 1968—1973 in the Department of Zoology, Charles University, Praha under the technical assistance of Ms. Vlasáková — *P. (A.) ericeti:* 3 L I, 5 L II, 6 L III; *P. (A.) sexpunctatus:* 1 L I, 2 L II, 4 L III; *P. (A.) viridicupreus:* 3 L I, 5 L II, 9 L III; *P. (B.) livens:* 4 L I, 3 L II; *P. (E.) fuliginosus:* 2 L I, 1 L II, 1 L III; *P. (E.) gracilis:* 2 L I, 4 L II, 3 L III; *P. (E.) micans:* 1 L I, 2 L II, 3 L III). The origin of the reared adults was as follows: *P. (A.) ericeti* — Boh. Krušné hory, Abertamy, 850 m., 11. V. 1969; *P. (A.) sexpunctatus* — Boh. or. Hradec Králové, 24. IV. 1968; *P. (A.) viridicupreus* — Slov. or. Latorica, Zatín. 22. V. 1973; P. (B.) *livens* — Boh. centr. Čelákovice, IV. 1973; P. (E.) *fuliginosus* — Boh. centr. Čelákovice, 21. III. 1969; *P. (E.) gracilis* — Boh. occ. Hájek (Soos), IV. 1973; *P. (E.) micans* — Boh. centr. Čelákovice, 21. III. 1969.

Additional material of larvae *P. (E.) fuliginosus* was found in the Šumava mountains (Jelení vrchy, 940 m., 29. VII. 1965 — 1 L I, 2 L III, Hůrka lgt.) and in the Krkonoše mountains (Sněžné jámy, 14000 m., VIII. 1970 — 2 L III, Martiš lgt.). The larvae of *P. (Idiochroma) dorsalis* were found in Central Bohemia (Lochkov, 6. VII. 1957 — 1 L I, 1 L II, 1 L III, 18. VII. 1957 — 1 L I) and in South-west Bohemia (Lužany, 2. IX. 1955 — 2 L III).

The method of rearing was described by Hůrka (1972).

To estimate the timing of egg production, females from natural conditions were dissected and their ovaries studied. The number of dissected females was as follows: *P. (A.) sexpunctatus* 42, *P. (A.) viridicupreus* 35, *P. (B.) livens* 3, *P. (E.) fuliginosus* 195, *P. (E.) gracilis* 4, *P. (E.) micans* 69, *P. (I.) dorsalis* 140.

SUBGENUS AGONUM BONELLI, 1811

About 15 species of this subgenus (from N. America, Europe and Japan) are diagnosed, more or less in detail, in larval stage. In only a few of them all three larval instars are described.

Platynus (Agonum) ericeti (Panzer, 1809)

Figs. 1—13

?Emden, 1929: 274, L I; ?Emden, 1942: 66, L I; Lindroth, 1955: 2, Fig. 1 c, L I (left mandible and clypeus).

Material: 3 L I, 5 L II, 6 L III.

Description

Larval instar III: Head subquadrate, a little wider than long. Clypeus slightly extended, about 7 times broader than long, with distinct lateral tubercles, fore margin denticulate; clypeus near 1.5 times broader than anguli frontales (Fig. 3). Frontale slightly longer than wide; epicranial sulcus distinctly longer than the last antennal segment. Antennae a little longer than mandibles, the length ratio of individual segments: 1.5 : 1.2 : 1.4 : 1, first and second segments glabrous (Fig. 6). Mandibles short, robust retinaculum slightly above the middle, penicillus long, distinctly longer than retinaculum (Fig. 9). Stipes about 3 times longer than wide and as long as palpus, outer margin with 4—6 setae; length ratio of palpal segments: 1 : 1.6 : 1.6 : 1. First segment of galea longer (1.1 times) than second (Fig. 12). Second segment of labial palpus longer than first (1.2 times) (Fig. 15). Width of head capsule 0.98—1.14 (average in 6 specimens 1.05) mm.

Thorax — pronotum 1.4 times wider than long; both terga of meso- and metathorax about 2.5 times wider than long. Tarsus and tibia of equal length.

Abdomen — terga 1—8 with 2 rows of setae, on terga 3—5 anterior row consists of 6 longer and 6 shorter setae, posterior row of 6 longer and 4 shorter setae (Fig. 17); terga 1 and 2 with a pair of additional short setae in both rows, on terga 6—8 third pair of setae in posterior row short. Cerci 2.5 times longer than width of tergum 9 at base of cerci, with 9 setae; pair of setae on tergum 9 rather long.

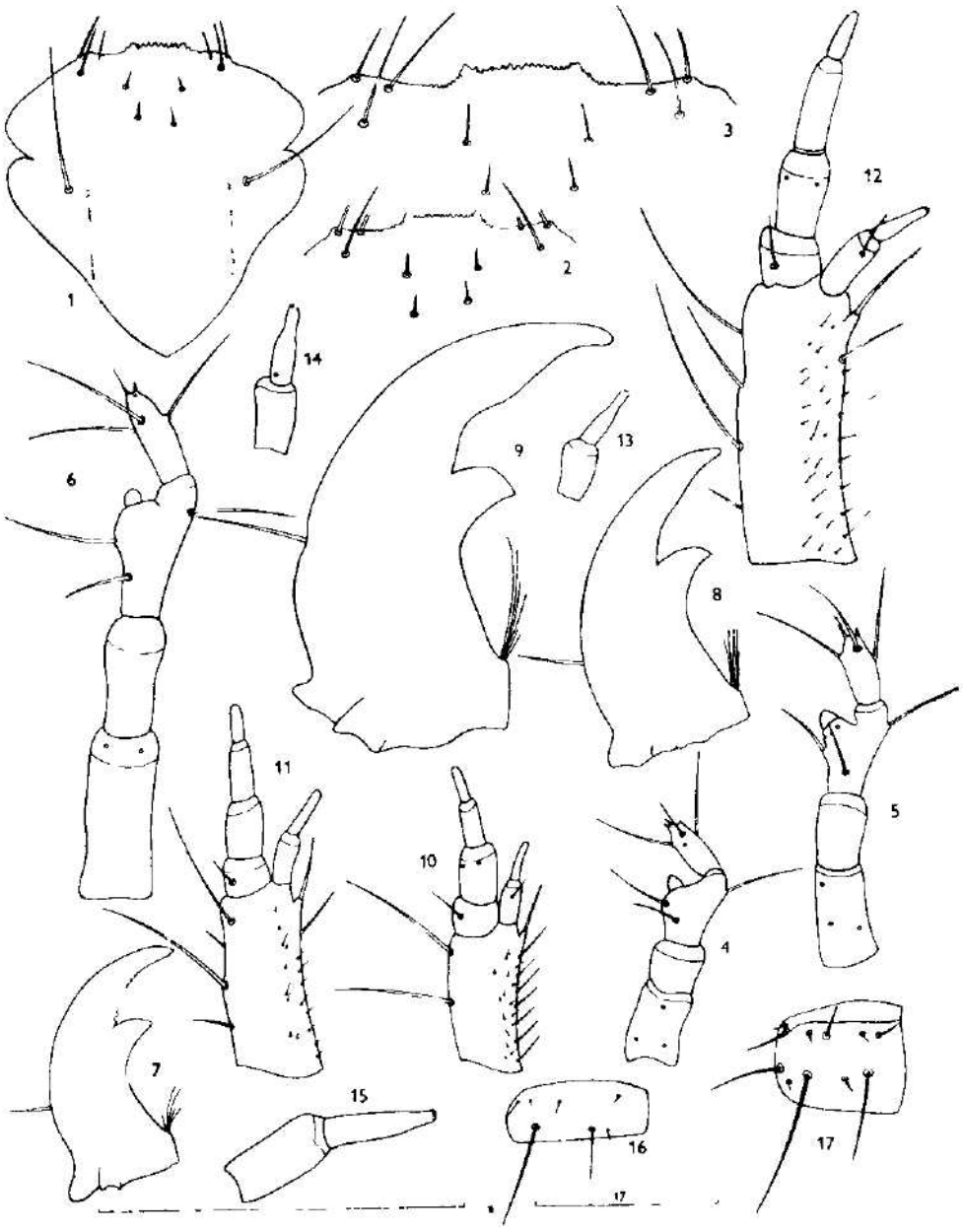
Length 8.8—10.5 mm, width 1.4—1.6 mm.

Larval instar II: Head — length ratio of antennal segments — 1.3 : 1 : 1.3 : 1 (Fig. 5). Stipes 2.4 times longer than wide and about as long as palpus, outer margin with 4 setae; length ratio of palpal segments — 1 : 1.5 : 1.5 : 1; both segments of galea of equal length (Fig. 11). Width of head capsule 0.68—0.80 (average in 5 specimens 0.74) mm.

Abdomen — pair of setae on tergum 9 shorter.

Length 6.0—7.0 mm, width 0.9—1.0 mm.

Larval instar I: Head — clypeus very little extended; frontale with egg bursters in a form of 2 rows of closely set short spines, about 20—25 spines



Figs 1–17. *P. (A.) ericeti*: 1 – frontale L I; 2, 3 – clypeus and anguli frontales L II, L III; 4, 5, 6 – antenna L I, L II, L III; 7, 8, 9 – mandible L I, L II, L III; 10, 11, 12–maxilla L I, L II, L III; 13, 14, 15 – labial palpus L I, L II, L III; 16 – abd. tergum 1 L I; 17 – abd. tergum 4 L III. Scales = 0.5 mm.

in each row (Fig. 1). Epicranial sulcus shorter than the last antennal segment. Length ratio of antennal segments — 1.5 : 1 : 1.5 : 1.2 (Fig. 4). Blades of mandibles serrate (Fig. 7). Stipes only twice longer than wide, distinctly shorter than palpus, outer margin with 2 setae; length ratio of palpal segments — 1 : 1.5 : 1.2 : 1 (Fig. 10). Width of head capsule in 3 specimens: 0.55, 0.60, 0.62 mm (Emden, 1942: 66 gives 0.50 mm for 1 larva possibly of this species).

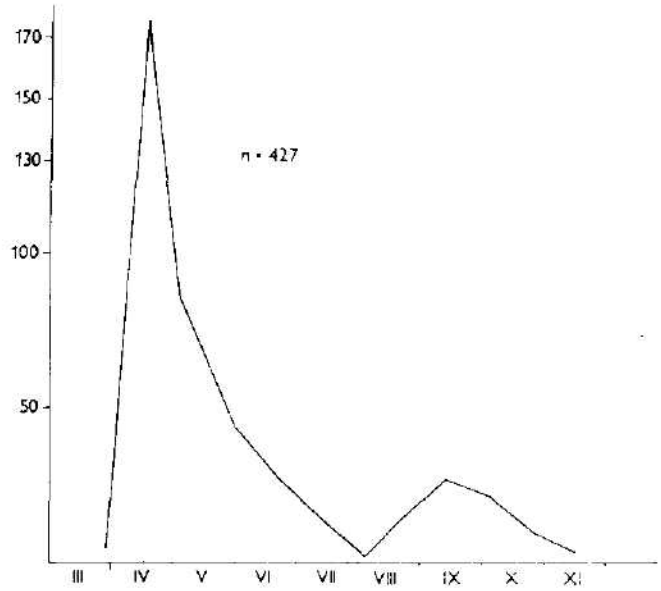


Fig. 18. *P. (A.) ericeti* — seasonal dynamics (pitfall trapping) in Šumava mountains (Horská Kvilda, 1050 m) in 1961.

Abdomen — terga 2—8 in anterior row with 6 short setae, in posterior row with 4 long setae, on tergum 1 one additional pair of short setae in both anterior and posterior rows (Fig. 16). Cerci with 5 setae.

Length 4.4—5.2 mm, width 0.6—0.7 mm.

Bionomic notes

Rearing. Only one of the three pairs collected on May 11, 1969 in a peat-bog near Abertamy (850 m) in the Krušné hory mountains (Ore Mountains) laid eggs (23 specimens of larval instar I were found from May 23 to June 11). Larval instar I (10 specimens) developed in 4—6 days, larval instar II (8 specimens) lasted 6—8 days, larval instar III (4 specimens) 10—16 days and the pupal stage (4 specimens) developed in 6—7 days, all stages at the mean temperature 21 °C (18 °C—23 °C). One male developed from the L I to the adult stage in 27 days, three females in 28, 33 and 34 days. The mortality rate of larval instar I was 17%, of L II 9% and of L III and the pupal stage 0%.

In the natural conditions of the Šumava mountains in Southwest Bohemia (Horská Kvilda, 1050 m, 1961), the occurrence of adults reachs its peak in April (Fig. 18); the new generation appears from the end of August to the beginning

of October, with peak occurrence in September (immature adults 11. IX.). Emden (1942: 66) gives 1 L I of *P. (A.) ericeti?*, found on 7. VI. 1913 in Sphagnum, from former E. Prussia.

It is evident that *P. (A.) ericeti* reproduces in spring and belongs to the species characterized by the breeding type without the larval diapause.

Platynus (Agonum) sexpunctatus (Linnaeus, 1758)

Figs. 19—34

Material: 1 L I, 2 L II, 4 L III.

Description

Larval instar III: Head — about 1.1 times wider than long. Clypeus slightly extended, about 6 times broader than long, distinctly denticulate, with great lateral teeth and shallow convexity at middle (Fig. 21); clypeus almost 1.5 times broader than *anguli frontales*, which denticulate in the inner part. Frontale slightly wider than long; epicranial sulcus about as long as last antennal segment. Antennae a little longer than mandibles, length ratio of segments — 1.9 : 1.3 : 1.5 : 1 (Fig. 25). Mandibles short, length to width ratio 2.3 : 1, blades smooth, short retinaculum approx. in the middle, penicillus long, distinctly longer than retinaculum (Fig. 28). Stipes 3 times longer than wide and 1.3 times longer than palpus, outer margin with 4—5 setae; length ratio of palpal segments — 1.2 : 1.7: 1.5 : 1; both segments of galea of equal length (Fig. 31). Basal segment of labial palpus 1.1 times longer than second (Fig. 33). Width of head capsule 1.20—1.34 (average in 4 specimens 1.26) mm.

Thorax — tarsus and tibia of about equal length.

Abdomen — on terga 3—5 anterior row consists of 6 longer and 6 shorter setae, posterior row of 6 longer and 2 shorter setae; terga 1 and 2 with a pair of additional short setae in both rows, on terga 6—8 third pair of setae in posterior row short. Cerci 3 times longer than width of tergum 9 at base of cerci, with 9 setae. Pair of setae on tergum 9 rather long.

Length in 3 specimens 12.0—13.0 mm, width 1.8—2.1 mm.

Larval instar II: Head — length ratio of antennal segmets — 1.7 : 1.1 : : 1.4 · 1 (Fig. 24). Stipes about 2.5 times longer than wide and 1.2 times longer than maxillar palpus, outer margin with 4 setae; length ratio of palpal segments — 1 : 1.5 : 1.3 · 1 (Fig. 30). Both segments of labial palpus of equal length (Fig. 32). Width of head capsule in two specimens 0.90 and 0.94 mm.

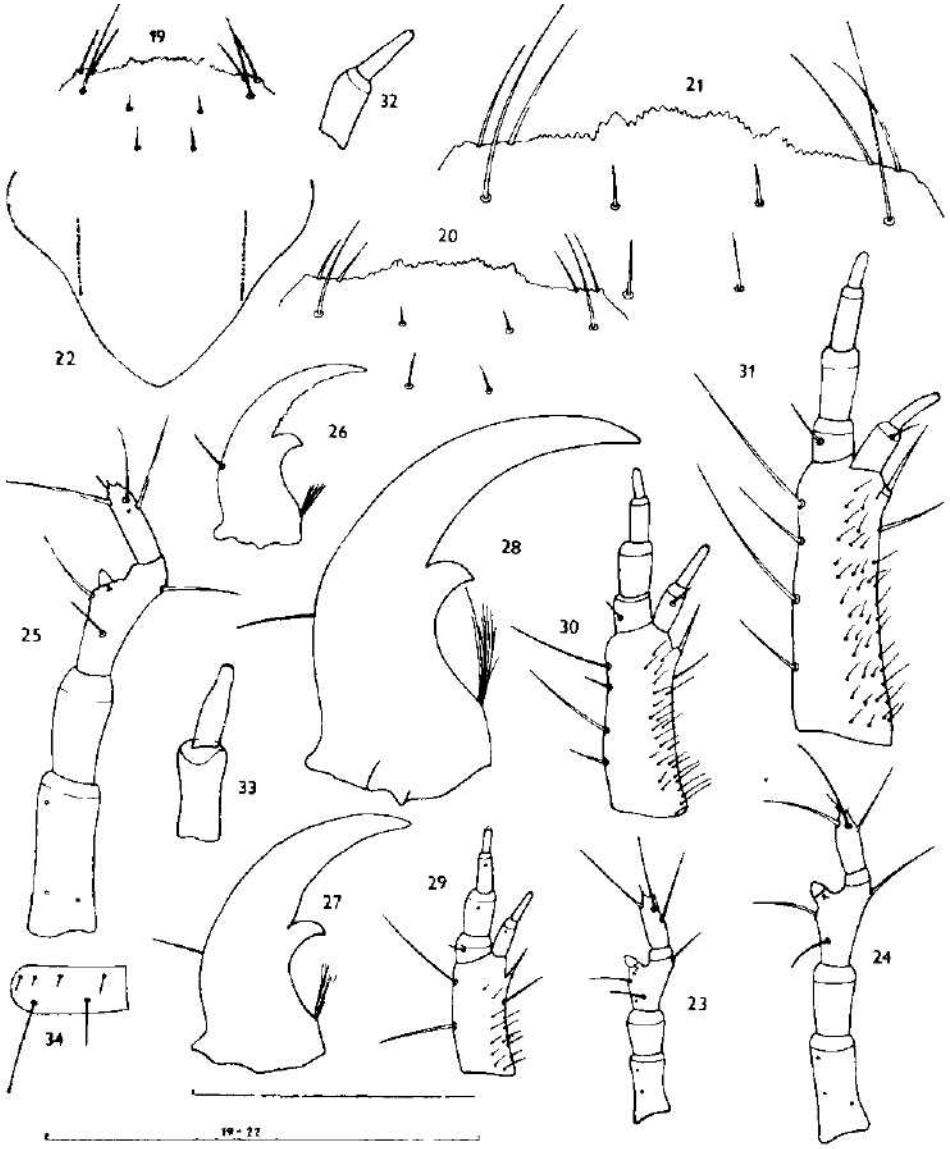
Abdomen — pair of setae on tergum 9 shorter.

Length 8 and 10 mm, width 1.2 and 1.6 mm.

Larval instar I: Head — clypeus very little extended (Fig. 19); frontale slightly longer than wide, egg bursters in a form of 2 rows of closely set short spines, 22 spines in each row (Fig. 22); epicranial sulcus shorter than last antennal segment. Length ratio of antennal segment — 1.40 : 1.00 : 1.35 : 1.15 (Fig. 23). Blades of mandibles serrate (Fig. 26). Stipes only 2.2 times longer than wide, shorter than palpus, outer margin with 2 setae; length ratio of palpal segments — 1 : 1.5 . 1.3 : 1; second segment of galea shorter than first (Fig. 29). Width of head capsule in 1 specimen 0.64 mm.

Abdomen — terga 2—8 in anterior row with 6 short setae, in posterior row with 4 longer setae; on tergum 1 one additional pair of very short setae in anterior row (Fig. 34). Cerci with 5 setae.

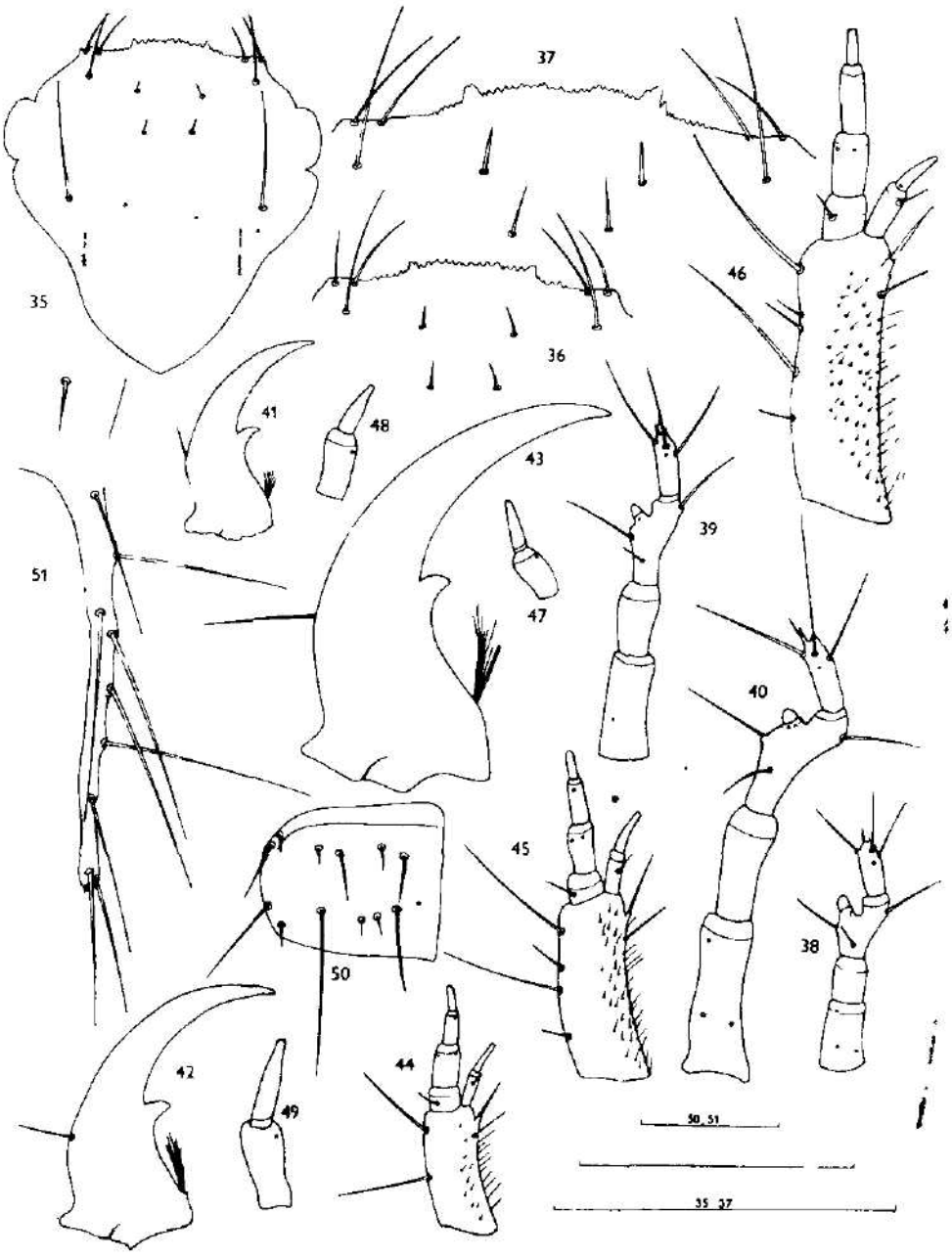
Body size 4.8 × 0.8 mm.



Figs. 19—34. *P. (A.) sexpunctatus:* 19, 20, 21 — clypeus and anguli frontales L I, L II, L III; 22 — egg bursters; 23, 24, 25 — antenna L I, L II, L III; 26, 27, 28 — mandible L I, L II, L III: 29, 30, 31 — maxilla L I, L II, L III; 32, 33 — labial palpus L II, L III; 34 — abd. tergum 1 L I. Scales = 0.5 mm.

Bionomic notes

Rearing. 7 L I and 2 L II were found from May 25 to May 31 in the rearing box of one female collected on April 24, 1968 in East Bohemia (Hradec Králové); 1 L II in addition on July 5. 6 L I developed 4—6 days, 5 L II 4—7 days,



Figs. 35–51. *P. (A.) viridicupreus:* 35 – frontale L I; 36, 37 – clypeus and anguli frontales L II, L III; 38, 39, 40 – antenna L I, L II, L III; 41, 42, 43 – mandible L I, L II, L III; 41, 42, 43 – mandible L I, L II, L III; 44, 45, 46 – maxilla L I, L II, L III; 47, 48, 49 – labial palpus L I, L II, L III; 50 – abd. tergum 4 L III; 51 – cercus L III. Scales = 0.5 mm.

2 L III 20 and 23 days and 2 pupae 6 days, all stages at the mean temperature 22 °C (18 °C—27 °C). One male developed from the L I to the adult stage in 39 days, one female in 40 days.

In natural conditions of Czechoslovakia the peak occurrence of adults takes place in April and May, the mating from April to June. In the dissected females mature eggs were found till half of June; in July and August the females were "spent". Hatching of young beetles occurs from July to September.

P. (A.) sexpunctatus belongs also to the breeding type without the larval diapause.

Platynus (Agonum) viridicupreus (Goeze, 1777)

Figs. 35–51

Material: 3 L I, 5 L II, 9 L III.

Description

Larval instar III: Head subquadrate. Clypeus slightly extended, about 10 times broader than long, distinctly denticulate, with great lateral teeth and shallow convexity at middle; clypeus twice broader than anguli frontales, which denticulate in the inner part (Fig. 37). Frontale sligtly wider than long; epicranial sulcus as long as last antennal segment. Antennae a little longer than mandibles, length ratio of individual segments — 2 : 1.4 : 1.6 : 1 (Fig. 40). Mandibles short, length to width ratio 2.4 : 1, blades smooth, short retinaculum close below the middle, penicillus long, distinctly longer than retinaculum (Fig. 43). Stipes about 3 times longer than wide and 1.3 times longer than palpus, outer margin with 4—5 setae; length ratio of palpal segments — 1.2 : : 1.7 : 1.9 : 1; both segments of galea of equal length (Fig. 46). Basal segment of labial palpus 1.1 times longer than second (Fig. 49). Width of head capsule in 9 specimens 1.24—1.41 (average 1.33) mm.

Thorax — tarsus and tibia of about equal length.

Abdomen — on terga 3—5 anterior row consists of 6 longer and 6 shorter setae, posterior row of 6 longer and 4—5 shorter setae (Fig. 50); on terga 1 and 2 one pair of additional short setae in anterior row; on terga 6—8 third pair of setae in posterior row short. Cerci 3 times longer than width of tergum 9 at base of cerci, with 9 setae; pair of setae on tergum 9 moderately long (Fig. 51).

Length in 9 specimens 10.0—15.0 (aver. 13.2) mm, width 1.6—2.2 mm.

Larval instar II: Head — clypeus less extended, only 1.7 times broader than anguli frontales (Fig. 36). Frontale about as long as wide; epicranial sulcus shorter than last antennal segment. Length ratio of antennal segments — 1.6 : 1.2 : 1.5 : 1 (Fig. 39). Stipes about 2.6 times longer than wide and 1.2 times longer than palpus, outer margin with 4 setae; length ratio of palpal segments — 1 : 1.5 : 1.5 : 1 (Fig. 45). Width of head capsule in 5 specimens 0.85—0.94 (aver. 0.90) mm.

Abdomen — pair of setae on tergum 9 shorter.

Body size in 5 specimens 6.0—10.0 (aver. 8.2) × 1.1—1.6 mm.

Larval instar I: Head — Frontale slightly longer than wide, egg bursters in a from of 2 rows of closely set short spines being greater caudad, 19—21

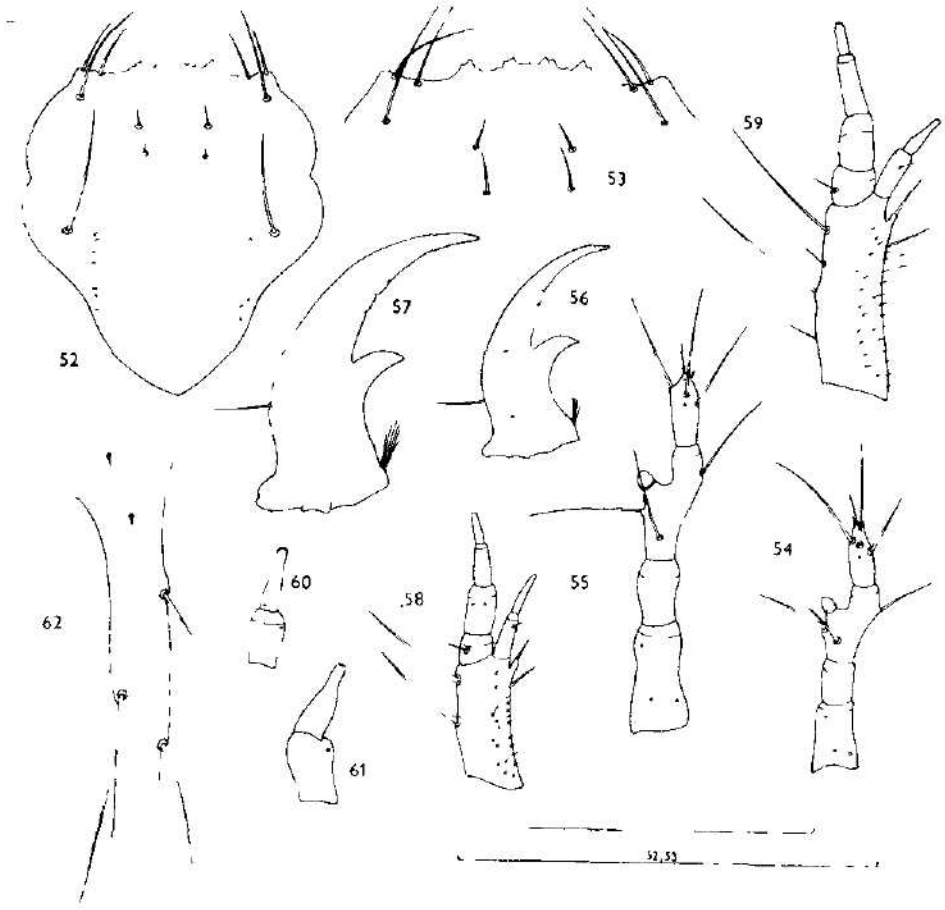
spines in each row (Fig. 35); epicranial sulcus distinctly shorter than last antennal segment (1 : 1.8). Length ratio of antennal segments — 1.5 : 1 : 1.5 : 1.2 (Fig. 38). Blades of mandibles serrate (Fig. 41). Stipes 2.3 times longer than wide, as long as palpus, outer margin with 2 setae; length ratio of palpal segments — 1 : 1.6 : 1.4 : 1: second segment of galea shorter than first (Fig. 44). Width of head capsule in 3 specimens 0.64, 0.64, 0.65 mm.

Abdomen — terga 2—8 in anterior row with 4 shorter setae, in posterior row with 4 longer setae; on tergum I one additional pair of short setae in anterior row. Cerci with 5 setae.

Body size in 3 specimens 4.2—5.6 × 0.72—0.84 mm.

Bionomic notes

Rearing. From the adults found on May 22, 1973 in Southeastern Slovakia we obtained the first instar larvae from June 11 to July 7. L I (6 specimens)



Figs. 52–62. *P. (B.) livens:* 52 — frontale L I; 53 — clypeus and anguli frontales L II; 54, 55 — antenna L I, L II; 56, 57 — mandible L I, L II; 58, 59 — maxilla L I, L II; 60, 61 — labial palpus L I, L II; 62 — basal part of cercus L II. Scales = 0.5 mm

developed 6—8 days (20.5 °C), L II (4 specimens) 5—8 days (21 °C), L III (3 specimens) 8, 9 and 11 days (22 °C) and pupal stage (3 specimens) 6, 6 and 7 days (22 °C). Two specimens developed from the first larval instar to the adult stage at the mean temperature 21.5 ° in 26 and 27 days.

The peak occurrence of adults takes place in the southern part of Slovakia from the second half of May to the end of June. The mating was observed on May 22. In the second half of June mature eggs were found only in females in their second reproductive season; the females in their first reproductive season were "spent".

P. (A.) viridicupreus also represents the breeding type without the larval diapause.

Taxonomic notes

The characteristic features of *Agonum* larvae are: blade of mandible in L II and L III smooth, in L I finely serrate; clypeus denticulate, wider than anguli frontales; first seta of cerci in L II and L III inserted near their base, cerci about 3 times longer than width of tergum 9 at base of cerci; egg bursters in a form of 2 rows of closely set short spines.

SUBGENUS BATENUS MOTSCHULSKY, 1864

Only the L III and L II larvae of *P. (B.) mannerheimi* Dej. (as *Platynus)* are described by Thompson (1979).

Platynus (Batenus) livens (Gyllenhal, 1810)

Figs. 52—62

Material: 4 L I, 3 L II.

Description

Larval instar II: Head — subquadrate. Clypeus with 4 great double-teeth and with some denticles between them, 1.8 times longer than anguli frontales, which are concave, without denticles (Fig. 53). Frontale about as long as wide; epicranial sulcus shorter than last antennal segment. Antennae a little longer than mandibles, length ratio of segments — 1.6 : 1 : 1.7 : 1.1 (Fig. 55). Mandibles short, length to width ratio 2.3 : 1, blade with 1—4 small incisions; large retinaculum close below the middle, penicillus short, about as long as retinaculum (Fig. 57). Stipes about 2.6 times longer than wide, near as long as maxillar palpus, outer margin with 3—4 setae; length ratio of palpal segments — 1.3 : 1.8 : 1.9 : 1; both segments of galea of equal length (Fig. 59). Second segment of labial palps 1.1 times longer than first (Fig. 61). Width of head capsule in 3 specimens 0.86. 0.92, 0.92 mm.

Thorax — tarsus 1.2 times longer than tibia.

Abdomen — on terga 1—6 anterior row consists of 6 larger and 8 shorter setae, posterior row of 4 larger and 8 shorter setae; on terga 7 and 8 one pair of shorter setae in posterior row absent. Cerci 3 times longer than width of tergum 9 at base of cerci, with 9 setae, basal setae minute; pair of setae on tergum 9 small (Fig. 62).

Body size in 3 specimens 8.2—9.0 × 1.2—1.4 mm.

Larval instar I: Head — 2 inner teeth of clypeus less protruding; frontale slightly longer than wide, egg bursters in a form of 2 rows of spaced short spines being anteriorly more minute and doubled or tripled, 22—30 spines in each row (Fig. 52); epicranial sulcus about twice shorter than last antennal segment. Length ratio of antennal segments — 1.3 : 1 : 1.7 : 1.3 (Fig. 54). Blade of mandible with 3—6 small incisions, great retinaculum placed distinctly below the middle of mandible (Fig. 56). Stipes about 2.4 times longer than wide. shorter than maxillar palpus, outer margin with 2 setae; length ratio of palpal segments — 1 : 1.6 : 1.3 : 1.1; both segments of galea of about equal length (Fig. 58). Second segment of labial palps nearly 1.2 times longer than first (Fig. 60). Width of head capsule in 4 specimens 0.56—0.64 (average 0.61) mm

Thorax — tarsus 1.5 times longer than tibia.

Abdomen — on terga 1—8 in anterior row 6 short, in posterior row 4 longer and 2 minute setae. Cerci with 5 setae.

Body size in 4 specimens 4.0—5.4 × 0.60—0.65 mm.

Bionomic notes

Rearing. The adults found in April in a lowland forest near Čelákovice laid eggs at the beginning of May. First instar larvae were found from May 15 to June 6, second instar larvae after 10—14 days (mean temperature 19 °C).

In natural conditions of lowland forests in Czechoslovakia, the occurrence of adults reaches its peak in April and May. Mature eggs were found in two females dissected at the end of May, one females dissected in August had inactive ovaries.

It seams evident that also *P. (B.) livens* belongs to the species without the larval diapause in the breeding cycle.

Taxonomic notes

Comparison of our diagnosis of *P. (B.) livens* with the description of *P. (B.) mannerheimi* Dej. by *Thompson* (1979) gives the following characteristic of the subgenus *Batenus* in L II and L III: blade of mandible with some small incisions, penicillus short, nearly as long as retinaculum; basal setae of cerci conspicuously short.

SUBGENUS EUROPHILUS CHAUDOIR, 1859

In 7 North American and/or European species the larvae are diagnosed; only in *P. (E.) gratiosus* Mann. and *P. (E.) retractus* Le Conte all larval instars are described.

Platynus (Europhilus) fuliginosus (Panzer, 1809)

Figs. 63—79

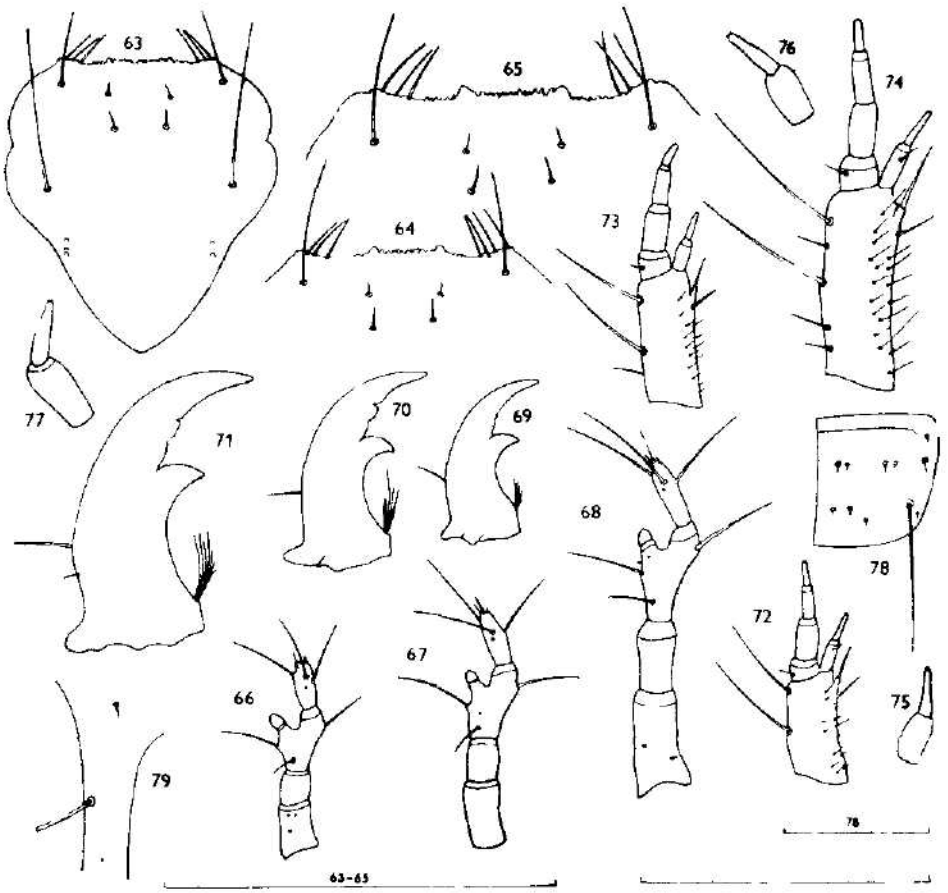
Larsson, 1941: 323, Figs. 45 b, 46 c; Sarova, 1958: 60, Figs. 120 b, 123 a; Sarova, 1964: 172, Figs. 150—5, 154—1; Larsson, 1968: 377, 380, Figs. 49 b, 50 c (in all figures clypeus and mandible of L II or L III).

Material: 3 L I, 1 L II, 5 L III.

Description

Larval instar III: Head — subquadrate. Clypeus slightly protruding, with 2 great lateral teeth and duble denticulate fore margine; clypeus 1.2 times

broader than anguli frontales, these with concave fore margin, denticulate in the inner third, with 3—4 setae on the outer part (Fig. 65). Frontale nearly as long as wide, epicranial sulcus about as long as last antennal segment. Antennae longer than mandibles, length ratio of segments — 1.35 : 1.00 : 1.35 : 1.00 (Fig. 68). Mandible 2.3 times longer than wide, at base with 1 long and 1 short seta on outer margin, blade with distinct incision at its middle; great retinaculum inserted above the middle of mandible; penicillus long (Fig. 71). Stipes 3 times longer than wide and 1.2 times longer than palpus, outer margin with 5 setae; ratio of palpal segments — 1.1 : 1.7 : 1 7 : 1; basal segment of galea 1.2 times longer than second (Fig. 74). First segment of labial palps 1.1 times longer than second (Fig. 77). Width of head capsule in 5 specimens 0.88—0.97 (average 0.92) mm.



Figs 63—79. *P. (E.) fuliginosus*: 63 — frontale L I; 64, 65 — clypeus and anguli frontales L II, L III; 66, 67, 68 — antenna L I, L II, L III; 69, 70, 71 — mandible L I, L II, L III; 72, 73, 74 — maxilla L I, L II, L III; 75, 76, 77 — labial palpus L I, L II, L III; 78 — abd. tergum 8 L III; 79 — basal part of cercus L III. Scales = 0.5 mm

Thorax — tibia and tarsus of about equal length.

Abdomen — on terga 1—4 in anterior row 6 longer and 6 shorter setae, in posterior row 4 longer and 6 shorter setae; on terga 5—8 in posterior row 2 longer and 8 shorter setae (Fig. 78). Cerci slender, 4 times longer than width of tergum 9 at base of cerci, with 9 setae; pair of bristles on tergum 9 short (Fig. 79).

Body size in 5 specimens 8.0—10.8 × 1.2—1.7 mm.

The characters given in keys by Larsson (1941, 1968) and Šarova (1958, 1964) are not reliable.

Larval instar II: Head — epicranial sulcus shorter than last antennal segment. Length ratio of antennal segments — 1.5 : 1 : 1.7 : 1.3 (Fig. 67). Mandible with only 1 longer seta on the outer margin (Fig. 70). Stipes 2.4 times longer than wide and about as long as palpus, outer margin with only 3 setae; length ratio of palpal segments — 1.1 : 1.7 : 1.4 : 1; both segments of galea of equal length (Fig. 73). Width of head capsule in 1 specimen 0.66 mm.
Body size 7.4 × 1.0 mm.

Larval instar I: Head — clypeus not protruding, 1.4 times broader than anguli frontales. Frontale 1.1 times longer than wide, egg bursters in a form of 2 rows of spaced, minute spines, 9—13 spines in each row (Fig. 63). Epicranial sulcus distinctly longer than last antennal segment. Length ratio of antennal segments — 1.5 : 1 : 1.7 : 1.4 (Fig. 66). Blade of mandible serrate (Fig. 69). Stipes twice longer than wide, shorter than palpus, outer margin with 2 setae; length ratio of palpal segments — 1 : 1.6 : 1.4 : 1 (Fig. 72). Both segments of labial palps of nearly equal length (Fig. 75). Width of head capsule in 3 specimens 0.47, 0.48 and 0.54 mm.

Thorax — tarsus about 1.1 times longer than tibia.

Abdomen — on terga 1—8 there are 6 setae in anterior row, 4 longer and 2 minute setae in posterior row. Cerci 3 times longer than width of tergum 9 at base of cerci, with 5 setae.
Body size in 3 specimens 3.7—5.0 × 0.6—0 8 mm.

Bionomic notes

Rearing. From the 4 pairs found on March 21, 1969 in Central Bohemia we obtained, from May (1) to July and in November (1), only 7 larvae. Three specimens of L II developed at the mean temperature 20 °C in 5, 6 and 8 days, 3 L III at the same temperature in 9, 10 and 11 days; 2 pupae developed at 21 °C 5 days, 1 pupa at 17,5 °C in 9 days. The development of 2 females from L II to the adult stage lasted 20 days (21.5 °C) and 24 days (18.5 °C). Wasner (1979) gives about 2 months as a time of individual development till hatching of the imagines (rearing temperature not given).

In Czechoslovakia the peak occurrence of adults takes place in May and June. Most mature eggs were found in dissected females from the end of May to the end of June. The larvae were found in mountains on July 29 (940 m, 1 L I, 2 L III) and in August (1400 m, 2 L III). The occurrence of immature young betles takes place from August to November and reaches its peak in September.

Our findings are in agreement with the data given from England by Greenslade (1965), Dawson (1965) and Murdoch (1966) and from South-West Germany by Wasner (1979). The occurrence of larvae in autumn (October) reports Tietze (1974) from Hercynia (south of GDR).

P. (E.) fuliginosus belongs to the species without the larval diapause in the breeding cycle.

Platynus (Europhilus) gracilis (Sturm, 1824)

Figs. 80—96

Material: 2 L I, 4 L II, 3 L III.

Description

Larval instar III: Head — subquadrate. Clypeus slightly protruding, with 2 great lateral teeth and denticulate fore margin; clypeus 1.5 times broader than anguli frontales, these with denticulate margin in the inner part, the outer margin with 2 setae (Fig. 82). Frontale nearly as long as wide, epicranial sulcus about as long as last antennal segment. Antennae slightly longer than mandibles, lenght ratio of segments — 1.45 : 1.00 : 1 45 : 1.00 (Fig. 85). Mandible 2.3 times longer than wide at base, with 1 long and 1 short seta on outer margin, blade with distinct incision approx. at its middle, great retinaculum inserted distinctly above the middle of mandible, penicillus long (Fig. 80). Stipes 3 times longer than wide, distinctly longer than palpus, outer margin with 5 setae; ratio of palpal segments — 1.1 : 2 : 1.5 : 1; basal segment of galea 1.2 times longer than second (Fig. 91). First segment of labial palps 1.2 times longer than second (Fig. 94). Width of head capsule in 3 specimens 0.90, 0.96, 0.97 mm.

Thorax — tibia and tarsus of about equal length.

Abdomen — on terga 3—8 6 longer and 6 shorter setae in anterior row, 4 longer and 8 shorter setae in posterior row (Fig 95), on terga 1 and 2 one additional pair of short setae in anterior row, in posterior row 6 longer and 6 shorter setae. Cerci slender, 3.5 times longer than width of tergum 9 at base of cerci, with 9 setae. Pair of setae on tergum 9 moderately long (Fig. 96).

Body size in 3 specimens 8.8—10.4 × 1.2—1.5 mm.

Larval instar II: Head — epicranial sulcus shorter than last antennal segment. Length ratio of antennal segments — 1.5 : 1 : 1.7 : 1.5 (Fig. 84). Mandible with only 1 longer seta on outer margin (Fig. 87). Stipes 2.3 times longer than wide, nearly as long as palpus, outer margin with only 3 setae; length ratio of palpal segments — 1 : 1.7 : 1.4 : 1; both segments of galea of equal length (Fig. 90). Basal segment of labial palps 1.1 times longer than second (Fig. 93). Width of head capsule in 4 specimens 0.60—0.66 (average 0.64) mm.

Larval instar I: Head — clypeus not protruding, 1.8 times broader than anguli frontales. Frontale 1.1 times longer than wide, egg bursters in a form of 2 rows of spaced, minute spines, 8—12 spines in each row (Fig. 80). Epicranial sulcus 1.5 times shorter than last antennal segment. Length ratio of antennal segments — 1.4 : 1 : 1.7 : 1.6 (Fig. 84). Blade of mandible serrate (Fig. 86). Stipes 2 times longer than wide, shorter than palpus, outer margin with 2 setae; length ratio of palpal segments — 1 : 1.4 : 1.3 : 1 (Fig. 89). Both

segments of labial palps of about equal length (Fig. 92). Width of head capsule in 2 specimens 0.48 mm.

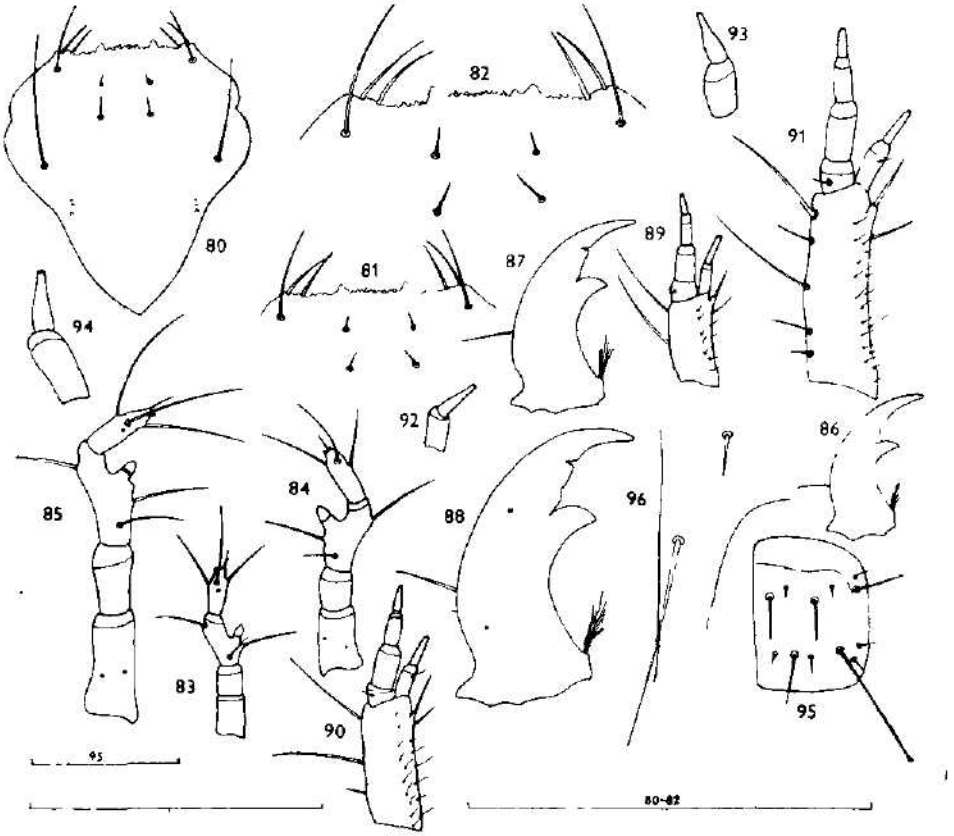
Thorax — tarsus nearly 1.2 times longer than tibia.

Abdomen — on terga 1—8 6 setae in anterior row, 4 longer and 2 minute setae in posterior row. Cerci 3 times longer than width of tergum 9 at base of cerci, with 5 setae.

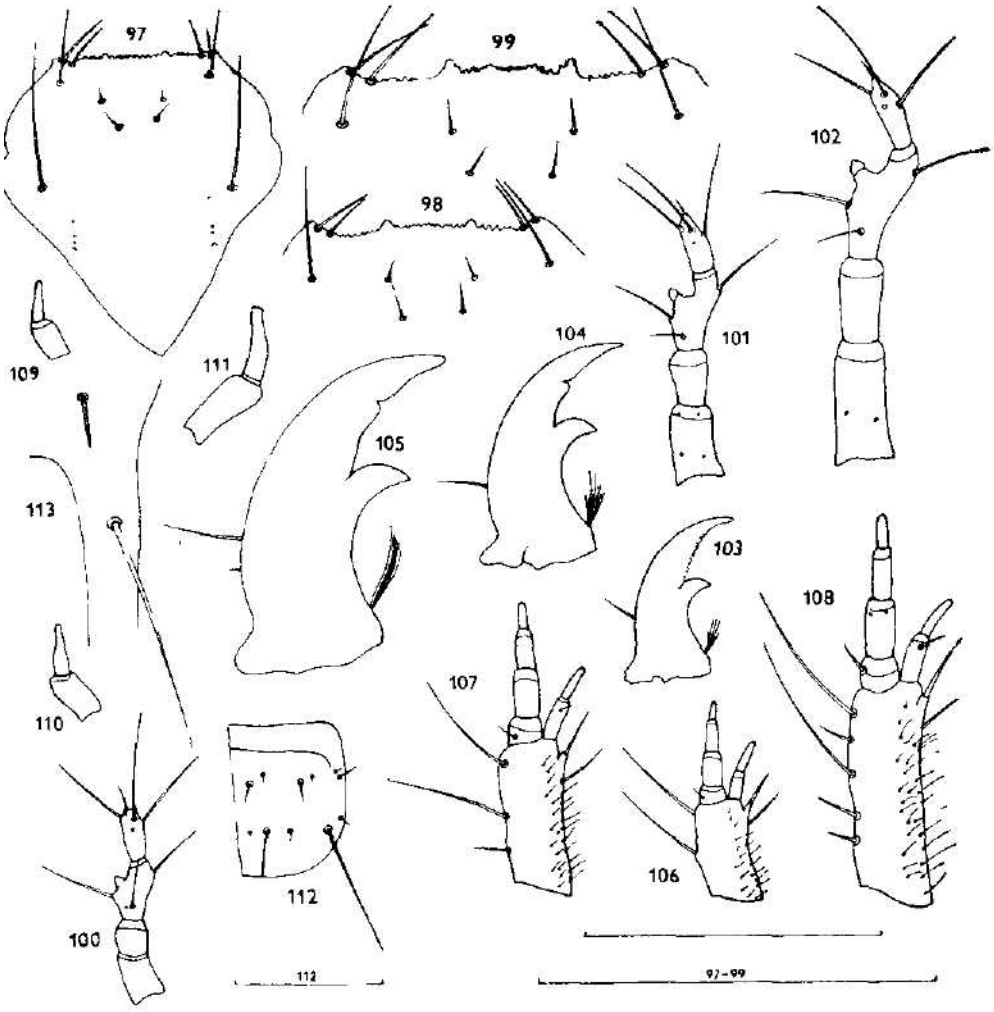
Body size in 2 specimens 4.3 × 0.6 mm and 5.0 × 0.6 mm.

Bionomic notes

Rearing. The adults were found at the beginning of April in a peat-bog near Hájek (Soos) in West-Bohemia. The larval instar I appeared from the end of May to June 20 and in 3 specimens lasted 4, 5 and 6 days at the mean temperature 20.5 °C. One specimen of larval instar II developed 8 days at 21 °C. The development of one adult from the L I lasted 38 days (21.5 °C). Wasner (1979) gives about 2 months as a development rate from the egg till hatching of



Figs. 80–96. *P. (E.) gracilis:* 80 — frontale L I; 81, 82 — clypeus and anguli frontales L II, L III; 83, 84, 85 — antenna L I, L II, L III, 86, 87, 88 — mandible L I, L II, L III; 89, 90, 91 — maxilla L I, L II, L III; 92, 93, 94 — labial palpus L I, L II, L III; 95 — abd. tergum 8 L III; 96 — basal part of cercus L III. Scales = 0.5 mm.



Figs 97–113. *P. (E.) micans:* 97 frontale L I; 98, 99 – clypeus and anguli frontales L II, L III; 100, 101, 102 antenna L I, L II, L III; 103, 104, 105 – mandible L I, L II, L III; 106, 107, 108 – maxilla L I, L II, L III; 109, 110, 111 – labial palpus L I, L II, L III; 112 – abd terum 8 L III; 113 – basal part of cercus L III. Scales = 0.5 mm.

adult (L I 10—12, L II 10—15, L III 11—17, pupa 6 days — rearing temperature not given).

In Czechoslovakia the occurrence of adults reaches its peak in May. Mature eggs were found in dissected females in mid — June. Immature imagines appeared in August.

P. (E.) gracilis belongs also to the breeding type without the larval diapause.

Platynus (Europhilus) micans (Nicolai, 1822)

Figs. 97–113

Material: 1 exuvia L I, 1 L II, 1 Exuv. L II, 3 L III.

Description

Larval instar III: Head — subquadrate. Clypeus slightly protruding, with 2 great lateral teeth, whole margin between them with denticles; clypeus 1.5 times broader than anguli frontales, these with convexe margin, denticulate in the inner part, with 2 setae on outer margin (Fig. 99). Frontale as long as wide, epicranial sulcus a little longer than last antennal segment. Antennae slightly longer than mandibles, ratio of segments — 1.5 : 1.1 : 1.5 : 1 (Fig. 102). Mandibles short, robust, about 2.4 times longer than wide, with 1 long and 1 short seta on outer margin, blade with distinct incision at middle, retinaculum large, inserted approax at. the middle of mandible; penicillus long (Fig. 105). Stipes 3 times longer than wide, distinctly longer than palpus, outer margin with 5 setae; ratio of palpal segments — 1.1 : 2 : 1.5 : 1; basal segment of galea 1.1 times longer than second (Fig. 108). First segment of labial palpi 1.1 times longer than second (Fig. 111). Width of head capsule in 3 specimens 0.92, 0.99, 1.02 mm.

Thorax — tibia and tarsus of nearly equal length.

Abdomen — on terga 1—8 there are 6 longer and 6 shorter setae in anterior row, 4 longer and 8 shorter setae in posterior row (Fig. 112); tergum 1 sometimes with additional pair of short setae in anterior row. Cerci slender, 4 times longer than width of tergum 9 at base of cerci, with 9 setae; pair of setae on tergum 9 moderately long (Fig. 113).

Body size in 3 specimens 10.1—10.6 × 1.5—1.6 mm.

Larval instar II: Head — epicranial sulcus shorter than last antennal segment. Length ratio of antennal segments — 1.3 : 1 : 1.4 : 1 (Fig. 101). Mandibles only with longer seta on outer margin (Fig. 104). Stipes 2.4 times longer than wide, as long as palpus, outer margin with only 3 setae; length ratio of palpal segments — 1 : 1.8 : 1.5 : 1 (Fig. 107). Both segments of labial palps of equal length (Fig. 110). Width of head capsule in 1 specimen 0.76 mm.

Body size 6.0 × 2.0 mm.

Larval instar I: Head — clypeus not protruding; frontale slightly longer than wide, egg bursters in a form of 2 rows of spaced, minute spines, 9 spines in each row (Fig. 97). Epicranial sulcus shorter than last antennal segment. Length ratio of antennal segments — 1.4 : 1 : 1.5 : 1.4 (Fig. 100). Blade of mandible serrate (Fig. 103). Stipes twice longer than wide, shorter than palpus, outer margin with 2 setae; ratio of palpal segments — 1.1 : 1.5 : 1.5 : 1, second segment of galea 1.1 times longer than first (Fig. 106). Basal segment of labial palps a little shorter than second (Fig. 109). Other characters not available.

Bionomic notes

Rearing. One specimen of larval instar I (from a pair collected on March 21, 1969 in Central Bohemia) developed for 5 days in June at the mean temperature 22 °C (20 °C—23 °C), specimens of larval instar II for 8, 9 and 11 days at the same temperature.

In the natural conditions of lowland forests in Czechoslovakia the peak occurrence of imagines takes place in May. In Southeast Slovakia mating was observed on May 24. Also in May most mature eggs were found in dissected

females. The number of immature adults of the new generation reaches its peak in July and August.

P. micans belongs also to the species without the larval diapause in the breeding type.

Taxonomic notes

The larval characters of *Europhilus* are as follows: blade of mandible in L II and L III with 1 distinct incision, in L I finely serrate. Clypeus denticulate, with 2 distinct lateral teeth, wider than anguli frontales. First seta of cerci in L II and L III inserted near their base; cerci about 3—4 times longer than width of tergum 9 at base of cerci. Egg bursters in a form of 2 rows of spaced, minute spines, 5—13 spines in each row.

The separation of the species described in the paper is possible according to following keys.

L II and L III

Outer margin of stipes in L III with 5, in L II with 3 setae

1 (4) Anguli frontales with 2 bristles at the fore margin (Figs. 82, 99). Pair of bristles on tergum 9 moderately long (Figs. 96, 113). Outer pair of longer bristles in posterior row on tergum 8 nearly 4 times longer than inner pair (Figs. 95, 112)
2 (3) Retinaculum placed distinctly above the midle of mandible (Figs. 87, 88) . . . . . *P. (E.) gracilis*
3 (2) Retinaculum placed approx. at middle of mandible (Figs. 104, 105) *P. (E.) micans*
4 (1) Anguli frontales with 3—4 bristles at the fore margin (Figs. 64, 65). Pair of bristles on tergum 9 short (Fig. 79). Outer pair of longer bristles in posterior row on tergum 8 at least 10 times longer than inner pair . . *P. (E.) fuliginosus*

L I

1 (4) Anguli frontales with 2 bristles at the fore margin. Outer pair of longer bristles in posterior row on tergum 8 twice longer than inner pair.
2 (3) Retinaculum distinctly above the middle of mandible (Fig 86) *P. (E.) gracilis*
3 (2) Retinaculum approx. at middle of mandible (Fig. 103) . . . . *P. (E.) micans*
4 (1) Anguli frontales with 3—4 bristles at fore margin. Outer pair of longer bristles in posterior row on tergum 8 at least 4 times longer than inner pair . . . . . *P. (E.) fuliginosus*

SUBGENUS IDIOCHROMA BEDEL, 1902

The sole species *P. (I.) dorsalis* (Pont.) is described in detail in larval instar III by Kemner (1913). Larsson (1941, 1968) and Šarova (1958, 1964) repeat only the data given by Kemner.

Platynus (Idiochroma) dorsalis (Pontoppidan, 1763)

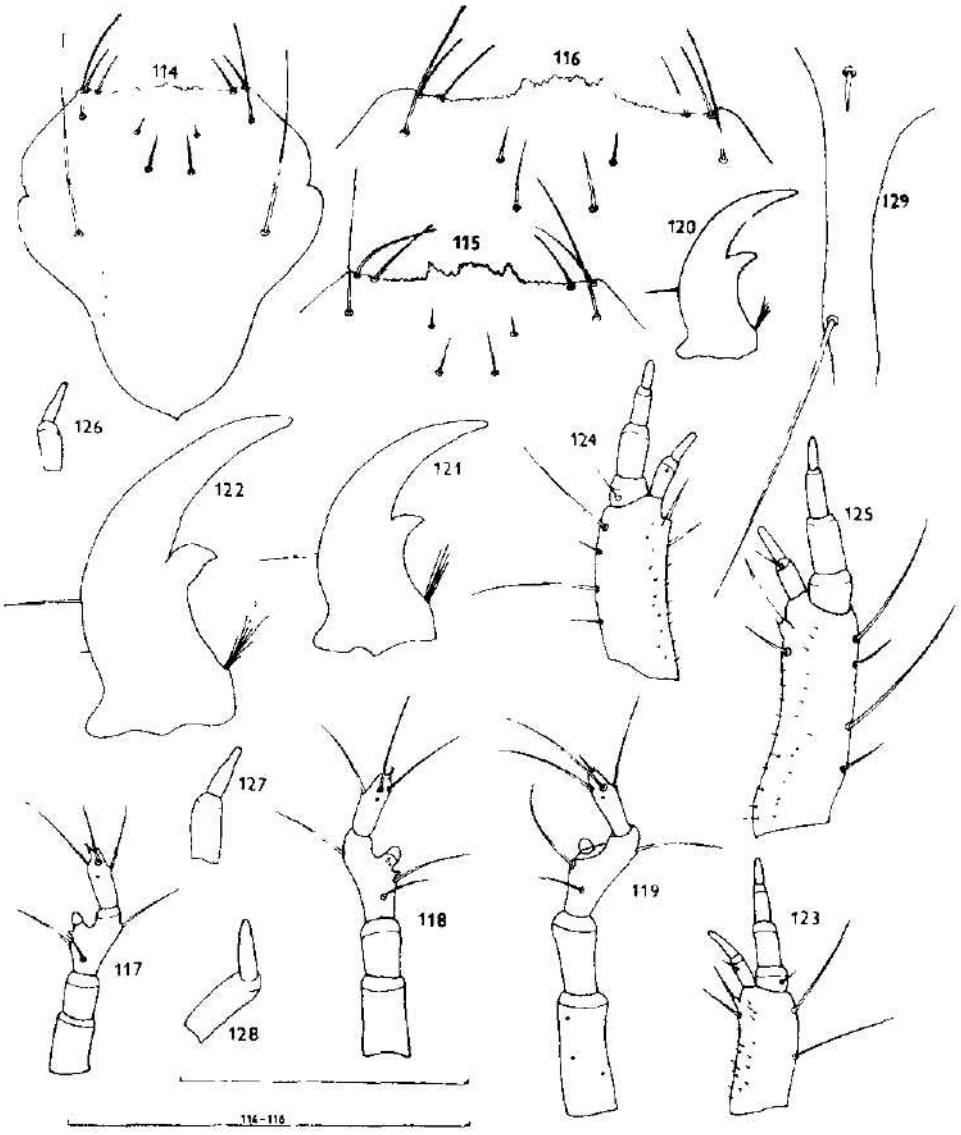
Figs. 114—129

Kemner, 1913: 18—21, Figs. 9—11, L III; Larsson, 1941: 320, Fig. 42 c; Šarova, 1958: 61, Fig. 120 m; Šarova, 1964: 172, Fig. 150—9; Larsson, 1968: 376, 386, Fig. 47 c.

Material: 2 L I, 1 L II, 3 L III.

Description

Larval instar III: Head — 1.1 times broader than long. Clypeus narrow, protruding, with 2 great lateral teeth and denticulate, semicircular inner part, narrower than anguli frontales, these denticulate in inner third (Fig. 116). Frontale as long as wide, epicranial sulcus distinctly longer than last antennal



Figs. 114—129. *P. (I.) dorsalis:* 114 — frontale L I; 115, 116 — clypeus and anguli frontales L II, L III; 117, 118, 119 — antenna L I, L II, L III; 120, 121, 122 — mandible L I, L II, L III; 123, 124, 125 — maxilla L I, L II, L III; 126, 127, 128 — labial palpus L I, L II, L III; 129 — basal part of cercus L III. Scales = 0.5 mm.

segment. Antennae longer than mandibles, length ratio of segments — 1.7 : : 1.1 : 1.5 : 1 (Fig. 119). Mandible 2.4 times longer than wide at base, with 1 long and 1 short seta on outer margin, blade smooth; retinaculum placed at middle of mandible, penicillus longer than reticulum (Fig. 122). Stipes 3 times longer than wide and 1.3 times longer than palpus; ratio of palpal segments —

1 : 1.9 : 1.5 : 1; both segments of galea of nearly equal length (Fig. 125). First segment of labial palps 1.3 times longer than second (Fig. 128). Width of head capsule in 3 specimens 1.04, 1.04, 1.08 mm.

Thorax — tibia and tarsus of about equal length.

Abdomen — on terga 1—8 6 longer and 6 shorter setae in anterior row, 4 longer and 6 shorter setae in posterior row. Cerci very slender and long, at least 5 times longer than width of tergum 9 at base of cerci, with 9 setae; a pair of setae at base of cerci strong (Fig. 129).

Body size in 3 specimens 12.0—12.4 × 1.3—1.4 mm.

Our data agree with the description by K e m n e r (1913).

L a r v a l i n s t a r II: Head — clypeus a little broader than anguli frontales (Fig. 115) Epicranial sulcus about as long as last antennal segment. Length ratio of antennal segments — 1.3 : 1 : 1.4 : 1.1 (Fig. 118). Mandible with only 1 longer seta on outer margin (Fig. 121). Stipes 2.5 times longer than wide and only 1.1 times longer than palpus; length ratio of palpal segments — 1.1 : 1.9 : : 1.3 : 1; basal segment of galea a little longer than second (Fig. 124). First segment of labial palpus 1.2 times longer than second (Fig. 127). Width of head capsule in 1 specimen 0.86 mm.

Abdomen — on terga 4—8 all pairs of short setae in anterior row and outer pair of short setae in posterior row minute or absent.

Body size in 1 specimen 7.4 × 1.0 mm.

L a r v a l i n s t a r I: Head — frontale 1.1 times longer than wide, egg bursters in a form of 2 rows of very spaced, minute spines, 6—8 spines in each row; pars aboralis frontalis pointed caudad (Fig. 114). Epicranial sulcus distinctly shorter than last antennal segment. Length ratio of antennal segments — 1.45 : : 1.00 : 1.70 : 1.40 (Fig. 117). Blade of mandible serrate (Fig. 120).Stipes twice longer than wide, shorter than palpus; length ratio of palpal segments — 1 : 1.7 : 1.4: : 1; both segments of galea of equal length (Fig. 123). Basal segment of labial palps 1.1 times longer than second (Fig. 126). Width of head capsule in 2 specimens 0.54 and 0.64 mm.

Abdomen — on terga 1—8 there are 6 setae in anterior row, 4 setae in posterior row. Cerci 4 times longer than width of tergum 9 at base of cerci, with 5 setae.

Body size in 2 specimens 5.6—6.0 × 0.8 mm.

B i o n o m i c n o t e s

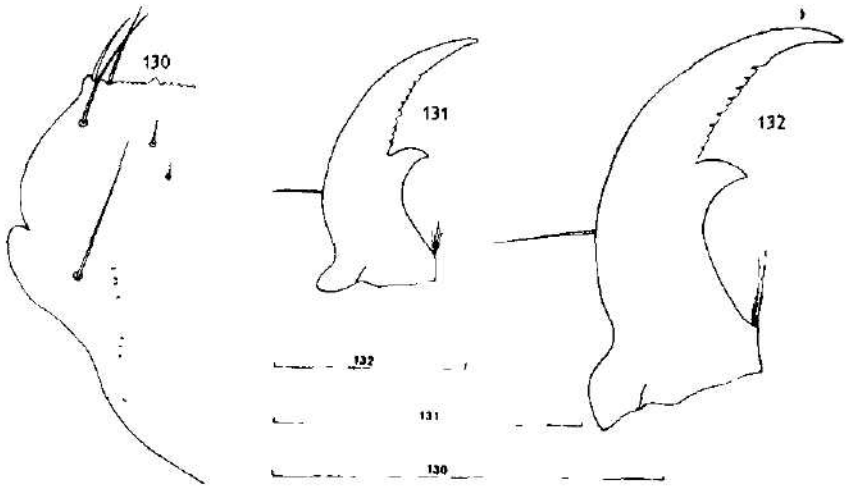
In natural conditions of Czechoslovakia the occurrence of adults reaches its peak from May to July. In June most mature eggs were found in dissected females. The larvae of all instars were found in July (Central Bohemia), last larval instar as late as on September 2 (Southwest Bohemia) The peak occurrence of immature adults of the new generation takes place in August.

The given data agree with the conclusions of the paper by K r e c k w i t z (1980). According to this author the females of *P. dorsalis* encase each egg in a mud cell and attach it to a stone or a plant. Without soil in the substrate no oviposition takes place in laboratory conditions. Embryonic, larval and pupal development lasted for about 45 days at 20 °C.

P. dorsalis belongs evidently to the species without the larval diapause in the breeding cycle, according to K r e c k w i t z (1980) with a facultative dormancy in the adults which is governed by photoperiod.

Taxonomic notes

Larval characters of *Idiochroma* are as follows: blade of mandible in L II and L III smooth, in L I finely serrate. Clypeus denticulate, with 2 distinct lateral teeth, nearly as wide as anguli frontales or narrower. Cerci slender, long, in



Figs. 130—132. *P. (L.) assimilis:* 130 — left part of frontale L I; 131 — mandible L I; 132 — mandible L III. Scales = 0.5 mm.

L II and L III at least 5 times longer than width of tergum 9 at base of cerci; first seta inserted wide of their base. Egg bursters in a form of 2 rows of 6—8 very spaced spines.

TAXONOMIC NOTES AND KEYS

The taxonomic study of our larval samples as well as the literary data on immature forms of the genus *Platynus* Bon. demonstrate that the reliable distinguishable characters on the subgeneral level in larval instars II and III are: the form and chaetotaxy of mandible, of abdominal tergum 9 and cerci, of clypeus and of maxilla; in larval instar I they are shown by the arrangement of egg bursters and the form of clypeus.

The most characteristic subgeneral features are given in the following keys.

Larval instars II and III

1 (4) Blade of mandible smooth
2 (3) Cerci slender, long, at least 5 times longer than width of tergum 9 at base of cerci; first seta inserted wide of their base (Fig. 129). Clypeus narrow, nearly as wide as anguli frontales (Figs. 115, 116) . . . . . *Idiochroma (dorsalis)*
3 (2) Cerci less slender, about 3 times longer than width of tergum 9 at base of cerci; first seta inserted near their base (Fig. 51). Clypeus wider than anguli frontales (Figs. 3, 21, 37) . . . . . *Agonum* Bon.
4 (1) Blade of mandible at least with 1 distinct incision or serrate
5 (6) Blade of mandible with 1 distinct incision (Figs. 71, 96, 105) *Europhilus* Chaud.
6 (5) Blade of mandible with 1—4 small incisions (Fig. 57) or serrate (Fig. 132)
7 (8) Cerci with 8 strong bristles and 1 small basal seta; pair of setae on tergum 9 small . . . . . *Batenus* Motsch.
8 (7) Cerci with 9 strong bristles; pair of setae on tergum 9 moderately long . . . . . *Limodromus (assimilis)*

Larval instar I

The common characters of first instar larvae are: egg bursters in a form of 2 rows of short spines; blade of mandible finely serrate; outer margin of stipes with 2 setae; cerci with 5 bristles.

1 (4) Egg bursters in a form of 2 rows of closely set short spines (Figs. 1, 22, 35, 130)
2 (3) Egg bursters rather long, consisting of at least 30 short, equal spines each (Fig. 130). Blade of mandible coarserly serrate (Fig. 131) *Limodromus (assimilis)*
3 (2) Egg bursters shorter, consisting each at most 25 spines, being greater posteriorly (Figs. 1, 22, 35). Blade of mandible finely serrate (Figs. 7, 26, 41) . . . . . *Agonum* Bon.
4 (1) Egg bursters in a form of 2 rows of more spaced short spines (Figs. 52, 63, 114).
5 (6) Egg burster consists of 22–30 spines (Fig. 52). Blade of mandible with 3–6 incisions (Fig. 56) . . . . . *Batenus* Motsch.
6 (5) Egg burster consists at most 15 spines (Figs. 63, 114). Blade of mandible finely serrate (Figs. 69, 86, 103, 120)
7 (8) Egg burster consists of 8–13 spines (Figs. 63, 80, 97). Clypeus distinctly wider than anguli frontales . . . . . *Europhilus* Chaud.
8 (7) Egg burster consists of 6–8 very spaced spines (Fig. 114). Clypeus nearly as wide as anguli frontales . . . . . *Idiochroma (dorsalis)*

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SOME NEMATODES OF THE GENUS RHABDOCHONA (SPIRURIDA) FROM FISHES OF JAPAN

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Abstract Three species of *Rhabdochona* Railliet 1916 are redescribed from freshwater fishes of Japan (Hokkaido and Honshu) *R oncorhynchi* (Fujita, 1921) from *Oncorhynchus masou Salmo trutta, Salmo gairdneri Salvelinus leucomaenis*, and *Salvelinus fontinalis* (Salmonidae), *R coronacauda* Belouss, 1965 from *Opsariichthys uncirostris* (Cyprinidae), and *R. zacconis* Yamaguti, 1935 from *Tribolodon hakuensis* and *Zacco platypus* (Cyprinidae) The following are regarded as synonyms of *R oncorhynchi* (Fujita, 1921) *R fujii* (Fujita, 1921), *R salvelini* Fujita, 1927, *R amago* Yamaguti, 1935 and *R oncorhynchi* Fujita, 1940, all described from salmonid fishes in Japan *Rhabdochona coronacauda* is a new record for Japan Restudy of Yamaguti's type series of *R. zacconis* showed that the specimens (♀♀) from *Liobagrus reini* are not conspecific with those from the type host, *Zacco platypus*

INTRODUCTION

Nematodes of the genus *Rhabdochona* Railliet 1916 are common parasites of the digestive tract of fishes in Japan Up to the present time, a total of ten nominal species from the territory of present-day Japan and near Kurile Islands and Sakhalin has been assigned at one time or another to this genus As already pointed out by Rasheed (1965 a, b), Margolis (1968) and others, many of these species were reported from identical or closely related hosts and the descriptions often were inadequate and drawings very schematic, leaving the validity of some species in doubt Clarification of the taxonomic status of these species is important for the solution of zoogeographical questions concerning the genus *Rhabdochona* and its host fishes, and can only be achieved through examination of type or topotypic material The availability of a substantial new collection of specimens from Japan and the opportunity to re-examine the type specimens of two species *R zacconis* Yamaguti, 1935 and *R amago* Yamaguti, 1935 have made it possible for us to establish the validity of certain species and relegate others to their synonymy

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This paper has been cited in the following papers as being "in press" in the Research Bulletin of the Meguro Parasitological Museum Moravec F 1975, Studie ČSAV, 8 1—105, Margolis L, Moravec F and McDonald T E 1975, Can J Zool, 53 960—966, and Moravec F and Daniel M, 1976, Folia Parasitol (Praha), 23 175—178 However, it was not published owing to the suspension of the Meguro Museum's Bulletin series

MATERIALS AND METHODS

The new material was collected by one of us (N. P. B.) in 1969 from the degestive tract of a number of salmonid and other fishes from streams and lakes in Hokkaido and Honshu. These nematodes were fixed in hot formalin-alcohol-acetic acid solution and stored in glycerine-alcohol or 4% formaldehyde. For examination they were cleared in glycerine and *en face* views were prepared according to Anderson's (1958) method with glycerine jelly. Representative specimens of each species have been deposited in the Institute of Parasitology, Czechoslovak Academy of Sciences, Prague and the Meguro Parasitological Museum, Tokyo; all remaining material is deposited in the collections of the Pacific Biological Station, Nanaimo, British Columbia.

The type material of *R. zacconis and R. amago,* now housed in the Meguro Parasitological Museum, Tokyo, was kindly made available for restudy by Dr. Satoru Kamegai, Director of the Museum. Several specimens from the late Dr. T. Fujita's collections, designated as "*Cystidicola fujiii*" (= *Rhabdochona fujiii*) and "*Rhabdochona salvelini,*" were sent to us through the courtesy of Prof. H. Mori and Prof. K. Shimakura from the Department of Applied Zoology, Faculty of Agriculture, Hokkaido University, Sapporo. We presume these specimens are part of Dr. Fujita's type material.

In the following account of the species encountered, measurements are given in millimeters and the names of hosts are in accordance with those used by Okada (1960).

REVIEW OF SPECIES

1. *Rhabdochona oncorhynchi* (Fujita, 1921) Fujita, 1927 (Fig. 1—26)

Syn.: *Rhabdochona fujiii* (Fujita, 1921) Fujita, 1927; *Rhabdochona salvelini* Fujita, 1927; *Rhabdochona amago* Yamaguti, 1953; *Rhabdochona oncorhynchi* Fujita, 1940.

Description: Medium sized nematodes with smooth cuticle. Mouth approximately hexagonal in shape, surrounded by two large lateral amphids and four small subapical papillae. Prostom funnel-shaped, basal teeth usually distinctly visible in lateral view, sometimes indistinct; in dorsoventral view basal teeth seem to be absent and prostom to be sligtly longer than in lateral view. Internally prostom provided with ten marked longitudinal ribs (2 + 2 lateral, 3 dorsal, 3 ventral), extending usually along whole length of prostom. Near anterior margin of prostom ribs form small, forwardly directed teeth; dorsal and ventral ribs always forming single tooth each, lateral ribs usually dividing at anterior end to form two incompletely separated teeth; division of lateral ribs often indistinct or absent and in such cases lateral teeth simple, wide, with or without a weakly outlined longitudinal groove. Vestibule relatively long, deirids medium sized, bifurcated, situated approximately in middle of vestibular length. Tail of both sexes ending in blunt point.

Male (10 specimens): Length of body 4.79-9.93, maximum width 0.109-0.136. Prostom 0.018—0.036 long, 0.015—0.021 wide, with basal teeth feebly developed. Length of vestibule including prostom 0.090—0.153. Length of muscular oesophagus 0.171—0.306 and of glandular oesophagus 1.50—3.26. Distance of nerve ring from anterior extremity 0.105—0.240, of excretory pore 0.135—0.420, of deirids 0.063—0.105. Number of subventral preanal papillae variable, occurring in following combinations: 7 + 8, 7 + 9, 8 + 8, 8 + 9, 9 + 9, 9 + 10, and 10 + 10; additional pair of lateral preanal papillae approximately at level of third subventral pair (counting from cloacal opening). Six pairs postanal papillae present, second pair lateral and remaining pairs subventral. Longitudinal ventral cuticular ridges in front of preanal papillae present in older males, in younger males indistinct. Left spicule 0.426—0.555 long, shaft comprising approximately its

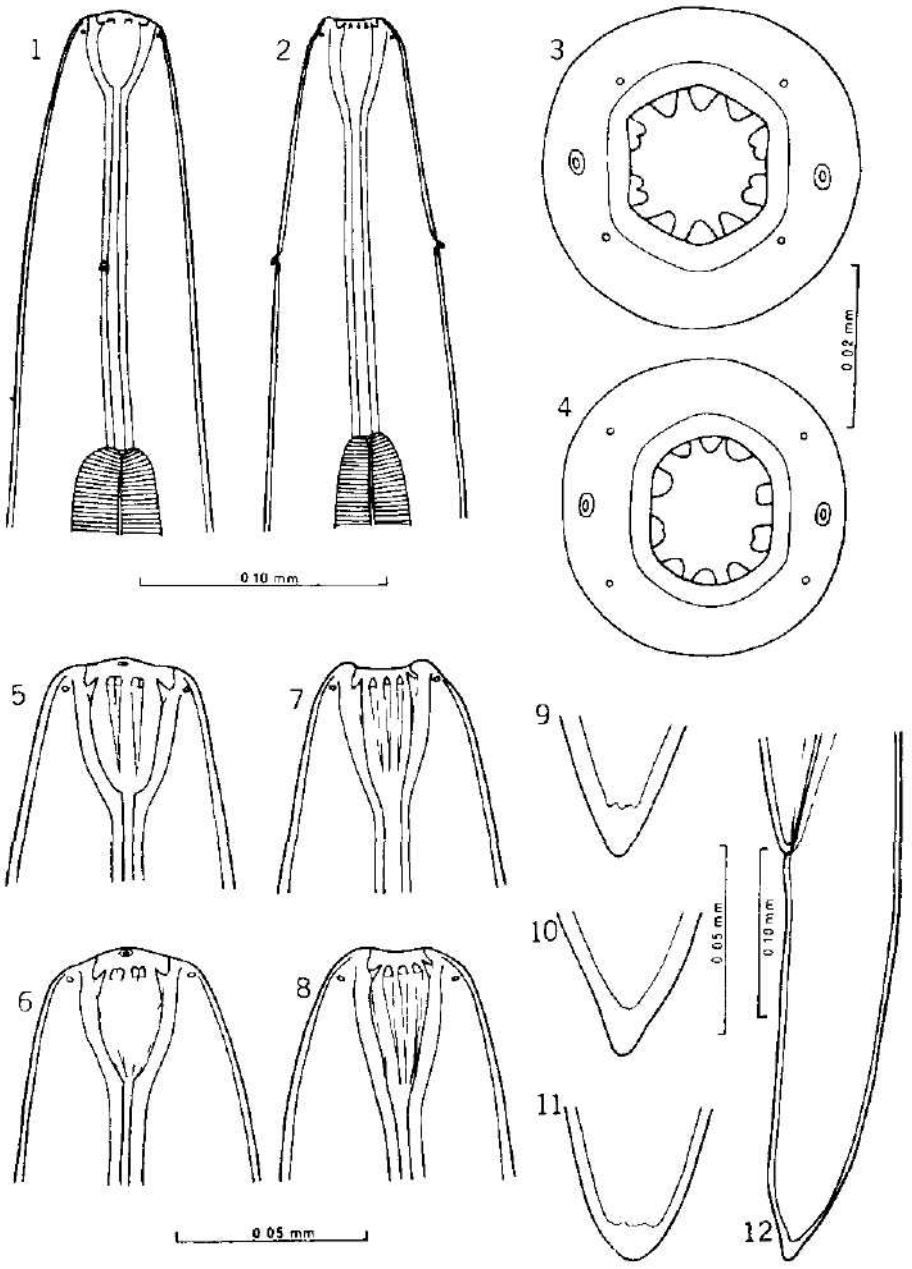

Fig. 1—12. *Rhabdochona oncorhynchi* (Fujita, 1921). 1, 2 — anterior end of female, lateral and dorsal views; 3, 4 — anterior end of female, *en face* view; 5, 6 — prostom of female, lateral view; 7, 8 — prostom of female, dorsal view; 9—11 — tip of female tail; 12 — female tail; (Fig. 1, 2, 4, 5, 7, 9, 10, 11, 12 — specimens from *S. fontinalis;* Fig. 3 — from *S. trutta;* Fig. 6, 8 — from *O. masou*).

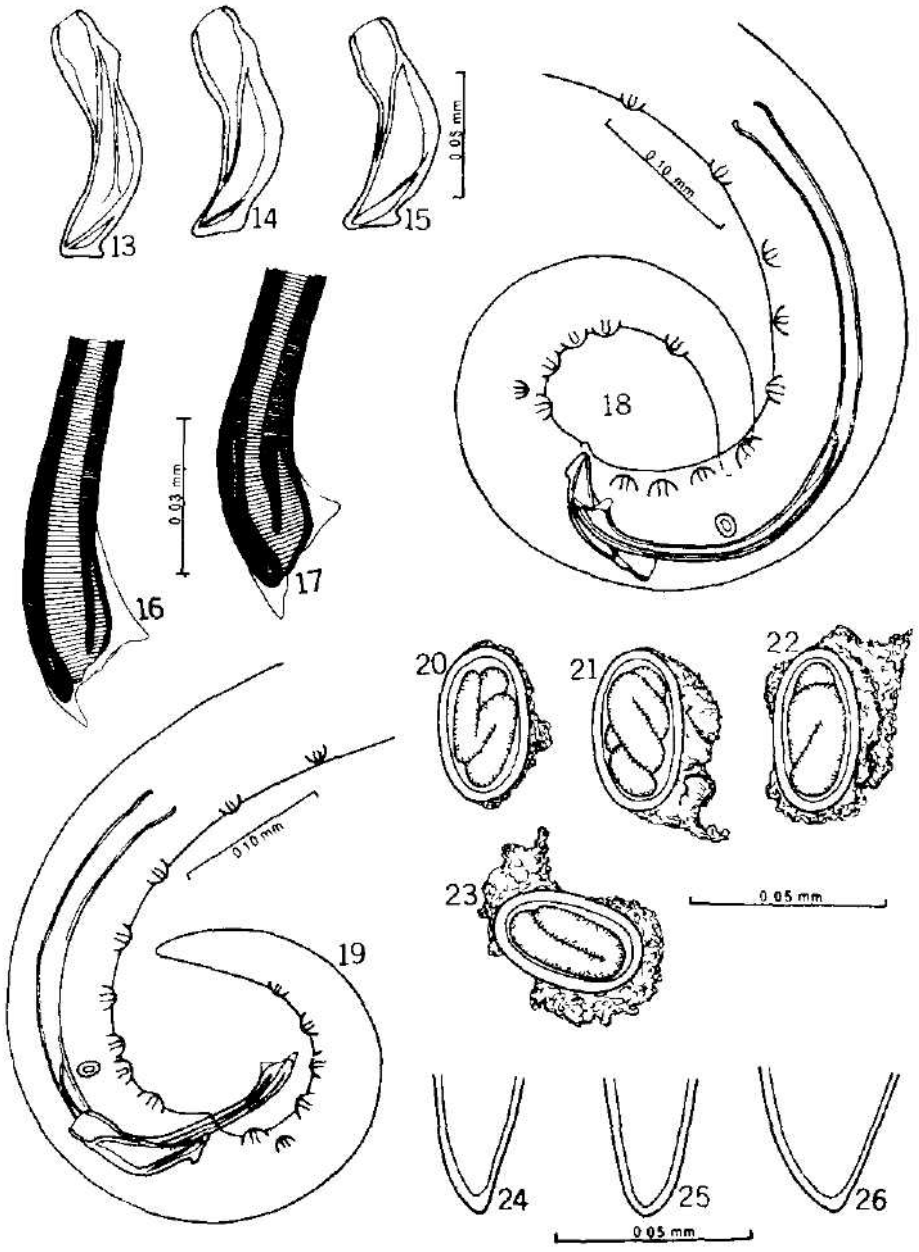

Fig. 13–26. *Rhabdochona oncorhynchi* (Fujita, 1921). 13–15 – right spicule, 16, 17 – distal tip of left spicule; 18, 19 – posterior end of male, 20–23 – eggs showing variations in flock-like coating, 24–26 – tip of male tail; (Fig 13, 14, 15, 18, 23, 25 – specimens from *S. fontinalis;* Fig. 16, 20, 21, 22, 26 – *from S. trutta;* Fig. 17, 19, 24 – from *S. gairdneri*).

anterior half; distal tip slightly widened, blunt or lanceolate, with wide cuticular membrane forming ventral process. Right spicule 0.093—0.120 long, its distal end provided with dorsal barb. Ratio of lengths of spicules 1 : 3.94—4.85. Tail 0.210—0.420 long, ending in blunt point.

Female (14 specimens): Length of gravid females 9.18—23.53; maximum width 0.136—0.299. Prostom 0.030—0.039 long, 0.021—0.030 wide, with basal teeth distinctly visible in lateral view. Length of vestibule including prostom 0.108—0.219. Length of muscular oesophagus 0.216—0.480 and of glandular oesophagus 2.71—4.53. Distance of nerve ring from anterior extremity 0.177 to 0.303, of excretory pore 0.279—0.555, of deirids 0.075—0.117. Tail fairly wide, tapering to posterior end; tip bluntly conical or rounded. Vulva approximately equatorial in largest females, in younger females postequatorial; distance of vulva from posterior extremity 4.53—10.34. Mature eggs (containing larvae) oval-shaped, with relatively thick shell, 0.042—0.045 × 0.021—0.027. Surface of eggs smooth, provided with fine, irregular, flock-like coating.

Hosts: *Oncorhynchus masou* (Brevoort), *Salmo trutta* Linnaeus, *Salmo gairdneri* Richardson, *Salvelinus leucomaenis* (Pallas), and *Salvelinus fontinalis* (Mitchill) (all Salmonidae).

Localities: Hokkaido – Shikiyu River (30. VI. 1969), Upper Nishibetsu River (3. VI. 1969), Chihase River (22 VII 1969); Honshu – Owada River (8. VII. 1969), Lake Towada (9. VII. 1969), Lake Chuzenji (28. VII. 1969).

Comments: Fujita (1921) described two new nematode species from the intestine of salmonid fishes in Hokkaido, *Cystidicola oncorhynchi* from fry of *Oncorhynchus keta* and *Cystidicola fujiii* from *Oncorhynchus nerka* and *Salvelinus kundscha* (= *S. leucomaenis*). Later, Fujita (1927 a, 1927 b) transferred both species to *Rhabdochona* and added a third species of this genus to the Japanese fauna, *R. salvelini* from *Salvelinus pluvius* from Lake Biwa. Fujita (1927 a, 1927 b) differentiated *R. salvelini* from other members of *Rhabdochona* on the basis of its allegedly equal spicules, "more backwardly situated vulva." and location in the host (abdominal cavity). However, Fujita's figures and our re-examination of some of his specimens indicate that he mistook the small spicule for a gubernaculum and probably considered the larger spicule to be double owing to the structure of its blade. The position of the vulva relative to body length is rather variable and changes considerably during growth and development. The occurrence of *R. salvelini* in the abdominal cavity of the host probably resulted from post-mortem migration or rupture of the intestinal wall during dissection.

Yamaguti (1935) briefly described another new species, *R. amago*, from Japan on the basis of females recovered from "amago" (= *Oncorhynchus rhodurus*). The original description was subsequently (Yamaguti, 1941) supplemented with data from males and females from *Salvelinus malma*. Nematodes from *Mogurnda obscura* (Eleotridae), reported as *R. amago* by Yamaguti (1941), probably belong to another species.

Finally, Fujita (1940) compounded an already confused situation with regard to the Japanese species of *Rhabdochona* from salmonids by establishing a second species under the name *R. oncorhynchi*. This species was described from immature females from *Oncorhynchus keta* from Sapporo, Hokkaido, the same host and locality reported for his earlier species of the same name. Fukui (1961) and Yamaguti (1961) considered *R. oncorhynchi* Fujita, 1940 to be identical with *R. oncorhynchi* (Fujita, 1921).

Table 1. Comparison of measurements (in mm)

	R. oncorhynchi after Fujita (1921)		*R. fujiii* after Fujita (1921)	
	♂♂	♀♀	♂♂	♀♀
Length of body	4.5—9.0	12—15	7—9	8.5—22
Width of body	0.13	0.2	0.08	0.16
Length of prostom		0.03		0.03
Width of prostom		0.02		0.02
Length of vestibule		0.20		0.21
Distance of nerv. ring				
Distance of excr. pore				
Distance of deirids				
Length of musc. oesophagus		0.48		0.45
Length of gland. oesophagus		2.85		3.33
Length of tail		0.22		0.42
Size of eggs		0.038 × 0.013		0.045—0.048 × 0.026
Length of larger spicule	0.47		0.46	
Length of smaller spicule	0.13		6.11 (?)*	
Pairs of preanal papillae	8—9		7—8	
Pairs of postanal papillae	5		5	
Host	*Oncorhynchus keta*		*Oncorhynchus nerka* *Salvelinus kundscha* (= *S. leucomaenis*)	

* Probably an error for 0.11.

Our re-examination of type or presumed type material of *R. fujiii*, *R. salvelini*, and *R. amago* indicates that these three "species" are, in fact, identical with one another and with our material described above. Unfortunately none of the original specimens of *R. oncorhynchi* were available to us. Judging from Fujita's (1921) brief description and figures, this species resembles the other nominal species and our material from salmonids in Japan in many taxonomically important features (shape of prostom, character of basal as well as anterior lateral teeth, length of spicules, arrangement of papillae, shape of tail tip, etc.). The principal measurements of the different lots of our new material and of the nominal species from Japanese salmonids are given in Tables 1 and 2, respectively, for comparative purposes. The egg breadth reported for *R. oncorhynchi* probably is an error; it is approximately one-half the measurement obtained from our material and from the other nominal species.

We believe all the nominal species of *Rhabdochona* from Japanese salmonids represent but a single species. Accordingly, the valid name of this species is *Rhabdochona oncorhynchi* (Fujita, 1921). *Rhabdochona fujiii* (Fujita, 1921), *R. salvelini* Fujita, 1927, and *R. amago* Yamaguti, 1935 are new synonyms.

Rasheed (1965 b) synonymized *R. amago* with *R. zacconis* Yamaguti, 1935, the latter having been described from fishes of the families Cyprinidae and Bagridae in Japan. Re-examination of type specimens of *R. zacconis* revealed that this is a composite species, both components of which are quite different from *R. amago* (= *oncorhynchi*).

of *R. oncorhynchi*, *R. fujiii*, *R. salvelini*, and *R. amago*

R. salvelini after Fujita (1927a, b)		*R. amago* after Yamaguti (1935) (own data in brackets)		*R. amago* after Yamaguti (1941)	
♂♂	♀♀	♀♀		♂♂	♀♀
	9.50	**25**	(21.11–27.34)	9.0 —10.0	11.6 – 15.3
	0 32	**0.35**	(0.367 – 0.435)	0.15 – 0.16	0.2
			(0.033 – 0.039)		
			(0.027 – 0.030)		
	0.25	0.14 – 0.17	(0.159 – 0.186)	0.115 – 0.150	0.11 – 0.14
	0.30	0.25—0.28	(0.270 – 0.279)		
		0.38 – 0.46	(0.471 – 0.480)	0.33 – 0.36	0.21 – 0.32
			(0.123)	0.075 – 0.100	0.084 – 0.105
	0.48	0.35 – 0.38	(0.390 – 0.429)	0.24 – 0.32	0.26 – 0.27
	about 4	3.4 – 4.1	(3.74 – 4.49)	2.6 – 2.95	2.8 – 3.1
0.46	**0.24**	0.3 – 0.37	(0.38 – 0.42)	0.27 – 0.31	0.24 – 0 26
	0.058 × 0.032	0.039 – 0.042	(0.042 – 0.045)		0.036 – 0.040
		×	×		×
		0.024 – 0.027	*(0.027 – 0.030)*		*0 021 – 0.025*
0.68				0.46 – 0.5	
0.14				0.108 – 0.110	
10 – 12				10	
5				5 + 1	
Salvelinus pluvius		*Oncorhynchus rhodurus*		*Salvelinus malma*	

2. *Rhabdochona coronacauda* Belouss, 1965 (Fig. 27—39)

Description: Small nematodes with smooth cuticle. Wide lateral alae present, extending approximately from level of nerve ring to anus. Mouth approximately hexagonal in shape, surrounded by four small subapical papillae and two lateral amphids. Prostom small, barrel-shaped, with marked basal teeth. Anterior teeth large, conical, 8 in number (2 + 2 lateral, 2 dorsal, 2 ventral); lateral teeth distinctly larger than dorsal and ventral teeth. Vestibule relatively long, straight in younger specimens and S-shaped in older specimens. Minute deirids simple, located slightly below middle of vestibular length.

Male (1 specimen): Length of body 3.17, maximum width 0.068. Maximum width of lateral alae 0.015. Prostom 0.010 in length and 0.007 in width. Length of vestibule including prostom 0.075. Length of muscular oesophagus 0.141 and of glandular oesophagus 0.471. Distance of deirids from anterior extremity 0.048, of nerve ring 0.114, of excretory pore 0.138. Posterior end of body curved ventrally, tail conical, 0.120 long, with rounded tip. Preanal papillae: 6 pairs subventral and 1 pair lateral; latter pair located between second and third subventral pair (counting from cloacal opening). Of six pairs postanal papillae, 5 pairs subventral and 1 pair lateral located at level of first subventral pair; third subventral pair distinctly larger than remaining pairs. Ventral preanal cuticular ridges absent. Left spicule 0.285 long, length of its shaft 0.141, distal tip of this spicule ventrally extended. Right spicule 0.075 long, with barbed distal end. Ratio of lengths of spicules 1 : 3.8.

Table 2. Measurements (in mm) of *R. oncorhynchi*

Host	*Oncorhynchus masou*		*Salmo trutta*	
	2 ♂♂	4 ♀♀	3 ♂♂	2 ♀♀
Length of body	8.49—9.93	10.85—23.53	4.79 —6.90	14.31
Width of body	0.136	0.177—0.299	0.122—0.136	0.245
Length of prostom	0 024—0.030	0.030—0.039	0.024	0.030—0.039
Width of prostom	0.015—0.018	0.024—0.030	0.018—0.021	0.024—0.030
Length of vestibule (including prostom)	0.147—0.150	0.162—0.219	0.090	0.108—0.135
Distance of nerve ring	0.216—0.240	0.240—0.321	0.105—0.135	0.177—0.195
Distance of exer. pore	0.420	0.375—0.555	0.135—0.270	0.279
Distance of deirids	0.081—0.105	0.087—0.117	0.063	0.075—0.087
Length of musc. oesophagus	0.270—0.306	0.324—0.480	0.171	0.216—0.339
Length of gland. oesophagus	3 01 —3.26	3.35 —4.53	1.50 —1.98	3.06 —3.26
Length of tail	0.405—0.420	0 255—0.390	0.210—0.333	0.270
Vulva from posterior extremity		5.40 —10.34		7.03
Size of eggs		0.042—0.045 × 0.024—0.027		0.042—0.045 × 0.024
Length of larger spicule	0.450—0.495		0.474—0.555	
Length of smaller spicule	0.102—0.108		0.105—0.120	
Spicular length ratio	1 : 4.09—4.58		1 : 3.94—4 74	
Preanal papillae	(8,8)—(9,10)+1		(8,9)—(9,10) +1	
Postanal papillae	5+1		5+1	
Locality	Nishibetsu River Shikiyu River Chihase River Lake Towada		Lake Chuzenji	

Female (3 specimens): Length of gravid females 5.60—6.04, maximum width 0.109—0.122. Maximum width of lateral alae 0.030. Prostom 0.012 long and 0.009 wide. Length of vestibule including prostom 0 099—0 108. Length of muscular oesophagus 0.129—0.183 and of glandular oesophagus 0.65. Distance of small deirids from anterior extremity 0.066—0.081, of nerve ring 0.120—0.174, of excretory pore 0.165—0.177. Tail conical, 0.087—0.135 long, with undetermined number of minute tooth-like processes encircling its trucated tip to form a corona of about 0.006 diameter, this crown-like formation sometimes indistinct. Vulva postequatorial, situated 2.26—2.56 from posterior extremity, sometimes with slightly elevated lips. Vagina directed posteriorly. Uteri opposed, containing numerous eggs with larvae. Mature eggs oval, smooth, without filaments or floats, 0.036—0.039 × 0 021.

Host: *Opsariichthys uncirostris* (Schlegel) (Cyprinidae).

Locality: Central Honshu — Lake Biwa (31. VII. 1969).

Comments: The only record of this species it that of Belouss (1965) who described it from fishes from the Primore region in the USSR (Far East). Our Japanese specimens agree fully with the original description of *R. coronacauda*, although Belouss did not mention the presence of lateral alae. It appears that this parasite is largely associated with cyprinid fishes of the subfamily Cultrinae.

from different hosts (own material)

Salmo gairdneri		*Salvelinus fontinalis*		*Salvelinus leucomaenis*	
2 ♂♂	2 juv. ♀♀	2 ♂♂	4 ♀♀	1 ♂	2 ♀♀
5.58—6.23	9.18—9.83	8.58—9.28	15.12 —18.47	9.21	17.46 —17.54
0.109	0.136	0.136	0.204—0.245	0.136	0.190—0.204
0.024	0.030	0.018—0.021	0.033—0.036	0.036	0.027—0.033
0.018	0.024	0.015—0.018	0.027	0.018	0.021
0.117—0.138	0.150—0.168	0.135—0.144	0.174—0.195	0.153	0.171—0.180
0.201—0.216	0.249—0.252	0.207—0.225	0.264—0.303	0.231	0.276—0.282
0.294—0.321	0.363—0.372	0.360—0.378	0.453—0.504	0.360	0.435—0.450
0.075—0.081	0.087—0.090	0.084—0.087	0.099—0.111	0.081	0.087—0.090
0.252—0.267	0.318—0.336	0.285—0.303	0.345—0.465	0.270	0.330—0.348
1.77 —1.92	2.71 —2.72	2.50 —2.68	4.05 —4.35	3.09	3.17 —3.39
0.258—0.285	0.207—0.233	0.345—0.369	0.264—0.318	0.369	0.321—0.333
	4.53—4.67		7.48 —8.43		8.07 —8.34
			0.042—0.045		0.042—0.045
			×		×
			0.021—0.027		0.024
0.435—0.447		0.426—0.495		0.465	
0.093—0.096		0.102		0.096	
1 : 4.53—4.81		1 : 4.17—4.85		1 : 4.84	
(7,8)—(7,9)+1		8—9+1		10+1	
5+1		5+1		5+1	
Nishibetsu River Owada River Lake Chuzenji		*Nishibetsu River*		*Chihase River*	

In the monograph by Skrjabin et al. (1967) this species is listed as *R. coronocauda* Belouss, 1952; apparently this name had been taken from Belouss's unpublished thesis (1952), part of which was published in 1965; in the 1965 paper the parasite was reported as "*R. coronacauda* sp. nov."

3. *Rhabdochona zacconis* Yamaguti, 1935 (Fig. 40—56)

Description: Medium sized nematodes with smooth cuticle. Mouth approximately hexagonal, slightly compressed dorsoventrally, surrounded by two large lateral amphids and four small subapical papillae. Prostom thick-walled, funnel-shaped, without basal teeth; longitudinal ribs supporting prostom indistinct; 14 well separated anterior teeth present (4 + 4 lateral, 3 dorsal, 3 ventral); lateral teeth arranged in pairs. Remaining part of vestibule fairly long. Deirids of medium size, bifurcate, located posterior to middle of vestibular length. Tail of both sexes conical, terminating in a sharp point.

Male (4 specimens): Length of body 6.69—10.06, maximum width 0.122 to 0.177. Prostom 0.018—0.021 long and 0.012 wide. Length of vestibule including prostom 0.135—0.207. Length of muscular oesophagus 0.279—0.390 and of glandular oesophagus 2.45—4.90. Distance of nerve ring from anterior extremity 0.192—0.237, of excretory pore 0.303, of deirids 0.075—0.090. Number of subventral preanal papillae variable, occurring in following combinations: 7 + 8, 8 + 9, and 9 + 9; additional pair of lateral preanal papillae situated at level of third subventral pair (counting from cloacal opening). Of six pairs of post-

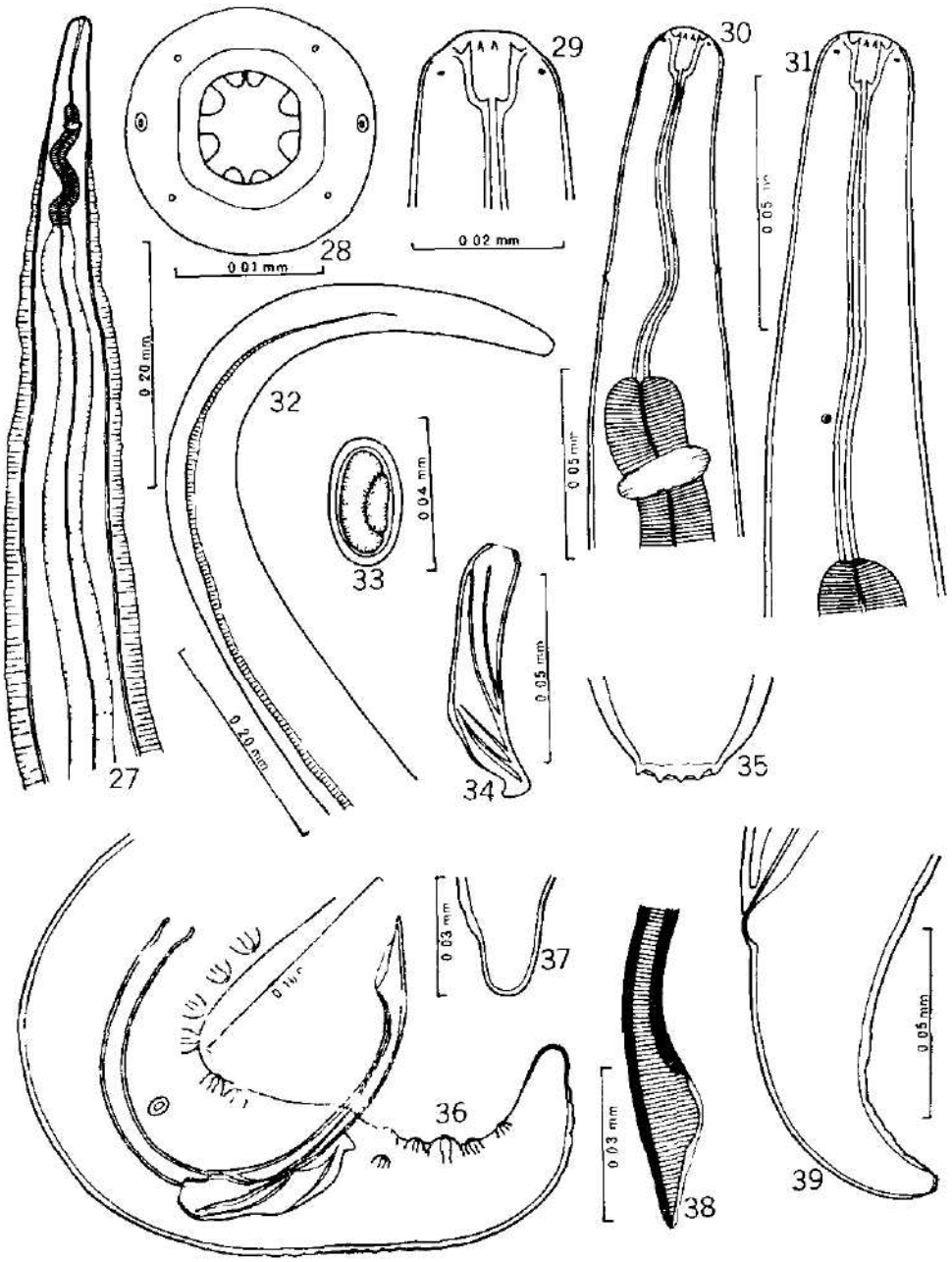

Fig. 27–39. *Rhabdochochona coronacauda* Belouss, 1965. 27 – anterior end of female, dorsal view; 28 – anterior end of female, *en face* view; 29 – prostom of female, lateral view; 30, 31 – anterior end of female, dorsal and lateral views; 32 – anterior end of female showing lateral alae, lateral view; 33 – egg; 34 – right spicule; 35 – tip of female tail; 36 – posterior end of male, 37 – tip of male tail; 38 – distal tip of left spicule; 39 – female tail.

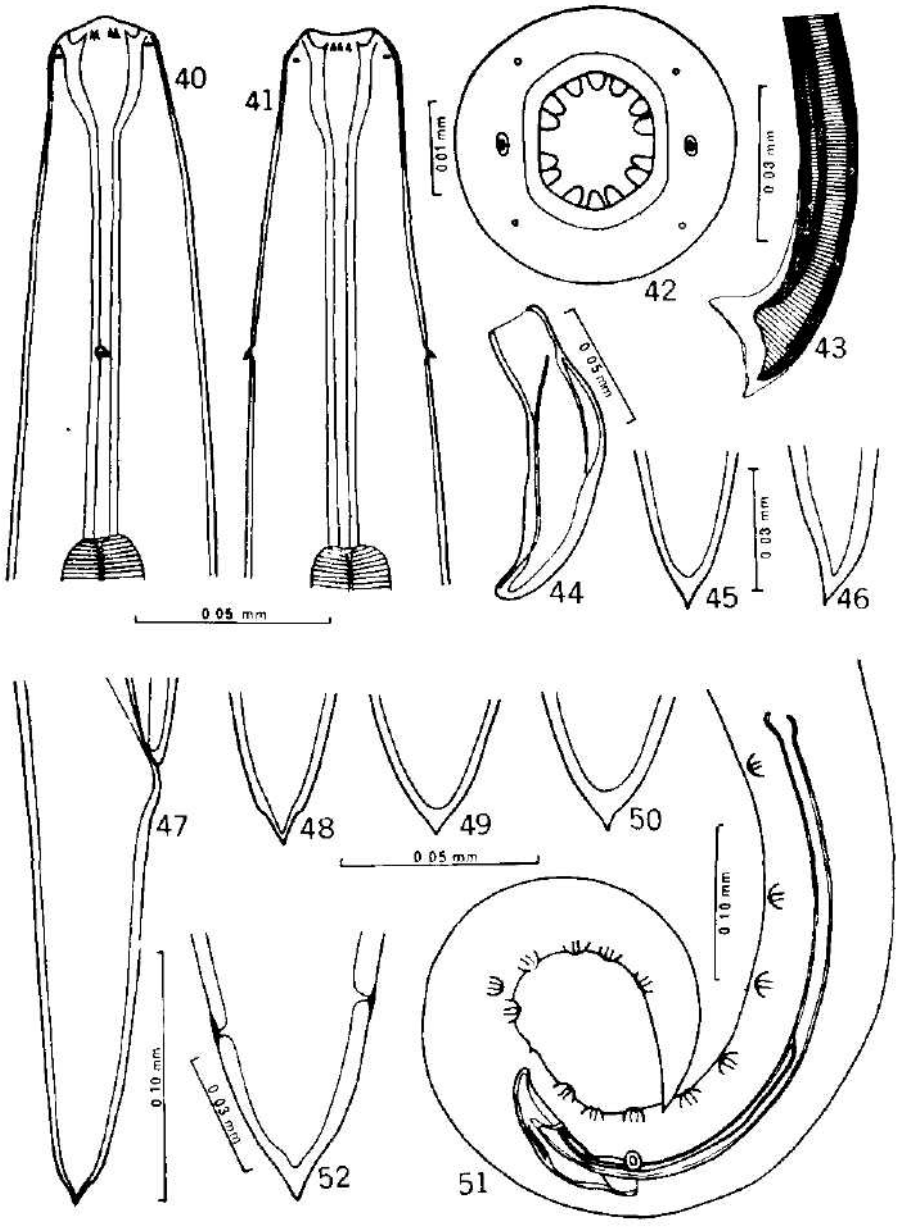

Fig. 40—52. *Rhabdochona zacconis* Yamaguti, 1935 from *T. hakuensis*. 40—41 — anterior end of young female, lateral and dorsal views; 42 — anterior end of female, *en face* view; 43 — distal tip of left spicule of young male; 44 — right spicule; 45, 46 — tip of male tail; 47 — female tail; 48—50 — tip of female tail; 51 — posterior end of male; 52 — tail end of female, dorsal view.

anal papillae, second pair lateral, remaining pairs subventral. Longitudinal
tral cuticular ridges anterior to preanal papillae well developed. Left sp
0.435—0.510 long and 0.012—0.015 wide at midlength, shaft comprising its
terior half; distal tip moderately extended, provided with wide cuticular m
brane forming large ventral process. Right spicule 0.108—0.120 long, boat-
ped, sometimes with dorsal barb on distal tip. Ratio of lengths of spicule
: 3.84—4.47. Tail conical, 0.354—0.411 long, terminating in sharp point.

F e m a l e (5 specimens): Length of females containing eggs 16.32—18 31,
ximum width 0.245—0.285. Prostom 0.030—0.033 long and 0 021—0.024 v
Length of vestibule including prostom 0.177—0.210. Length of muscular c
phagus 0.450—0 525 and of glandular oesophagus 4.15—5.98. Distance of n
ring from anterior extremity 0.264—0.309, of excretory pore 0.414—0.43
deirids 0.105—0.123. Tail conical, 0.273—0.303 long, terminating in sharp p

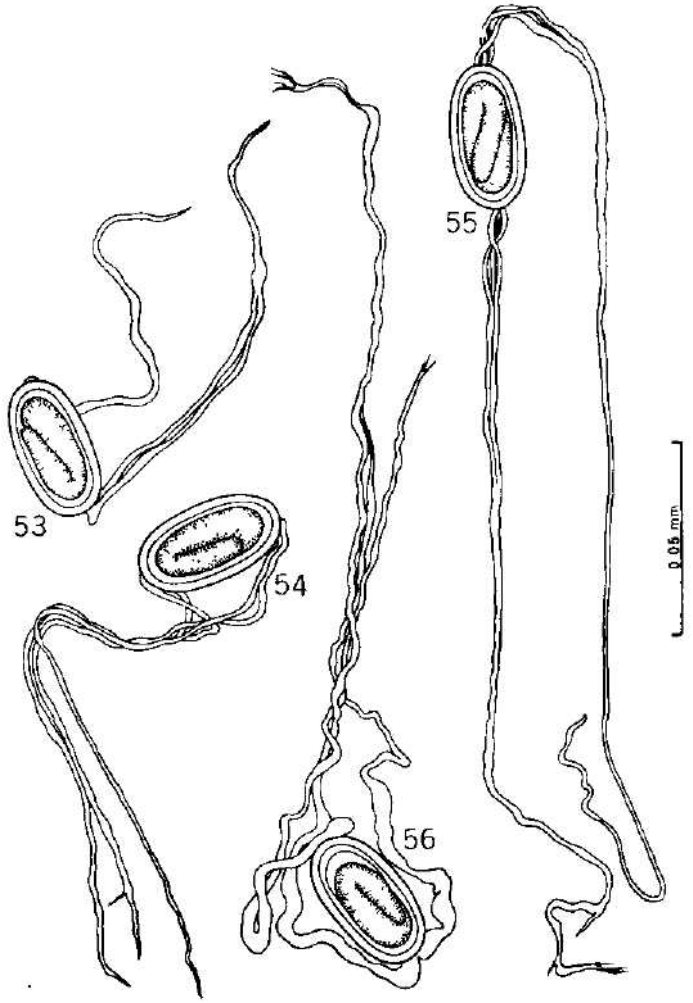

Fig. 53—56. *Rhabdochona zacconis* Yamaguti, 1935 — eggs.

in dorsal view two small phasmids visible. Vulva postequatorial, 6.94—8.30 from posterior extremity. Eggs elongate-oval, 0.036—0.039 × 0.021. Each pole of mature eggs (containing larva) provided with one, less frequently two, narrow filaments up to 0.57 long.

Hosts: *Tribolodon hakuensis* Günther and *Zacco platypus* (Temminck et Schlegel) (Cyprinidae).

Localities: Hokkaido — Lake Akan (21. VIII. 1969), Lake Chitose (12. VIII. 1969) and Chihase River (22. VII. 1969); Honshu — Lake Biwa (31. VII. 1969).

Comments: Yamaguti (1935) described *R. zacconis* as a new species from *Zacco platypus* and *Liobagrus reini* Hilgendorf (Bagridae), designating *Z. platypus* as the type host. We re-examined the type specimens of this species and found that the nematodes from *L. reini* (two females only) are both in morphology and measurements quite different from those (two males and two damaged females) from *Z. platypus* and evidently belong to a different species. As described by Yamaguti, *R. zacconis* is therefore a composite species.

Yamaguti (1935) did not designate a type specimen (i. e., a holotype) in his paper establishing *R. zacconis*, but one of his female specimens in the Meguro Parasitological Museum is labelled "Type sp." The Japanese legend on the slide (Meguro Parasit. Mus. coll. no. 22325) bearing this specimen indicates that it originated from *L. reini*; this was confirmed by Dr. Satoru Kamegai. According to Article 73 of the International Code of Zoological Nomenclature, in the absence of a published designation of holotype when a species is based on more than one specimen, all specimens on which the species is based are regarded as syntypes, including any labelled "type," and have equal status in nomenclature. Therefore, Yamaguti's specimen labelled "Type sp." does not have the status of holotype.

For the following reasons we believe it preferable to retain the name *R. zacconis* for the nematodes from *Z. platypus*: (1) *Z. platypus* is the type host, (2) the specific name is derived from the generic name of this host, (3) Yamaguti's description of the male pertains to specimens from *Z. platypus* (his collection does not contain any males from *L. reini*), and (4) his two figures (male posterior end, female anterior end) evidently are based on specimens from *Z. platypus*. (Yamaguti's brief description of the female is not diagnostic but, judging from the range of body lengths, is based on material from both host species.) We therefore propose that the name *R. zacconis* be applied to that species of *Rhabdochona* represented by Yamaguti's specimens from *Z. platypus* and we designate as its lectotype the male figured by him and now in the collections of the Meguro Parasitological Museum as no. 22326. The *Rhabdochona* species from *L. reini* needs to be redescribed and a new name proposed for it, but this should await collection of new, topotypic material including males.

Our material obtained from the cyprinid *Tribolodon hakuensis* is both morphologically and metrically in accordance with Yamaguti's specimens from *Z. platypus* and there is no doubt about their conspecificity. Yamaguti incorrectly reported the number of anterior teeth in the prostom as 12. The description of *R. zacconis* given above was based on specimens from *T. hakuensis*, because our new collections from *Z. platypus* contained only juveniles.

In some features this parasite of Japanese cyprinids resembles *R. oncorhynchi*, but differs from it distinctly in the type and somewhat smaller size of eggs, shape of the tail extremity, absence of basal teeth in the prostom, and number

of anterior prostomal teeth. Its closest relative is probably *R. canadensis*, recently described from cyprinid fishes from Alberta, Canada (Moravec and Arai, 1971). The two species differ distinctly only in the position of the deirids (more anterior relative to length of the vestibule in *R. canadensis)* and the shape of the distal end and width of the left spicule. (The width of this spicule in *R. canadensis* was not given in the original description; it is 0.06—0.09 mm at midlength.)

Acknowledgments

We wish to record our gratitude to Dr. Satoru Kamegai for the loan of the type material of *R. amago* and *R. zacconis* from Prof. Satyu Yamaguti's collections, and to Prof. H. Mori and Prof. K. Shimakura for the loan of some of the late Dr. T. Fujita's material of *R. fujii* and *R. salvelini.*

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MORPHOMETRIC NOTE ON CICHLASOMA NIGROFASCIATUM, C. SPILURUM AND THEIR HYBRIDS WITH NOTE ON C. CUTTERI (PISCES: CICHLIDAE)

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Abstract: 50 specimens of *Cichlasoma nigrofasciatum* (Günther, 1869), 3 specimens of *Cichlasoma spilurum* (Günther, 1862), 12 specimens of F_1 and 4 specimens of F_2 hybrids *Cichlasoma nigrofasciatum* x *Cichlasoma spilurum* and 10 specimens of hybrids between *Cichlasoma nigrofasciatum* and F_1 hybrid (*Cichlasoma nigrofasciatum* x *Cichlasoma spilurum*) from aquaria were examined with regard to 12 plastic and 9 meristic characters. Examined samples of specimens did not show any remarkable differences either in plastic or in meristic characters. Both species, *Cichlasoma nigrofasciatum*, *Cichlasoma spilurum* and 3 different hybrids differ from each other only in the coloration. Based on two specimens from aquaria, the validity of the species *Cichlasoma cutteri* Fowler, 1932 is discussed.

INTRODUCTION

The species *Cichlasoma nigrofasciatum* is now very common in the aquaria of Czechoslovak hobbyists, while *Cichlasoma spilurum* is rather rare. Xanthoric form of *Cichlasoma nigrofasciatum* was imported to Czechoslovakia in 1966 from the U. S. A. (Zukal, 1968). *Cichlasoma nigrofasciatum* and *Cichlasoma spilurum* are related species and they are classified by Regan (1905) within the genus *Cichlosoma*, section *Archocentrus*. Both species can product fertile hybrids (Frank, 1973; Stallknecht, 1979; Šamánek, 1971) in aquaria. The precise determination of both species and their hybrids is not easy. Specimens on the photographs published by Holly, Meinken, Rachow (1934—1967) and by Innes (1966) and designated as *Cichlasoma nigrofasciatum* agree with some hybrids between *Cichlasoma nigrofasciatum* and *Cichlasoma spilurum* described in this paper. Hykeš (1937) published two photographs with designation *Cichlasoma nigrofasciatum*, but one of his photos agrees with the same in Holly, Meinken, Rachow (1934—1967) and in Innes (1966).

According to Frey (1977) and Goldstein (1970), the name *Cichlasoma cutteri* is only the synonym of *Cichlasoma spilurum* and was used in aquarium literature for the species *Cichlasoma nigrofasciatum* — see Frey (1977).

MATERIAL AND METHODS

The measurements of plastic characters were made by means of dividers with the accuracy of ± 0.5 mm; the diameter of eye, the snout length, the length of postorbital part of the head, the interorbital width, the length and the depth of the caudal peduncle with the accuracy of ± 0.1 mm. Gill rakers, rows of scales and rays of fins were counted by use of binocular microscope. All examined specimens were preserved in 4% formalin or in spirit and before their death were kept in aquaria of fish hobbyists in Czechoslovakia.

Cichlids have two lateral lines, number of scales was counted separately. All measurements were made according to Regan (1905).

Table 1. Plastic Characters of *Cichlasoma nigrofasciatum*

Length group	Own data			Regan (1905)
	28—46	51—86	all specimens	43—82 mm TL
n	30	20	50	15
Body depth in % of body length	43 (36—53)	45 (38—52)	44 (36—53)	44—50
Head length in % of body length	36 (33—41)	33 (27—36)	35 (27—41)	33—36
Eye diameter in % of head length	29 (22—34)	26 (22—30)	28 (22—34)	29—36
Interorbital width in % of head length	33 (27—41)	44 (33—56)	37 (27—56)	31—38
Length of last dorsal spine in % of head length	38 (27—56)	43 (35—50)	40 (27—56)	40
Length of pectoral fin in % of head length	78 (67—90)	81 (52—96)	79 (52—96)	a little less than 100
Length of caudal peduncle in % of its depth	63 (52—75)	63 (42—85)	63 (42—85)	50—67
Snout length in % of length of postorbital part of head	90 (73—100)	106 (77—125)	96 (73—125)	les than 100

RESULTS AND DISCUSSION

Plastic characters of *Cichlasoma nigrofasciatum* are summarized in Table 1, meristic characters in Table 2. Considering plastic characters in bigger specimens (over 50 mm standard or body length), the interorbital width is wider and the snout longer than in smaller ones (under 50 mm standard length). Smaller specimens show tendency to lowering of the body depth, the height of the dorsal fin and the length of the pectoral fin and to increasing of the eye diameter and the head length. According to Regan (1905) there are no remarkable differences in the average of plastic characters. However, ranges of values of plastic characters given in this paper are greater than those given by Regan (1905), due probably to the higher number of specimens examined or aquarium life conditions. In meristic characters there are no remarkable differences among bigger and smaller specimens of *Cichlasoma nigrofasciatum*. Comparing data of Regan (1905) and Pellegrin (1903—1904) I found a smaller number of pectoral rays (but the first and the last pectoral rays are short, confluent and indistinct). Some lesser differences found in meristic characters among my material and the data of Regan (1905) and Pellegrin (1903—1904) can be explained by the larger number of specimens examined by me. The smaller number of scales in the lateral line I found is very interesting, the explanation lying possibly in the fact that I worked with aquaria specimens. The question of gill rakers is also of interest. Regan (1905) counted "7 or 8 gill rakers on lower part of anterior arch". On the "lower" part of the anterior arch I found 5 — 6 gill rakers, on the whole anterior arch 6—9 gill rakers (both numbers related to the number of gill rakers on the outer series of gill rakers of the first left arch). Unfortunately Regan (1905) did not inform of his method of gill rakers counting. Holly, Meinken, Rachow (1934—1967) and Hykeš (1937) used Regan's (1905) data. Sterba (1977), in his description, cited the following formula: D XVII/7—8, A IX/6, P 13—14, scales in the longitudinal row 29—30; Frey (1977) D XVII—XVIII/8—9, A VIII—X/

Table 2. Meristic Characters of *Cichlasoma nigrofasciatum*

	Own data			Pellegrin (1903–1904)	Regan (1905)
Length group	28–46 SL	51–86 SL	all specimens		43–82 mm TL
n	30	20	50	–	15
Scales in lateral lines	18/9 (16–20/6–10)	19/10 (17–20/8–12)	19/9 (16–20/6–10)	21/11	
Scales above 1st lateral line	4 (4– 5)	4 (4– 5)	4 (4– 5)	$3^1/_2$	4
Scales below 1st lateral line	10 (10–11)	11 (10–12)	10 (10–12)	10–11	11–12
Scales between lateral line and origin of soft part of dorsal fin	2	2	2	–	$2–2^1/_2$
Scales in longitudinal row	29 (26–31)	29 (26–31)	29 (26–31)	27–29	28–31
Rays in dorsal fin	XVIII/10 (XVII–XIX/8–10)	XVIII/10 (XVI–XIX/8–10)	XVIII/10 (XVI–XIX/8–10)	XVIII/8	XVII–XVIII/8–9
Rays in anal fin	IX/9 (VIII–IX/8–10)	IX/8 (VIII–X/7–10)	IX/8 (VIII–X/7–10)	X/7	VIII–X/6–8
Rays in pectoral fin	14	14	14	12	–
Gill rakers on the lower part of anterior arch	5	5 (5–6)	5 (5–6)	6–7	7–8
Gill rakers total on the anterior arch	8 (6–9)	8 (6–9)	8 (6–9)	–	–

Table 3. Plastic Characters of *Cichlasoma spilurum*

Length group n	Own data 36—43 mm SL 3	Günther (1862) — —	Regan (1905) 75—92 mm TL 5
Body depth in % of body length	40 (39—42)	50	50
Head length in % of body length	35 (33—37)	nearly 33	33
Eye diameter in % of head length	30 (29—33)	—	33
Interorbital width in % of head length	31 (29—33)	29	33—38
Length of last dorsal spine in % of head length	40 (34—44)	—	50—60
Length of pectoral fin in % of head length	80	less than 100	100 or more
Length of caudal peduncle in % of its depth	52 (39—61)	—	50—67
Snout length in % of length of postorbital part of head	89 (75—100)	—	100 and more

/7—9. The coloration of formalin specimens examined, transferred after several years into alcohol, is yellowish (in specimens under 50 mm body length) up to brownish (in specimens over 50 mm body length) with 8—9 brown-black vertical bars. The first bar is on the top of the head and it is indistinct. The second and the fourth bars are almost confluent into a shape of the "Y" letter. Between the second and the fourth bar at the origin of the dorsal fin there is the third bar forming only a spot. The last one is on the distal part of the caudal peduncle. The fourth bar is often interrupted. The 4th—7th (8th) bars continue on the dorsal fin, the 5th— 7th (8th) continue on the anal fin. Fins are whitish in small specimens (under 50 mm body length). In bigger specimens (over 50 mm body length) the pectoral and caudal fins are whitish; dorsal, ventral and anal fins are yellow-brownish to black. Six of the specimens examined represented the xanothoric form. These preserved specimens have been uniformly light yellow with whitish fins. For the coloration of both forms of this species see Fig. 1, 2. My living specimens of *Cichlasoma nigrofasciatum* are greyish with dark grey (mostly in males) or black (mostly in females in breeding colour) cross bars form described in Fig. 10. Pectoral fins are whitish; dorsal, anal and ventral ones greyish, in females often with green. Caudal fin greyish. Iris brownish to greyish. Mature females have a large orange spot on the abdominal part of the body. Specimens of colour pattern described here agree, according to Hyke š (1937), with Günther's description of the species. Specimens of the xanthoric form do not differ from specimens of the normal form either in plastic or in meristic characters. Both groups were therefore joined in common tables.

Plastic characters of *Cichlasoma spilurum* are summarized in Table 3, meristic ones in Table 4. In comparison with Gunther (1862) and Regan (1905) specimens examined by me have the body depth and the dorsal fin lower and the snout length shorter. In meristic characters there are some small differences in comparison with Günther (1862), Pellegrin (1903—1904) and Regan (1905), probably due to smaller number of specimens examined. The same is the problem of gill rakers counting as in *Cichlasoma nigrofasciatum*. Regan (1905) distinguishes *Cichlasoma nigrofasciatum* from *Cichlasoma spilurum* only be the snout length. In *Cichlasoma nigrofasciatum*, "Snout considerably

Table 4. Meristic Characters of *Cichlasoma spilurum*

Length group n	Own data 36–43 mm SL 3	Günther (1862) – –	Pellegrin (1903–1904) – –	Regan (1905) 75–92 mm TL 5
Scales in lateral lines	16/7 (14–17/6–7)	–	18–21/9–12	–
Scales above lateral line	5–6	4½	4½	5½
Scales below lateral line	12 (11–12)	11	11–13	12–13
Scales between lateral line and origin of soft part of dorsal fin	2	–	–	2–2½
Scales in longitudinal row	29 (26–30)	31	28–29	28–30
Rays in dorsal fin	XVIII/9	XVIII/10	XVIII/8–10	XVIII–XIX/9–10
Rays in anal fin	IX/8 (IX/7–8)	VIII–IX/7–8	VIII–X/7–8	VIII–IX (X)/7(8)
Rays in pectoral fin	14	–	14	–
Gill rakers on the lower part of anterior arch	6	–	6–7	6–7
Gill rakers total on the anterior arch	9 (8–9)	–	–	–

Table 6. Meristic Characters of F_1 Hybrids between *Cichlasoma nigrofasciatum* and *Cichlosoma spilurum*

Body length *n*	Normal form of *Cichlasoma nigrofasciatum* × *Cichlasoma spilurum* 45–67 mm 7	Xanthoric form of *Cichlasoma nigrofasciatum* × *Cichlasoma spilurum* 58–71 mm 5	F_1 hybrids alltogether 45–71 mm 12
Scales in lateral lines	18/9 (16–18/7–11)	19/9 (16–20/7–10)	18/9 (16–20/7–11)
Scales above 1st lateral line	4 (4– 5)	4 (4– 5)	4 (4– 5)
Scales below 1st lateral line	12 (11–13)	13 (12–14)	12 (11–14)
Scales between lateral line and origin of soft part of dorsal fin	2	2 (2– 3)	2 (2– 3)
Scales in longitudinal row	28 (26–29)	30 (29–31)	29 (26–31)
Rays in dorsal fin	XVIII/10 (XVII–XIX/8–10)	XVIII/10 (XVIII/9–11)	XVIII/10 (XVII–XIX/8–11)
Rays in anal fin	VIII/9 (VIII–IX/7–10)	IX/8 (VIII–IX/7–8)	VIII/9 (VIII–IX/7–10)
Rays in pectoral fin	14 (14–15)	14	14 (14–15)
Gill rakers on the lower part of anterior arch (outer serie)	6 (5– 7)	6	6 (5– 7)
Gill rakers total on the anterior arch (outer serie)	9 (7– 9)	9 (8–10)	9 (7–10)

Table 5. Plastic Characters of F_1 Hybrids between *Cichlasoma nigrofasciatum* and *Cichlasoma spilurum*

Body length n	Normal form of *Cichlasoma nigrofasciatum* × *Cichlasoma spilurum* 45—67 mm 7	Xanthoric form of *Cichlasoma nigrofasciatum* × *Cichlasoma spilurum* 58—71 mm 5	F_1 hybrids alltogether 45—71 mm 12
Body depth in % body length	46 (43—48)	44 (41—48)	45 (41—48)
Head length in % of body length	33 (31—34)	33 (31—34)	33 (31—34)
Eye diameter in % of head length	28 (26—29)	28 (26—32)	28 (26—32)
Interorbital width in % of head length	41 (38—43)	37 (33—41)	39 (33—43)
Length of last dorsal spine in % of head length	50 (43—57)	47 (42—53)	49 (42—57)
Length of pectoral fin in % of head length	91 (86—95)	83 (72—88)	88 (72—95)
Length of caudal peduncle in % of its depth	54 (45—58)	56 (51—64)	55 (45—64)
Snout length in % of length of postorbital part of head	95 (79—102)	110 (100—121)	101 (79—121)

shorter than postorbital part of head"; in *Cichlasoma spilurum*, "Snout as long or longer than postorbital part of head". My specimens of *Cichlasoma spilurum* have their snouts shorter than *Cichlasoma nigrofasciatum*. There are no differences available for a reliable determination of both species in plastic and in meristic characters as well as in the number, size and shape of teeth between specimens of *Cichlasoma nigrofasciatum* and *Cichlasoma spilurum* examined by me. The arrangement and form of teeth was studied, but the number of rows of teeth and their coloration in various specimens of both species as well as hybrids does not show any differences which could be used for determination. In younger specimens of *Cichlasoma nigrofasciatum* the number of teeth and also their rows visible is smaller than in older ones, and simultaneously in older specimens teeth have darker (reddish-brown) tips. Only in average of the length of the caudal peduncle in proportion to its depth there is a bigger difference. *Cichlasoma spilurum* has the caudal peduncle relatively shorter than *Cichlasoma nigrofasciatum* (*Cichlasoma spilurum* average 52, *Cichlasoma nigrofasciatum* average 63). In the averages of meristic characters there are smaller differences in scales in the lateral line, above and under the lateral line. Interesting is the comparison of my specimens from aquaria and specimens from nature studied by F o w l e r (1932). I found 9 spines in the anal fin, F o w l e r (1932) 7—8 (in average 8) spines. I have ascertained that only gill rakers in *Cichlasoma nigrofasciatum* are a little shorter and thicker than in *Cichlasoma spilurum*. Coloration of preserved specimens of *Cichlasoma spilurum* (Fig. 3) is yellow-brown with 10 indistinct brown cross bars. The 3rd—5th bars interfere with the dorsal fin. Bars are not interrupted or confluent. It is evident that only in the coloration there are remarkable differences between *Cichlasoma spilurum* and *Cichlasoma nigrofasciatum*. Living male of *Cichlasoma spilurum* is shown on Fig. 9. Meristic characters of *Cichlasoma spilurum* given by S t e r b a (1977) are the following: D XVIII/8—10, A VIII—X/7—8, scales in the lateral row 28—29; and by F r e y (1977) D XVIII—XIX/10,

Table 7. Plastic and Meristic Characters of F_2 Hybrids between *Cichlasoma nigrofasciatum* and *Cichlasoma spilurum*

Body length n	49—61 mm 4
Body depth in % of body length	45 (44—47)
Head length in % of body length	34 (32—36)
Eye diameter in % of head length	27 (25—29)
Interorbital width in % of head length	38 (36—40)
Length of last dorsal spine in % of head length	48 (44—53)
Lengt of pectoral fin in % of head length	84 (77—94)
Length of caudal peduncle in % of its depth	59 (51—70)
Snout length in % of length of postorbital part of head	99 (97—100)
Scales in lateral line	19/10 (17—20/9—11)
Scales above lateral line	4
Scales below lateral line	13 (12—13)
Scales between lateral line and origin of soft part of dorsal fin	2
Scales in longitudinal row	29 (28—30)
Rays in dorsal fin	XVIII/9 (XVIII/8—10)
Rays in anal fin	IX/8 (VIII—IX/8—9)
Rays in pectoral fin	14
Gill rakers on the lower part of anterior arch (outer series)	6 (6— 7)
Gill rakers total on the anterior arch (outer series)	9 (8—10)

A IX/8. Specimens from nature examined by Miller (1907) showed D XVII—XVIII/9—11, A VIII—IX/7—9, scales 5—6, 27—30, 12—13, head length 31—36 % of body length, body depth 38—59 % of body length, eye diameter 25—41 % of head length, pectoral fin length 77—100 % of head length.

Fanciers are crossing both species. Concerning this problem:

1. F_1 hybrids between *Cichlasoma spilurum* and *Cichlasoma nigrofasciatum*. Plastic characters are given in Table 5, meristic characters in Table 6. I have two groups of F_1 hybrids: *Cichlasoma nigrofasciatum* normal form × *Cichlasoma spilurum* and *Cichlasoma nigrofasciatum* xanthoric form × *Cichlasoma spilurum*. Two examined groups of hybrids differ in the snout length, in the length of the pectoral fin and in the number of scales in the longitudinal row. Hybrids F_1 are altogether intermediate. In the body depth, eye diameter, interorbital width and scales in the lateral line they are nearer to *Cichlasoma nigrofasciatum*, in the length of caudal peduncle and in the number of gill rakers nearer to *Cichlasoma spilurum*. F_1 hybrids differ from *Cichlasoma nigrofasciatum* and *Cichlasoma spilurum* in the length of the last dorsal spine and in the length of the pectoral fin. Hybrids of F_1 generation have in average the higher dorsal fin and the longer pectoral fin. Between the two examined groups of F_1 hybrids there are some interesting differences, but limited material does not allow any solid investigation. Coloration of F_1 hybrids is yellow-brown with 8 cross bars in dark brown. The first bar it indistinct, the second and the third are interrupted. The last bar is on the distal end of the caudal peduncle. The 3rd—7th bars interfere with the dorsal fin. Bars do not reach to the abdomen and the anal fin. Fins are greyish or greyish-black. F_1 hybrids between *Cichlasoma spilurum* and xanthoric form of *Cichlasoma nigrofasciatum* have all cross bars indistinct, see Fig. 5, 7; living F_1 hybrids on Fig. 11, 12.

2. F_2 hybrids between *Cichlasoma nigrofasciatum* and *Cichlasoma spilurum*. Plastic characters and meristic ones are summarized in Table 7. These hybrids are similar to F_1 hybrids in plastic characters (the length of the last dorsal

Table 8. Plastic and Meristic Characters of Hybrids between xanthoric female of *Cichlasoma nigrofasciatum* and male of F_1 (*Cichlasoma nigrofasciatum* × *Cichlasoma spilurum*)

Body length n	36—57 mm 10
Body depth in % of body length	45 (41—52)
Head length in % of body length	34 (30—38)
Eye diameter in % of head length	31 (26—35)
Interorbital width in % of head length	42 (34—46)
Length of last dorsal spine in % of head length	46 (42—52)
Length of pectoral fin in % of head length	85 (73—88)
Length of caudal peduncle in % of its depth	60 (51—67)
Snout length in % of postorbital part of head	94 (83—104)
Scales in lateral line	18/9 (16—20/7—10)
Scales above lateral line	4 (4— 5)
Scales below lateral line	12 (11—13)
Scales between lateral line and origin of soft part of dorsal fin	2
Scales in longitudinal row	28 (26—30)
Rays in dorsal fin	XVIII/10 (XVII—XIX/7—11)
Rays in anal fin	IX/8 (VII—X/7—9)
Rays in pectoral fin	15 (14—15)
Gill rakers on the lower part of anterior arch (outer series)	5 (4— 6)
Gill rakers total on the anterior arch (outer series)	7 (6— 8)

spine and the length of the pectoral fin). Coloration: 8 dark brown bars cross the body on the yellowis-brown ground colour. The first, the second and the third bars are indistinct (Fig. 6). When the 2nd and 3rd bars are marked, they are connected in a "Y" shape. The fourth bar is well separated from the third and the second ones. Fins greyish or greyish-black. Some of these specimens coincide with the specimens designated as *Cichlasoma nigrofasciatum* in the photographs given by Holly, Meinken, Rachow (1934—1967), Hykeš (1937) and Innes (1966). According to Hykeš (1937) specimens with this colour pattern were imported in 1933 to U. S. A. and Germany and they were designated as *Cichlasoma nigrofasciatum*.

3. Hybrids between *Cichlasoma nigrofasciatum*. Xanthoric female and male of F_1 hybrid between *Cichlasoma nigrofasciatum* and *Cichlasoma spilurum*. Plastic and meristic characters in Table 8. These hybrids are nearer to *Cichlasoma nigrofasciatum* in the number of gill rakers, in the snout length and in the shape of the caudal peduncle. The dorsal fin is higher and the pectoral fin longer than in *Cichlasoma nigrofasciatum* and *Cichlasoma spilurum* (both values in averages). The coloration is similar as in *Cichlasoma nigrofasciatum*, often with the typical dark spot on the orgin of the dorsal fin (equal to the third cross bar) — Fig. 8. The 4th bar is well separated from previous ones. Interesting is here the number of rays in the pectoral fin.

Frank (1973) reports that females of all described hybrids between *Cichlasoma spilurum* and *Cichlasoma nigrofasciatum* have not the orange spot on the abdominal part of the body, typical of females of *Cichlasoma nigrofasciatum*.

The stock of cichlids kept in aquaria and named *Cichlasoma nigrofasciatum* here is very variable in coloration. Interrupted or indistinct vertical cross bars occur, similarly as in hybrids of *Cichlasoma nigrofasciatum* and *Cichlasoma spilurum*. Cichlids designated as *Cichlasoma nigrofasciatum* in Czechoslovakia

Table 9. Plastic and Meristic Characters of *Cichlasoma cutteri*

Body length n	Own data 73—85 mm 2	Fowler (1932) 33—112 mm —
Body depth in % of body length	49 (45—53)	48—50
Head length in % of body length	31 (30—32)	33—43
Snout length in % of head length	45 (44—45)	29—50
Eye diameter in % of head length	28 (27—28)	20—40
Eye diameter in % of snout length	61 (60—62)	38 and more
Length of third dorsal ray in % of head length	103 (95—111)	100—113
Height of spinous dorsal fin in % of head length	52 (44—59)	44—47
Length of third anal ray in % of head length	83 (73—93)	83—100
Height of spinous anal fin in % of head length	46 (41—50)	50
Length of pectoral fin in % of head length	88 (81—95)	89—91
Length of ventral fin in % of head length	86 (85—86)	89
Least caudal peduncle depth in % of head length	47 (44—50)	45—50
Scales in lateral line	17/—	18—20/10—11
Scales above lateral line	7 (6—7)	7
Scales below lateral line	15	—
Scales between lower part of lateral line and origin of soft part of anal fin	6	7
Predorsal scales	14 (13—14)	13—14
Scales between lateral line and origin of soft part of dorsal fin	2	—
Scales in longitudinal row	29	—
Rows of scales on cheek	7	6—7
Rays in dorsal fin	XVIII/10 (XVIII/9—10)	XVIII—XIX/10, I
Rays in anal fin	VIII/9 (VIII/8—9)	IX/8, I
Rays in pectoral fin	15	—
Rays in ventral fin	6	—
Gill rakers total on the anterior arch	9	3 + 7

(probably in the world as well — see Holly, Meinken, Rachow, 1934—1967; Innes, 1966) may in many cases be hybrids of various generations between *Cichlasoma nigrofasciatum* and *Cichlasoma spilurum*.

Cichlasoma cutteri Fowler, 1932 is, according to Frey (1977) and Goldstein (1970), identical with *Cichlasoma spilurum* (Günther, 1862), but the Fowler's (1932) description is not the same as the description of *Cichlasoma spilurum* given by Günther (1862) and Regan (1905, 1906—1907). I found two specimens which have plastic nad meristic characters corresponding well to Fowler's (1932) description. These specimens have more, relatively thicker and shorter, gill rakers and a higher number of scales above and under the lateral line and the higher number of pectoral rays than *Cichlasoma spilurum*. Preserved formalin-alcohol specimens (Fig. 4) are brownish, with 5 or 6 indistinct somewhat darker cross bars in the similar manner as in the picture of Fowler (1932). Comparison of plastic and meristic characters of my specimens with Fowler's (1932) description of *Cichlasoma cutteri* is given in Table 9. Hykeš (1937) used Fowler's (1932) data, Sterba (1977) shows

D XVIII—XIX/10, A IX—XI/8, P 15, scales in lateral row 32—33. According to Hykeš (1937), Roszak (1953) and Stoye (1935), in *Cichlasoma cutteri* the iris is green, blue green or golden. The iris of *Cichlasoma spilurum* is greyish-brown. Fowler (1932) found *Cichlasoma cutteri* in Costa Rica, Stoye (1935) obtained specimens of *Cichlasoma cutteri* from La Ceiba (Honduras).

SUMMARY

The problem of correct species designation of *Cichlasoma nigrofasciatum* and *Cichlasoma spilurum* and of their different hybrids, was studied with regard to plastic and meristic characters. Unfortunately, only aquarium specimens could be used. Data obtained were compared with published descriptions of both species. *Cichlasoma nigrofasciatum* differs from *Cichlasoma spilurum* reliably only in coloration. Small differences were found in some averages of plastic and meristic characters and in the shape of gill rakers. Hybrids of different grades between the two species mentioned are intermediate, but nearer to *Cichlasoma nigrofasciatum*. Many specimens of fish designated generally as *Cichlasoma nigrofasciatum* in the aquarium literature can be hybrids of different generations between *Cichlasoma nigrofasciatum* and *Cichlasoma spilurum*. Their identification is not easy, but specimens with the 2nd and 4th cross bars in the Y letter shape wiht the spot (equal to the 3rd bar) on the base of the dorsal fin are supposed to belong to *Cichlasoma nigrofasciatum;* specimens with the 2nd, 3rd and 4th cross bars irregular, absent or with the 2nd and 3rd bars connected, are probably hybrids between *Cichlasoma nigrofasciatum* and *Cichlasoma spilurum*. Specimens with regular cross bars without the spot on the origin of the dorsal fin are probably *Cichlasoma spilurum* or *Cichlasoma cutteri*, which differ from each other in some meristic characters (the number of pectoral rays, scales below and above the lateral line and shape of gill rakers).

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The figures will be found at the end of this issue

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EFFECT OF COMPLEXITY ON EXPLORATION IN THE WILD RAT BANDICOTA BENGALENSIS

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Abstract: Exploratory responses of Indian mole rat *Bandicota bengalensis* (Gray) to artificial environments, the + — and I-mazes, were recorded. The number of visits made to arms by each individual were noted for a 5 minute period daily. It was found that the complexity of maze resulted in a greater level exploration and vice versa.

INTRODUCTION

Exploration is quickly induced in wild or laboratory rats when unfamiliar areas are made accessibe to them (Berlyne, 1960; Barnett, 1963 and Greaves & Rowe, 1969). They move about the whole area to get information which they may use later (Barnett, 1975). Further, it has been observed from maze experiments (Montgomery, 1951) that the intensity of exploration is influenced by the complexity of the maze.

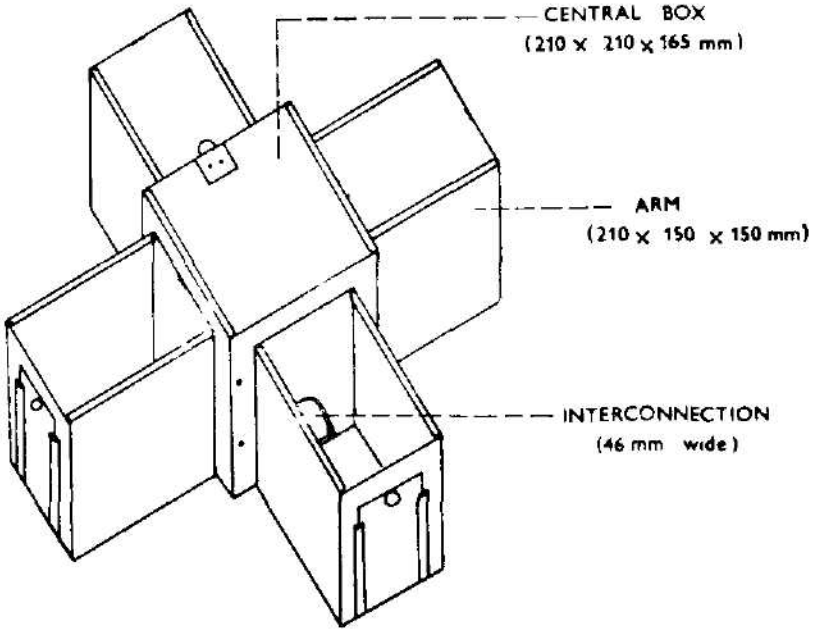

Fig 1. The plus maze. Arms are covered with transparent glass and the central box with an opaque lid.

The present study deals with the exploratory responses to two different maze types by the Indian mole rat *Bandicota bengalensis* (Gray). Information of this nature is not available for this species even though it has nation-wide importance as economic rodent pest.

MATERIAL AND METHODS

Ten adult individuals (males with body weight 331.67 ± 56.6 g) were randomly divided into two groups and were studied in the artificial environments, the +— or I-mazes. Each group consisted of five individuals trapped from the crop fields of Punjab Agricultural University, Ludhiana. They were kept in isolation in small cages during the whole period of experiment.

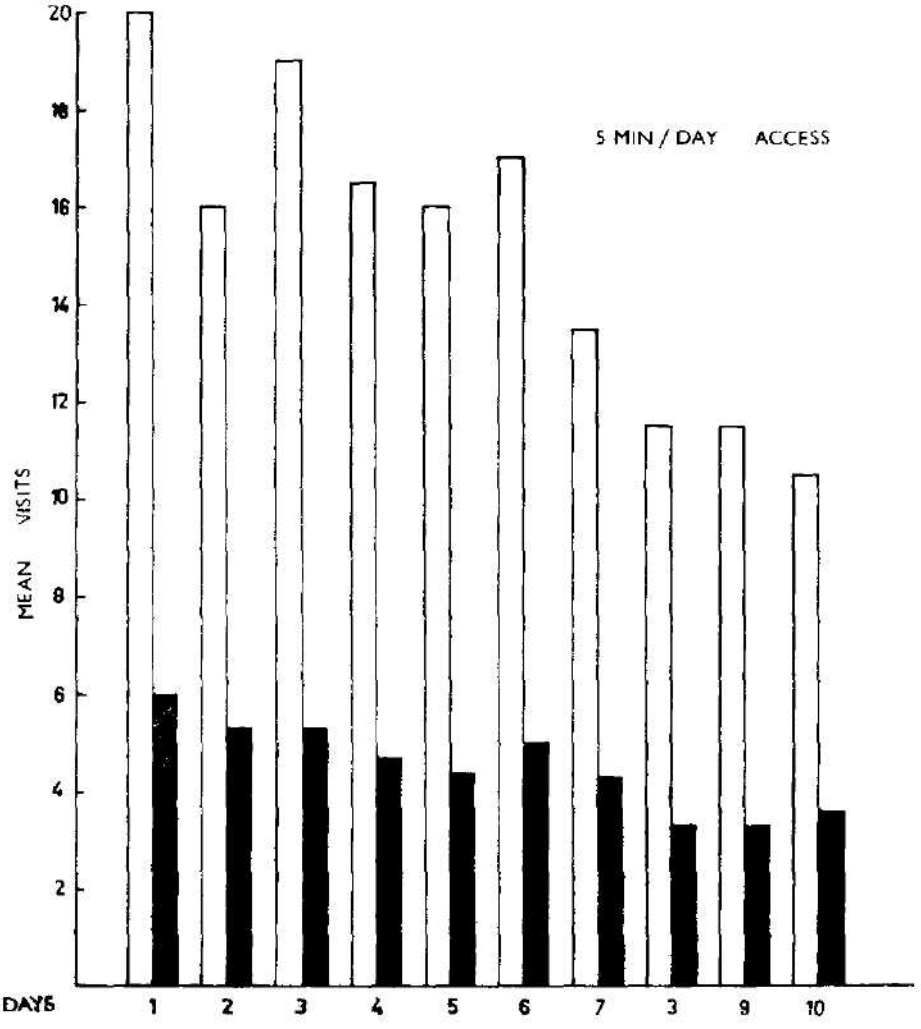

Fig. 2. Mean number of visits to arms by rats of group 1 (□ +— maze) and group 2 (■ I-maze).

The +— maze (Fig. 1) had a central square box (21 × 21 × 16.5 cm) with four radiating arms (each 21 × 15 × 15 cm) perpendicular to each other. The arms had interconnections (each 4.6 cm wide) with the central box for the rat to enter from nest to arms. The distal ends of arms and interconnections were equipped with sliding door arrangements. The arms were roofed with transparent glass plates and the central box with an opaque lid. The entry to two opposite arms of the +— maze was blocked to study the individual's activity in I-maze. Visits made to each arm were recorded for each individual by means of a stop watch.

The cages and maze were kept in an air-conditioned laboratory with 12 hr light-dark cycle. The individuals were fed in cages with ad libitum food (Wheat, *Triticum aestivum*) and water at all times.

During the test period, each individual was put in the central box of maze and visits to arms were observed for a 5 minute period daily. For 10 days, the individuals of group 1 and 2 were observed in +— and I-mazes respectively. Thereafter, the rats of group 1 were observed in I-and +— mazes successively, each for 10 days. Special care was taken to see that the animal was not disturbed while recording.

RESULTS AND DISCUSSION

Rats of both groups displayed more visits during the first two or three days, thereafter a decline followed (Fig. 2). The visits in +— and I-mazes were significantly different ($p < 0.01$) between the groups 1 & 2 (Group 1 $\bar{x} = 15.15$,

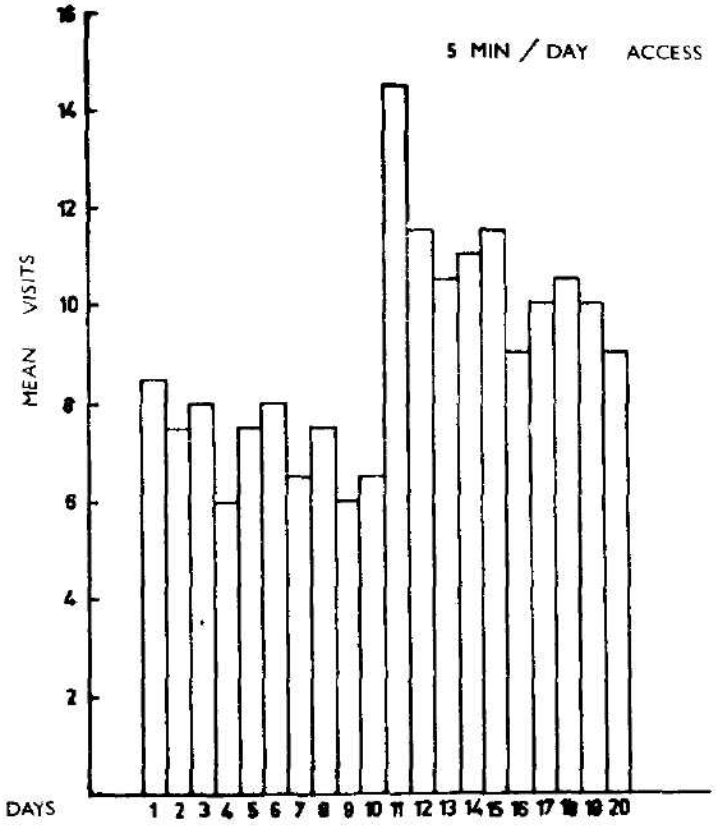

Fig. 3. Histogram of mean visits to arms by rats of group 1 in I-maze (1 to 10 days) and +— maze (11 to 20 days).

SE = 1.03 & group 2 $\bar{x}$ = 4.49, SE = 0.3037) although daily individual variations occurred. Even in group 1 +— and I-maze visits were significantly ($p < 0.01$) different (I-maze = 7.2, SE = 0.28 & +— maze = 10.75, SE = 0.50. See Figs. 3 & 4).

Novelty induces exploration (Harlow, 1953 & Berlyne, 1960). This may be due to excitation of central nervous system via exteroreceptors, caused by the discrepancy between familiar environment (small animal cage) and novel environment (maze). The animal's responsiveness is rather high on the first 2 or 3 days as it tends to investigate actively all parts of the novel environment accessible (Barnett, 1963; Hinde, 1970 & Cowan, 1977) and gets more accurate information about the environment which may be useful to it later. The response fades when the same environment stimulus is repeated to which gradual nervous habituation of the individual develops. It may result in the formation of "neuronal model" (Sokolov, 1960) of the environment in its brain system. With this model the individual compares information received by making occasional visits to the novel environment (although rewardless) even after acclimatisation. By this inquisitiveness the individual recognises

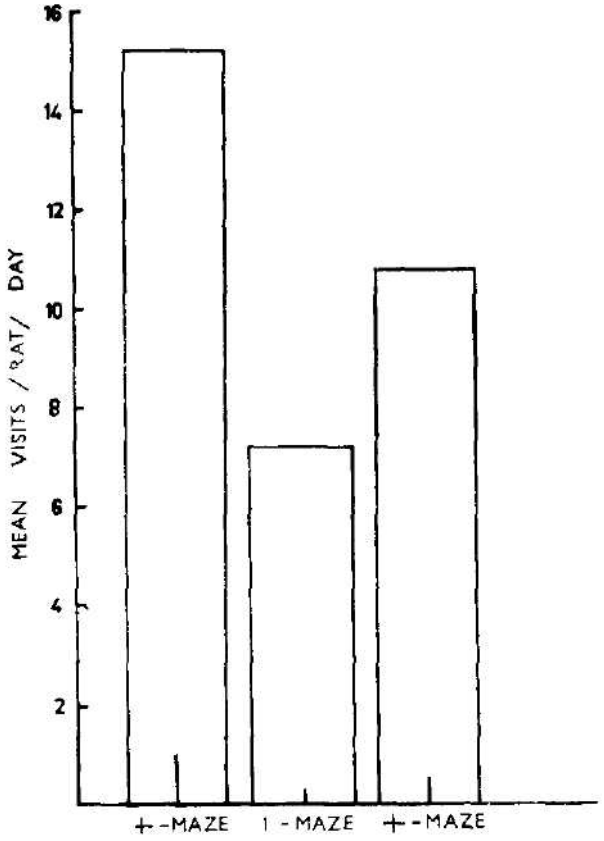

Fig. 4. The effect of complexity on exploration of *B. bengalensis* (Group 1). Vertical bars are ± SE of means.

immediately any minor change in its familiar environment. Hence, it scans the whole familiar area on every occasion. Thus the visits to arms have been more frequent in complex mazes than in simple ones.

Our observations suggest that the level of exploration is higher in complex mazes than in simple ones.

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AGE STRUCTURE OF CZECHOSLOVAK POPULATIONS OF ERINACEUS EUROPAEUS AND ERINACEUS CONCOLOR (INSECTIVORA: ERINACEIDAE)

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A b s t r a c t: The age structure of Czechoslovak hedgehog populations (213 specimens of *E. europaeus*, 162 specimens of *E. concolor*) has been classed according to tooth-wear. Mortality curves and the annual rate of survival had been calculated on the basis of the known composition of age in populations of both species. Although, according to conclusive evidence, the hedgehog in the field can attain the age of 6 years, very few animals of a population of *E. europaeus* (3.5 %) reach the age of 6- and more years. A difference was observed in the mortality rate of the two species, namely in that the rate of survival of adult *E. europaeus* was higher by 4.4 % than that of *E. concolor*, and the age structure of this species was shifted towards older age groups. A remarkable change in the age structure of the population occurred in the second half of the year due to the appearance of age group O. Also the rate of mortality changed greatly in the individual age groups in the course of the year in that mortality of older age groups increased in the first half of the year and in the second half there was a very high mortality in age group O.

There is surprizingly little knowledge of the age structure of populations of *E. europaeus* and *E. concolor*, although both species are among the most common insectivores of Czechoslovakia. More recently, this subject has been treated by K r a t o c h v í l (1975) and by the present author (Š k o u d l í n 1976) in an attempt to use tooth-wear as a criterion of age. Owing to a scarcity of information on the age structure, the present study has been undertaken for the purpose of giving at least a general idea of the age structure in populations of two Czechoslovak species of the genus Erinaceus.

MATERIALS AND METHODS

Our material collected in Bohemia and Moravia consisted of 215 (44 juvenile) specimens of *E. europaeus*, and 162 (25 juvenile) specimens of *E. concolor*. Using tooth-wear as a criterion of age, we divided our material in age groups as described in an earlier paper (Š k o u d l í n 1976). The young born in the calendary year of birth were placed in age group 0, adults were placed in 5 groups in agreement with the age categories. In order to emphasize interspecific differences in the age structure of "annual samples", individuals of age group V with more tooth abrasion than normal for a 5 year-old specimen were placed in group VI regardless of the amount of surplus abrasion.

Mortality curves were calculated by means of an exponential relationship (O d u m 1977) showing a decrease in population abundance in relation to time, and expressed by the equation $y = k \cdot e^{ax}$, modified to $\log y = \log k + x.\ a.\ \log e$. The convenience of this relation in a population study was tested by means of the correlation coefficient (r). The annual rate of survival $S = \sum_{i=2}^{n} Ni / \sum_{i=1}^{n-1} Ni$ was calculated with Ni as the abundance of the i-th group. ($A = 1 - S$ applies to the annual mortality rate). Instantaneous mortality (Z) for $t = 1$ was $Z = -\log_e S$.

Table 1. Age structure of Czechoslovak populations of *Erinaceus europaeus* and *Erinaceus concolor*

Age group	*E. europaeus*	*E. concolor*
I	29.2 %	31.4 %
II	23.4 %	22.6 %
III	19.9 %	19.7 %
IV	17.0 %	17.5 %
V	7.0 %	8.8 %
VI	3.5 %	—

AGE STRUCTURE OF POPULATIONS

In order to maintain that the age structure of the sample to be evaluated is identical to that of the whole population, it has to be assumed that no age group had been preferred during the collection of samples. If the absolute number of individuals in each age group is given in percentages of the total number, it is possible to obtain a picture of the age structure in Czechoslovak hedgehog populations (Table 1). As indicated by the results of our analysis, the hedgehog in the wild can attain an age of 6 and more years, but the number of animals of this age is very limited in a population. In our material it amounted to 3.5 % of adults for *E. europaeus*, while there was no animal of this age found in a population of *E. concolor*. Our values indicate certain differences in the mortality rate of the two species which evidence themselves in a slightly different age structure of their populations. As shown in Table 1, the rate of mortality was lower in the individual age groups of *E. europaeus* in comparison with a higher rate in those of *E. concolor*. The difference was more marked

Table 2. Parameters of the mortality courves

	Age group	k	a	r
E. europaeus (present study)	I—V	38.5	−0.237	−0.939
E. concolor (present study)	I—V	42.8	−0.280	−0.944
E. europaeus (Kratochvíl 1975)	I—V	95.3	−0.636	−0.964
E. concolor (Kratochvíl 1975)	I—V	176.3	−0.956	−0.970
E. europaeus A (present study)	I—V	51.4	−0.359	−0.948
E. europaeus B (present study)	0—V	33.6	−0.226	−0.918
E. europaeus A (Kratochvíl 1975)	I—V	94.4	−0.621	−0.936
E. europaeus B (Kratochvíl 1975)	0—V	42.1	−0.273	−0.975
E. concolor A (Kratochvíl 1975)	I—V	154.4	−0.901	−0.973
E. concolor B (Kratochvíl 1975)	0—V	62.2	−0.442	−0.926

A) 1th half of the year
B) 2nd half of the year

Table 3. Age structure of Czechoslovak population of *Erinaceus europaeus* in the first (A) and the second (B) half of the year

Age group	A	B
0	—	32.8 %
I	30.9 %	18 7 %
II	26.9 %	14.2 %
III	23.1 %	13.4 %
IV	11.5 %	12.0 %
V	7.6 %	8.9 %

if we calculated the curve of mortality for the known age structure in populations of both species on the basis of an exponential relations. (For parameters see Table 2).

Both the different steepness and the position of straight lines in a semilogarithmic illustration of the pertinent dependence indicated a slight shift towards older age groups in the age structure of populations of *E. europaeus* in comparison with that of *E. concolor* (Fig. 1). There was also a different rate of survival which was indirectly proportionate to mortality. For *E. europaeus*, the annual rate of survival of age groups I—V was 77 1 %, for *E. concolor* 72.7 %, i. e., a rate of survival higher by 4.4 % in all age groups of *E. europaeus*.

So far, data on the age structure of populations are available for age groups I—V (VI), i. e., for adults, but not for the young of the calendary year of birth, thus giving roughly a picture of the age structure of a population for the first half of the year in which animals of group O are absent. The young appearing at large in the second half of the year change this picture considerably. We have illustrated this change in the age structure on a population of *E. europaeus* which was more abundant in our material (Table 3).

An interesting feature emerging from our results was the higher rate of mortality of age groups I—V of *E. europaeus* (A = 0.30) in the first half of the year than that of age groups 0—V in the second half of the year (A = 0.23).

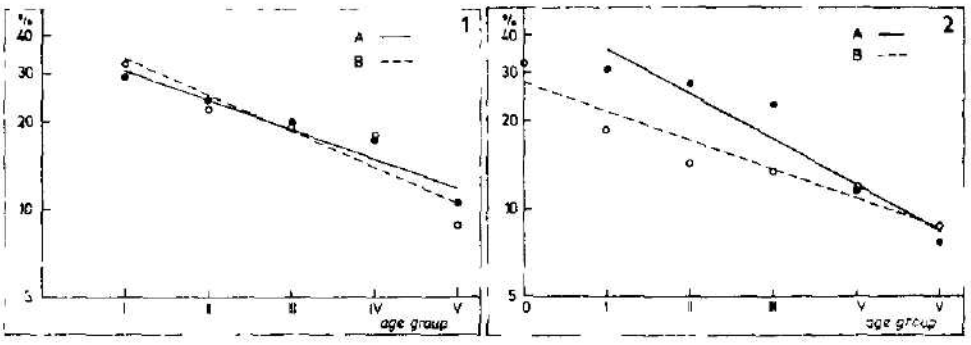

Fig. 1. Mortality curves of the Czechoslovak populations of *Erinaceus europaeus* (A) and *Erinaceus concolor* (B) for age groups I—V. Figures 1—5 are in the semilogarithmic transformation.
Fig. 2. Mortality curves of the Czechoslovak population of *Erinaceus europaeus* for the first (A) and second (B) half of the year.

However, as indicated by Fig. 2, there was no uniformity in the rate of mortality in the individual age groups, and an average rate of mortality only was obtained from straight lines in the figure. Losses were higher in older age groups at the beginning of the year, in the second half of the year there was a high mortality of age group O (A = 0.43). In order to complete the picture we calculated the instantaneous rate of mortality (Z = 0.564).

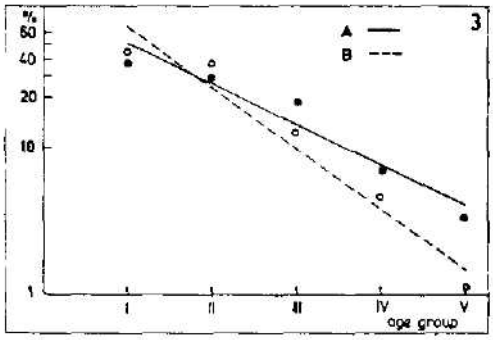

Fig. 3. Mortality curves of the Czechoslovak populations of *Erinaceus europaeus* (A) and *Erinaceus concolor* (B) for age groups I–V (according to Kratochvíl's (1975) data).

DISCUSSION

We evaluated our material under the assumption that the age structure in our sample was close to the actual representation of age groups in the whole population. In order to obtain a representative sample of a well-balanced population in which relations among the individual age groups did not change appreciably in the course of the year, it is essential to collect animals regularly throughout the year and to avoid any selectivity in the collection of the individual age groups. It was necessary to consider a number of factors which might interfere with the ideal state in the evaluation of our results. A major deterrent to a proportionate collection of age groups was the time of the incidence of members of age group 0. In the wild, they appeared as late as in the second half of the year (Kratochvíl 1975) and therefore had only half the chance than the remaining age groups to be included in the "annual sample". This fact accounted for a distortion of the picture of the age structure of a population in the total age analysis. We were unable to eliminate this distortion by merely doubling the number of group 0 animals because the activity and availability for sample collection changed in the course of the year. Therefore, we estimated the mortality and the age structure of the whole population of *E. europaeus* without the young of the calendary year of births, but included them in our estimate made for the second half of the year. With regard to this situation, the state of age group 0 should be considered as underestimated.

As an interesting fact a difference in the rate of mortality of the two hedgehog species (Fig. 1) was disclosed by our analysis. Also Kratochvíl (1975), using a different method of age determination, found an increased rate of mortality in the population of *E. concolor* as compared with that of *E. europaeus* (Fig. 3). He ascribed this to a shorter hibernation period (possibly associated with their places of origin), and to a higher biological activity of *E. concolor*,

and concluded that the average age of individuals of the population might be lower than that of *E. europaeus*. His hypothesis was supported by the fact that none of the specimens of *E. concolor* in our material was older than 5 years. However, according to the data in literature, an occasional individual of *E. concolor* might reach this age limit (Kratochvíl 1975) or even surpass it (e. g., Mohr 1936 ex Herter 1938).

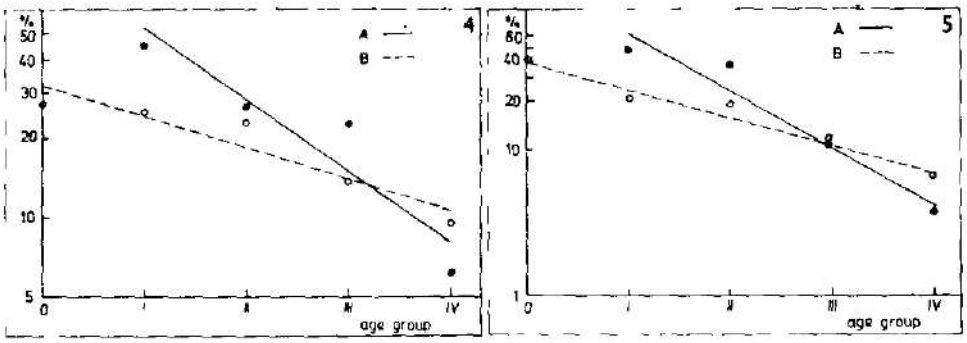

Fig. 4. Mortality curves of the Czechoslovak population of *Erinaceus europaeus* for the first (A) and second (B) half of the year (according to Kratochvíl's (1975) data).
Fig. 5. Mortality curves of the Czechoslovak population of *Erinaceus concolor* for the first (A) and second (B) half of the year (according to Kratochvíl's (1975) data).

Contrary to the common belief that the age limit was 8—10 years (Herter 1938, Gaffrey 1961, Feriancová-Masárová and Hanák 1965), conclusive evidence obtained from our field samples in which the number of 6- and more years old individuals was minimal showed that this limit was too high for the two species.

Mortality curves calculated on the basis of the data given by Kratochvíl (1975) for the two species (Fig. 3) were slightly steeper than those calculated from our own data. This resulted in a lower rate of survival in the first case (for *E. europaeus* S = 0.542, for *E. concolor* S = 0.385).

The difference might have been caused by a number of factors. A higher incidence of younger age groups might be due to intensive catching activities (Odum 1977), e. g. in pheasantries where hedgehogs are a readily available material for study. These populations are contmuously rejuvenated under the influence of man-made activities which result in a lower survival rate and a steeper mortality curve.

An interesting situation arose from results of the studies in the development of the age structure of a population made separately for each half of the calendary year. The results indicated quite clearly that the rate of mortality of the various age groups changed in the course of the year. In the first half of the year, the low percentage of individuals of older age groups indicated that the rate of mortality, particularly that of older individuals, must have increased either during or shortly after hibernation. In the second half of the year, in addition to an increased loss of animals of the oldest age groups, the

rate of mortality was increased mainly among the young born in the current year. A rather surprising feature observed in our material of *E. europaeus* was a higher mortality in the first half of the year suggesting that the anticipated high mortality of age group O in the second half of the year did not surpass that caused by hibernation (Fig. 2). Kratochvíl (1975) reported a similar situation fore the two species (Figs. 4, 5), but it should be stressed that our age group O consisted of weaned individuals which were no longer under the care of their mothers. A number of authors (Herter 1933, Krumbiegel 1955, Rödl 1971, Kratochvíl 1975) gave 40 days for an average duration of the sucking period. It is most likely that the rate of mortality is particularly high during the initial period, and that our recorded mortality of the older young (43 %) was not high enough to influence the average annual rate of mortality of the whole population.

Interesting conclusions might be obtained from the application of our results and hypotheses on the development of the age structure to a hypothetical population of *E. europaeus* consisting, e. g., of 100 animals. Let us start from the situation existing at the beginning of the year: Age group 0 is obsent, the population is composed by members of age groups I—VI, its age structure is in agreement with that shown in Table 1. The absolute majority of animals are mature. the remainder attains maturity in the course of the breeding season. According to Herter (1938), Krumbiegel (1955) and Rödl (1971), both the male and the female hedgehog mature sexually after their first hibernation at roughly the age of 10 months, and participate in the mating in the same year. Assuming a sex ratio of 85 females (46 %) to 100 males (54 %) (Herter 1938, Krumbiegel 1955), and one litter per year, the number of the young born in the calendary year is 184. A sex ratio of 1 : 1 or close to it might approximately be correct, because a similar sex ratio has been established for several other groups of insectivores, e. g., for members of the family Soricidae (Brambell et Hall 1937, Price 1953, Pucek 1960, Road 1965, Vlasák 1972). Rödl (1971) gave 4.55 for an average number of young in the litter; basing on his data, we have modified the number of the young in the litter to 4 with regard to the fact that young females which are generally numerous in a population produce smaller litters (Herter 1933). Working under the assumption that the number of animals in a balanced population should, at the beginning of the next breeding season, be identical with the original starting number of the previous year, the population ought to have lost 184 animals of all age groups within the course of the year. Losses in age groups I — V (VI) are given by the calculated average annual mortality, and amount to 23 animals. According to our results, the annual loss of animals of age group 0 (older than 40 days) is 79. This indicates that the remaining 82 young must mave died during the sucking period (0—40 days), suggesting a mortality of 44.3 % in the first 40 days of life. Mortality of this group is evidently highest in the young of the latest litters (particularly from young females — Rödl 1971) which have the least chance of survival (Kratochvíl 1975). In spite of this possibility and similar data on other insectivores, e. g., *Sorex vagrans* (Johnston and Rudd 1957). the value seems to be overstimated. It might suggest that either not all females participated in the reproduction (mainly females of age groups I and V (VI), or that there had been a shifting of the sex ratio to the advantage of males as suggested by older data (Keibel 1888 ex Herter 1938, Jacobfeuerborn 1908 ex Herter 1938).

SUMMARY

We obtained these results from the analysis of the age structure in Czechoslovak populations of *Erinaceus europaeus* and *Erinaceus concolor:*

1. It has been confirmed by conclusive evidence that the hedgehog in the wild can attain the age of 6 years and more. However, the number of animals of this age is extremely small in a population.
2. Differences in the rate of mortality of the two species reflect a slightly different age structure. According to results available at present, populations of *E. europaeus* have a lower average annual mortality rate than those of *E. concolor*, and the age structure of populations of the former species has evidently undergone a shift to the advantage of older age groups.
3. Age group 0 which appears in the second half of the year causes considerable changes to the age structure of the population. This account for differences in the age structure in the first and second half of the year.
4. The rate of mortality of individual age groups changes in the course of the year. It is remarkably increased in age groups IV and V (VI) in the first half of the year. In the second half of the year, there is a very high mortality of age group 0.

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It is my pleasant duty to acknowledge the assistance of Dr. L. Juska from the Laboratory of computer technique of Faculty of Natural Sciences of Charles University for his help in computing mortality curves.

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PLEISTOPHORA AGELASTICAE SP. N., A NEW MICROSPORIDIAN INFECTING AGELASTICA ALNI IN CENTRAL ASIA, U. S. S. R.

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A b s t r a c t: The microsporidian *Pleistophora agelasticae* sp. n. causes infections and mortality among *Agelastica alni* L. (Coleoptera, Chrysomelidae) from Alma Ata, Central Asia, USSR. It infects the gut of the host and spores are released in faeces. With a progressing infection the number of released spores and of infected cells decreases. Highest yields of spores animal are in its initial phase. The microsporidian is rather host-specific and is not transmitted to other hosts such as *Gastroidea viridula* or *Leptinotarsa decemlineata*.

In the course of a search for microsporidia which could be used for eventual biological control of *Leptinotarsa decemlineata* Say we concentrated on species infecting different Chrysomelidae in anticipation of their infectivity for the potato beetle as a closely related host. Our attention was focused primarily on beetles with similar ecology. The candidates had to be infectious for the potato beetle, had to produce long lasting infections during which spores would have been introduced into the host population. They should have been transmited via the egg to the progeny and with an increasing contamination of the environment they had to have an increased debilitating effect, reduce the egg number and finally kill the beetles. In this search we identified, beside microsporidia infectious to potato beetles which could also be produced on substitute host in the laboratory (H o s t o u n s k ý and W e i s e r. 1973, 1975, 1978), also some species which were not able to infect the beetle. Probably they could not develop well in the remains of solanin in the host gut. One of them was a species described here which was present in a population of *Agelastica alni* L. in Alma Ata (Kazakhstan, USSR) In insects inspected immediately after collection, spores of the pathogen were not found, but they appeared in further laboratory rearings of the beetles starting from a primary group of ovipositing adults and larvae. Beetles in rearings reduced the uptake of food, reduced oviposition and died during the next four weeks. Compared with non-infected animals in non-infected parallel lines, their fat body was totally reduced and in their gut the remains of food were mixed with masses of mature spores of the microsporidian

MATERIAL AND METHODS

The studied material of adult beetles was collected from an outbreak of *Agelastica alni* L. on *Salix* sp. in the Akademgorodok, the campus of the Kazakh Academy of Sciences in Alma Ata, Central Asia, USSR, at the end of April 1978. Out of the collected beetles 28 were dissected immediately and smears of their organs were inspected in watermounts at 160 and 400 × magnification. Faeces from the walls of the transport box were washed off with a minimum of water and inspected af-

ter sedimentation. All results were negative. The remaining 39 beetles were used for rearing. They were placed in plastic boxes containing the food plant in a vial with water. The lid of the box had openings sealed with fine netting. The used food plants, *Salix babylonica, Populus nigra — pyramidalis, P. tremula* and *Alnus glutinosa*, were all accepted equally, with an even distribution of frass and egg masses. Deposited eggs were viable and larvae developed normally on all food plants. When the first beetles died and spores of a microsporidian were detected in their bodies, larvae from eggs from noninfected adults and infected ones were reared separately, in the insectary at 25 °C, 70% RH and in a 16 hours day light. For experimental transmissions larvae of *Gastroidea viridula* Deg. were used fed with leaves of *Rumex obtusiofolius* and larvae of the Colorado beetle, *Leptinotarsa decemlineata*, on potato leaves.

Microscopical investigation was performed on fresh dissected animals in watermount as well as on histological sections. Beetles for dissection were kept for 4 hours without food in a vial closed with a cotton plug and the faeces from that vial were inspected first for microsporidian spores. After CO_2 anesthesis, animals were dissected and individual organs were inspected in watermounts. For histology beetles were fixed with Bouin's liquid, later the hard surface was removed and the internal organs were embedded in paraffin. Blocks were cut in section 4—6 μm thick and stained with Heidenhain's iron hematoxylin or with Giemsa. Positive watermounts were opened, the noninfected tissues removed and the infected parts smeared in smears which were stained with Giemsa after metanol fixation. Parts with dense groups of spores were treated with a droplet of boiling 10% HCl, washed with tap water, restained for 1 min. with Giemsa solution and inspected for determination of the number of nuclei in spores.

For experimental infections suspensions of spores were used isolated from infected beetles or their faeces. Beetles were crushed and homogenised in a glass-disintegrator in a small quantity of water. In a repeated centrifugation soluble substances were removed and for further purification the method using Brownian motion (Hostounský, 1978) was used. A suspension of purified spores was offered to newly hatched first larvae. Egg batches were collected daily with the leaves where they were fixed, and were isolated in single vials with cotton plugs. Hatching larvae were infected as soon as they fed on their egg shells. The suspension was offered in drops in platinum loops, their size contructed to contain 1 mm^3 of water, concentration of the suspension adjusted to 18.000 spores/loop. Individual larvae were brought with a brush to the stalk of the loop oriented to the window and they marched up to the loop and drank up the droplet. Only larvae which took up all the liquid were transferred in rearing cages and treated as parallel normal rearings. In the same way larvae of *Gastroidea viridula* and *Leptinotarsa decemlineata* were infected and kept in experiments. Numbers of spores in suspensions and finally in dead insects were counted in Bürkers haemocytometers.

RESULTS

A. Primary infections

During the introductory dissection of 28 beetles the microsporidian was found neither in tissues nor in the faeces. From the beginning of rearings on May 3, 1978. all animals were followed. At first the group of beetles accepted food regularly and daily egg batches averaging 30—33 eggs were laid. After May 19, some females discontinued egg laying, their egg filled hypogastric abdomen turned back to normal and beetles died gradually. Dissected animals had their fat body reduced or not formed at all. The epithelium of the gut was damaged, brittle. Bacteria entered the body cavity and produced a septicaemia. As shown in Fig. 1, the number of spores per animal had changed during the epizootic, the highest amount being in hosts at the beginning of the infection, and with lower actual counts in individuals at the end of the epizootic. Individual counts changed between 1 and 40 milion spores per animal.

B. Experimental infections

In experimental infections with 18×10^3 spores for one L_1 of *Agelastica alni* the course of the disease was very similar. Compared with control animals, infected ones reduced essentially their uptake of food during the first days after infection. Later feeding improved to normal, but the retardation of the development remained visible. Whereas control larvae pupated in 23 days,

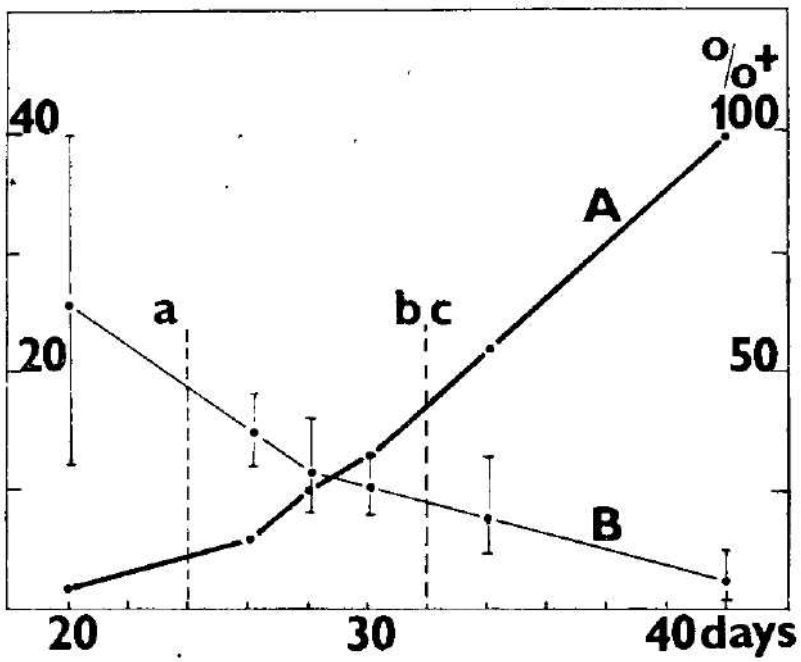

Fig. 1: Cumulative mortality of infected adults of *Agelastica alni* (A) and total spore content of *Pleistophora agelasticae* in dead animals (B), with range of variation. a — period of incubation before release of spores, b — period of primary spore release, acute phase, and c — late, sporadic release period — in spores/host in millions and % of dead in days.

infected ones reached hardly their half size and died on the 26th day without pupation As evident from Tab. 1, here also animals which had died immediately after the incubation period had as much as 10 times more spores in their gut than larvae dying at the end of the series. The number of spores/ /animal was reduced with the excretion of spores in faeces, the contents being 1×10^6 spores, animal.

After incubation evidently the pathogen accumulates in the wall of the intestine, with a different density of coverage, up to 13 mil. spores per animal. At this stage infected cells burst: probably, if most at the same time, the heavy damage causes sudden septicaemia and death before the spores leave the body. In cases with a subsequent maturation and bursting of cells, spores are released in faeces, damages are partially refilled by regeneration and the flow of spores is reduced. Retarded animals are not able to pupate as there

Tab. 1. Number of spores of *P. agelasticae* in daily dead laboratory infected *Agelastica alni*-larvae. Initial dosis: 18×10^3 spores/L_1

Date of colection	30. V.	6. VI.	15. VI.	19. VI.
Day after infection	6	13	22	26
Number of spores mature	0	13	2.8+	1.0+
spores in ml./animal	0	13	2.0+	1.0+
	0	5 6+	2.0+	1.0+
	0	7.6+		1.0+
		6.6+		1.0+
		9.2+		
		7.6+		
		5.6		
Total of dead per day	4	8	3	5
Average number of spores/anim. in ml	0	8.5	2.3	1.0

+ = spores present in faeces

is no supply of material for that in their fat body. But even in such cases there is no healing and recovery and animals develop chronical infections and septicaemias.

C. Infections of other hosts

Infections of *Gastroidea viridula* and *Leptinotarsa decemlineata* performed in the same way with virulent material were all negative and there were no spores in faeces after 8 to 14 days. Dissection after 14 and 20 days did not show any infection in the inspected tissues. Therefore the microsporidian under study is not infectious for the two other hosts.

D. Description of the pathogen and its pathology

The spores injected the germs into cells of the midgut epithel in which schizogony occurs in the basal part of the cells. From there a sphaerical to elongate sporont returns in the oposite direction with 2, 4 and up to 10 nuclei forming an irregular plasmodium. It can sometimes contain more than 30 nuclei. Early stages are hidden in the host cells, but at the time of formation of single

Tab. 2. Mortality of adult *Agelastica alni* with *P. agelasticae*-infection, and total spore count/animal in mil. Animals with natural infection

Date of colection	24. V.	29. V.	31. V.	2. VI.	5. VI.	11. VI.
Days in lab. rearing	21	26	28	30	34	41
Number of	40	18	16	14	12	4
spores per	12	16	12	10	10	4
animal		14	10	8	10	2
	16 an. negat.	12	8		8	
					6	
					6	15 an. 1.0
Total of inspected	18	4	4	3	8	18
Average nr. of spores/an. in mil.	2.9 (26)	15	11.5	10 6	7	1.4

sporoblasts, the space with sporoblasts and young spores is changed in a parasitophorous vacuole where the stages maturate into single spores. Due to the peristaltics of the gut, the bag-like mass of spores is moved down the cell and they remain in a group just beneath the ciliated membrane of the epithel. The cells protrude in the gut cavity, the membrane bursts and groups of spores are released with the faeces. Young schizonts are round bodies 3—5 μm and single young prosporoblasts are broad oval, uninucleate, 4—6 μm long and 2.5 μm broad. Sporoblasts are condensing in size to the size of the spores.

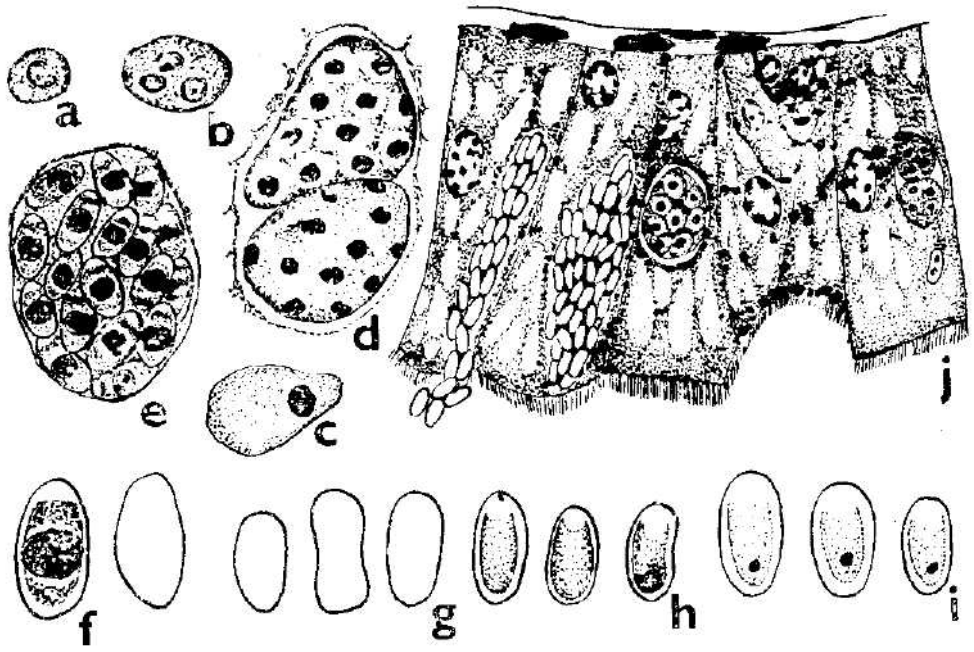

Fig. 2: Development of *Pleistophora agelasticae* in the host gut. a — young schizont, b — older schizont, c — young sporont, d — multinucleate plasmodium and another in progress of prosporoblast formation, e — mature spores in pansporoblast, f — sporoblast, g — sporoblast and different spores shapes in watermount, h — spores on dry smear, i — nuclei in hydrolysed spores, j — section of the gut of *Agelastica alni* with the infection.

They are formed in two sizes: microspores 4 × 2—2.5 μm, oval to kidney-shaped and macrospores 5—5.5 × 2.5 μm, elongated oval, with both blunt ends. The content of mature spores stains with difficulties. Hydrolysis with HCl shows in both types of spores a single nucleus 0.5 μm in diameter in the posterior third of the spore. The ratio of micro and macrospores in hydrolysed smears is 1 : 3 in favour of macrospores.

Infected cells are spread on sections over the gut wall, there are no ulcerose centers formed and no visible sign of any destruction of lateral walls of infected cells. The infection is very similar to cases where the infection enters only from the gut lumen. The microsporidian does not enter other tissues during the whole infection. During the final phase when the epithel is heavily damaged, the regeneration centers are not infected and destroyed cells are

readily replaced. The infection is reflected mainly in a reduced resorbtion of food and bad feeding. The fat body does not offer the reserves for pupal tissues, or in scare pupae and adults, the ovaries do not develop. The final symptom is a bacterial septicaemia. In late infections, during the second or third instars, some larvae pupate and some pupae produce adults. Most infected cells are eliminated during the prepupal stage and spores appear in adults occasionally. In accidental infections in late instars, which are common in nature, transmission to adults is more common, but infections are not lethal.

The studied microsporidian is a *Pleistophora* with typical multinucleate plasmodia in sporogony and with uninucleate spores. In spore size and shape it differs from other pleistophora's of chrysomelid beetles such as P. *grossa* or *P. fidelis* which are only one half of the spore length of our microsporidian. It differs also in its host range in not being infectious for *Gastroidea viridula* or *Leptinotarsa decemlineata*. We propose for this species the name *Pleistophora agelasticae* sp. n. Type deposed in our Prague collection.

DISCUSSION

Pleistophora agelasticae sp. n. has been shown to be a typical intestinal microsporidian with a chronic course of infection. The source of infection are spores eliminated from the host in his faeces. Progressing emptying of infected cells in the gut during the course of the infection reduces the total spore count per host. A similar case occurs in *Chrysomela grossa* infected with *Pleistophora grossa* (Hostounský, Weiser, 1978) where the infected cells burst late and the spore count of such larvae is much reduced. In *P. schubergi* the number of spores deposed in faecal pellets during the life of the caterpillar equals the final spore count in the larva. (Weiser, 1976). In the original group of *Agelastica* there probably was one beetle with a just beginning infection of a cell of its gut and the release of spores started very late. The original infectious dose decides how many cells are infected at the same time and decides the whole severity of the infection. Animals with a damage in a broader continous area must develop a more acute infection, animals with a scarce, occasional infection do not show serious symptoms and disseminate the infection. On the contrary, infections of other tissues, such as of the fat body, develop large masses of spores mainly when minute doses are swallowed whereas large doses cause damage of the port of entry, the gut, and septicaemias often are without development of the microsporidian in the target tissue, the fat body. The combination of dosage with the age of the host, the viability of spores exposed to sunshine and influence of many other factors decide about the severity of the infection and the host mortality.

The comparison of the microsporidia in Chrysomelid beetles is given in Hostounský and Weiser, 1973 and 1978. The genus *Pleistophora* in insect hosts and in other animals has several morphological types differing in formation of the sporonts and its revision is needed.

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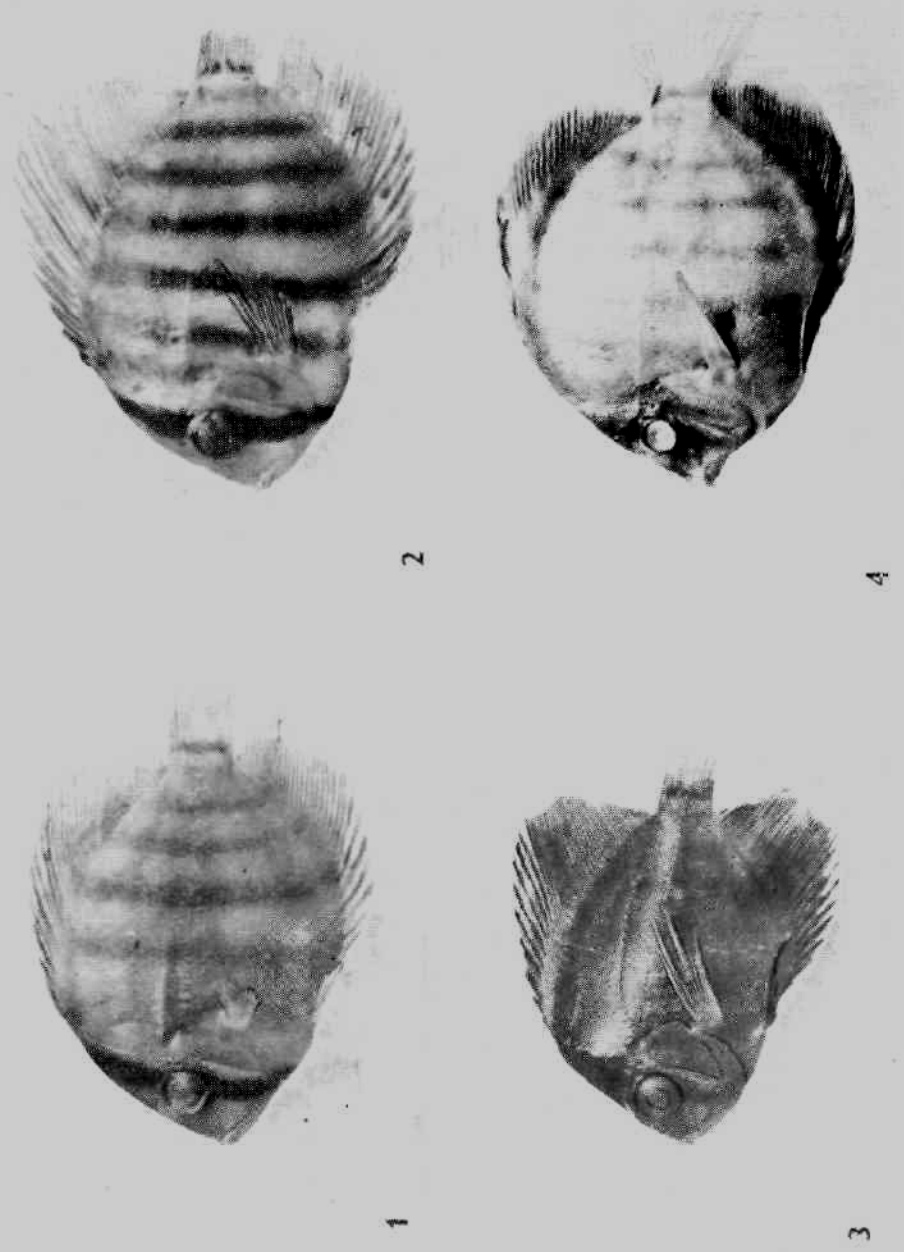
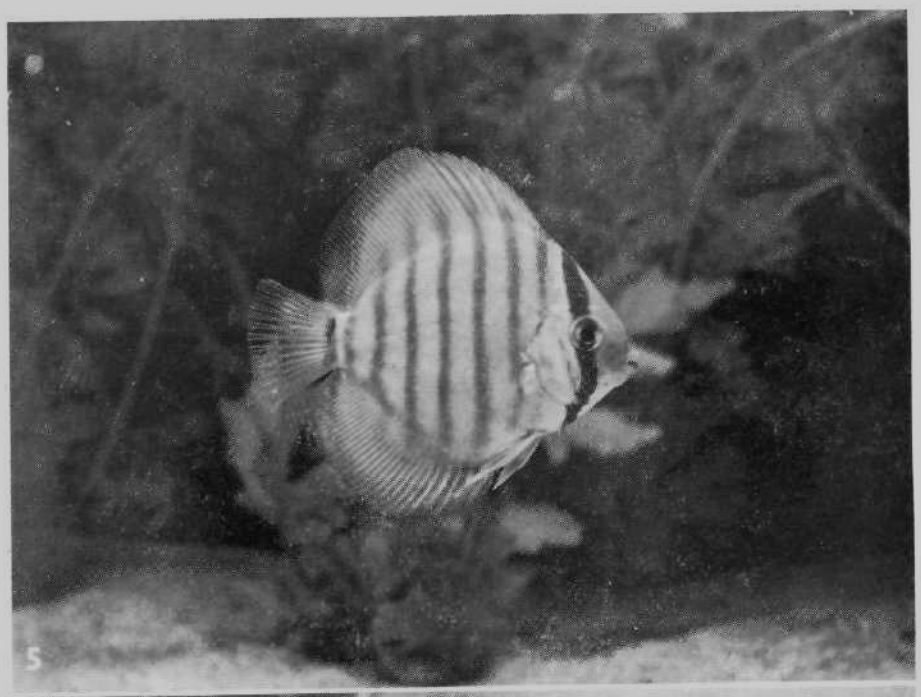


Fig. 1 — Specimen with body length 51 mm, number of vertical scale rows 49, apparently hybrid between *Symphysodon aequifasciatus* x *Symphysodon discus*.
Fig. 2 — Specimen with body length 49 mm, number of vertical scale rows 49, the same as above.
Fig. 3 — Very dark purple-brown specimen of *Symphysodon aequifasciatus*, body length 45 mm.
Fig. 4 — Specimen of *Symphysodon aequifasciatus*, body length 100 mm.



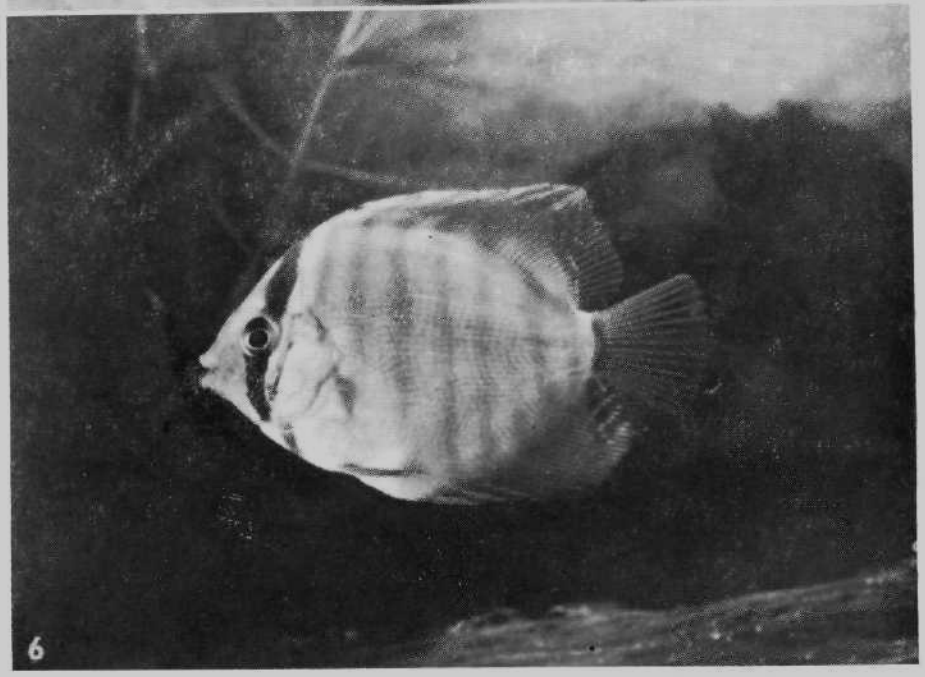


Fig. 5 — Living young aquarium specimen of *Symphysodon aequifasciatus* (photo R. Zukal).
Fig. 6 — Living young aquarium specimen of *Symphysodon aequifasciatus* (photo R. Zukal). Specimen with feebly developed dark bars.

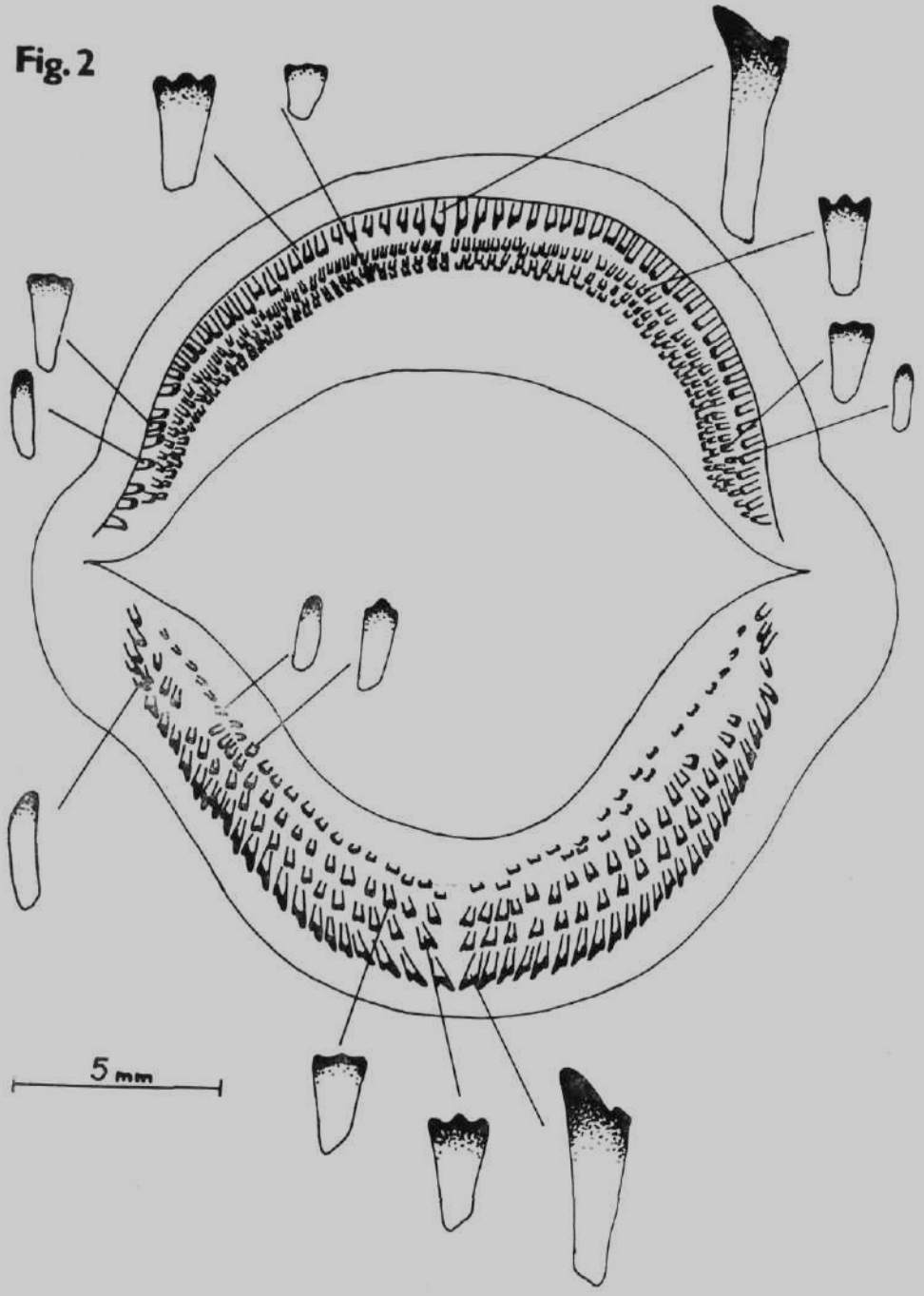
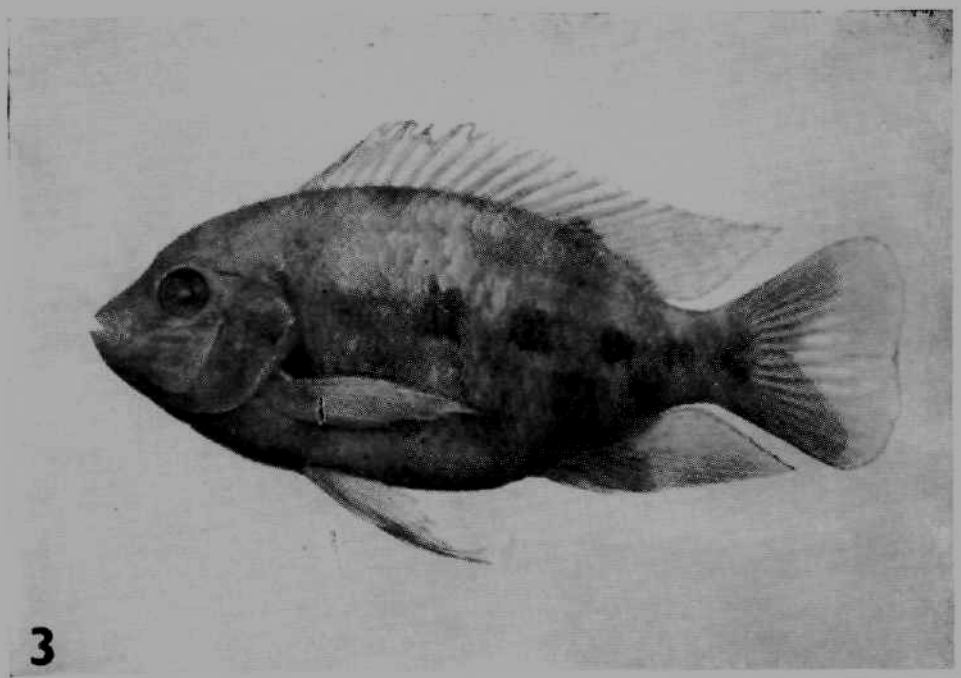


Fig. 2. Teeth of *Tilapia mariae* 143 mm body length of the "meeki" colour pattern



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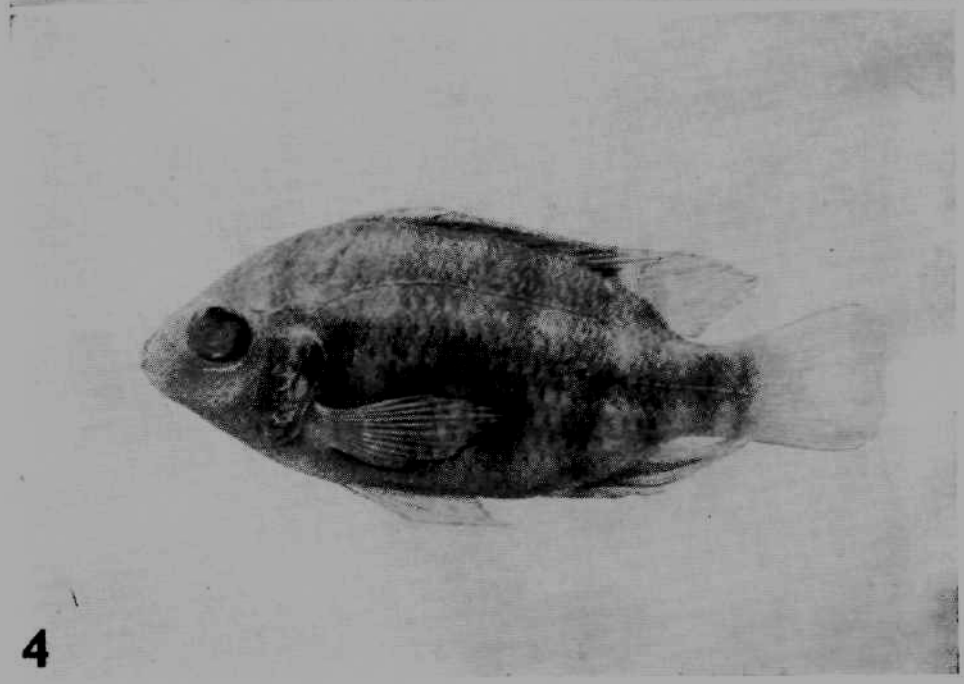

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Fig. 3. *Tilapia mariae* 103 mm body length, adult male in the "meeki" colour pattern
Fig. 4. *Tilapia mariae* 58 mm body length, juvenile specimen in the "mariae" colour pattern. Vertical bars due to fixation a little indistinct

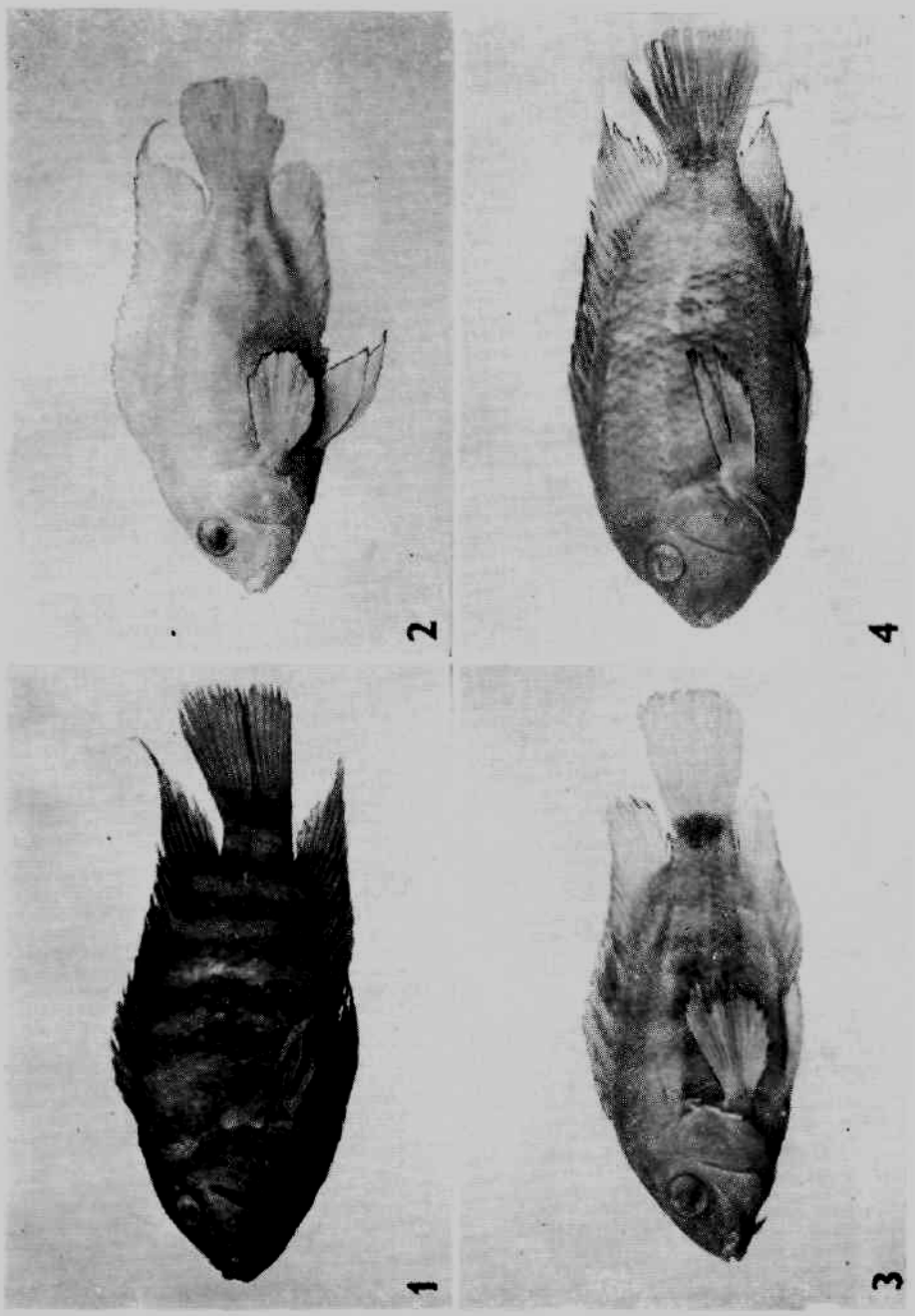


Fig. 1. *Cichlasoma nigrofasciatum* 70 mm SL, male. The second and the fourth vertical bar are almost confluent, the spot on the origin of the dorsal fin base almost indistinct.
Fig. 2. *Cichlasoma nigrofasciatum* 52 mm SL, xanthoric female. The part of caudal and anal fins broken.
Fig. 3. *Cichlasoma spilurum* 46 mm SL, juvenile specimen. Right maxillary partially out of its normal position.
Fig. 4. Specimen determinated as *Cichlasoma cutteri* 73 mm SL, sex unknown. Vertical bars very indistinct.

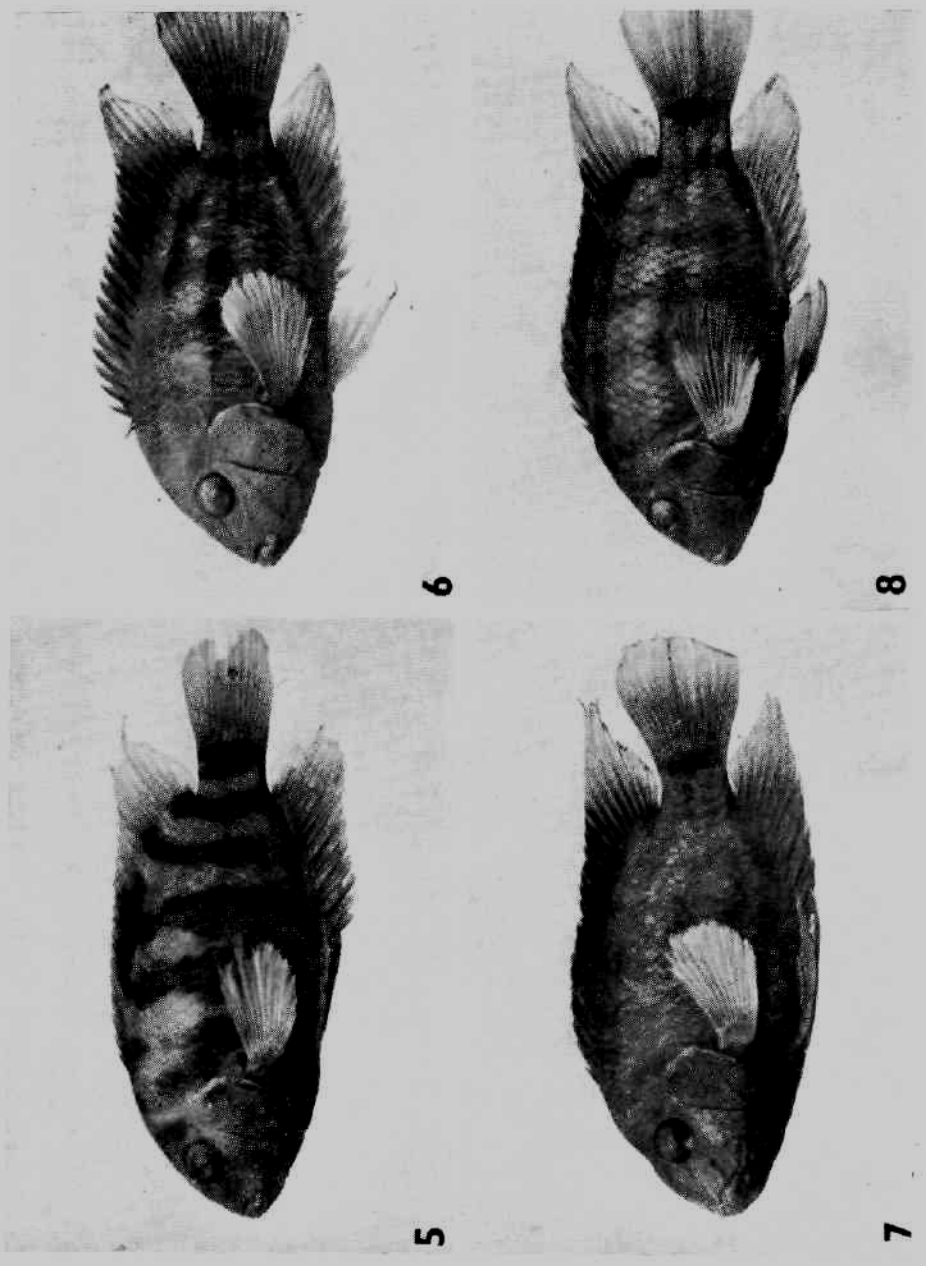
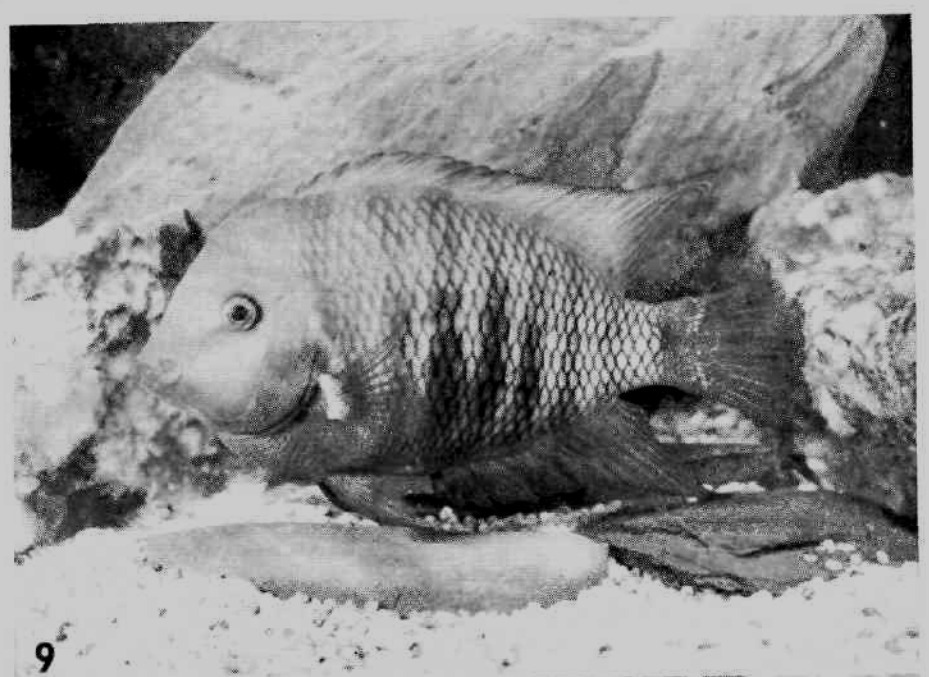


Fig. 5. F_1 hybrid between *Cichlasoma nigrofasciatum* and *Cichlasoma spilurum* 60 mm SL, sex unknown. The first dorsal spine out its normal position. The first, the se- interrupted.
Fig. 6. F_2 hybrid between *Cichlasoma nigrofasciatum* and *Cichlasoma spilurum* 60 mm SL, sex unknown. The first dorsal spine out its normal position. The first, the second and the third vertical bars are indistinct.
Fig. 7. F_1 hybrid between *Cichlasoma nigrofasciatum* xanthoric form and *Cichlasoma spilurum* 66 mm SL, sex unknown. All vertical bars are indistinct.
Fig. 8. Hybrid between *Cichlasoma nigrofasciatum* and F_1 *(Cichlasoma nigrofasciatum* × *Cichlasoma spilurum)* 60 mm SL, sex unknown. Vertical bars not clearly distinct, but almost identical, with those in *Cichlasoma nigrofasciatum.*



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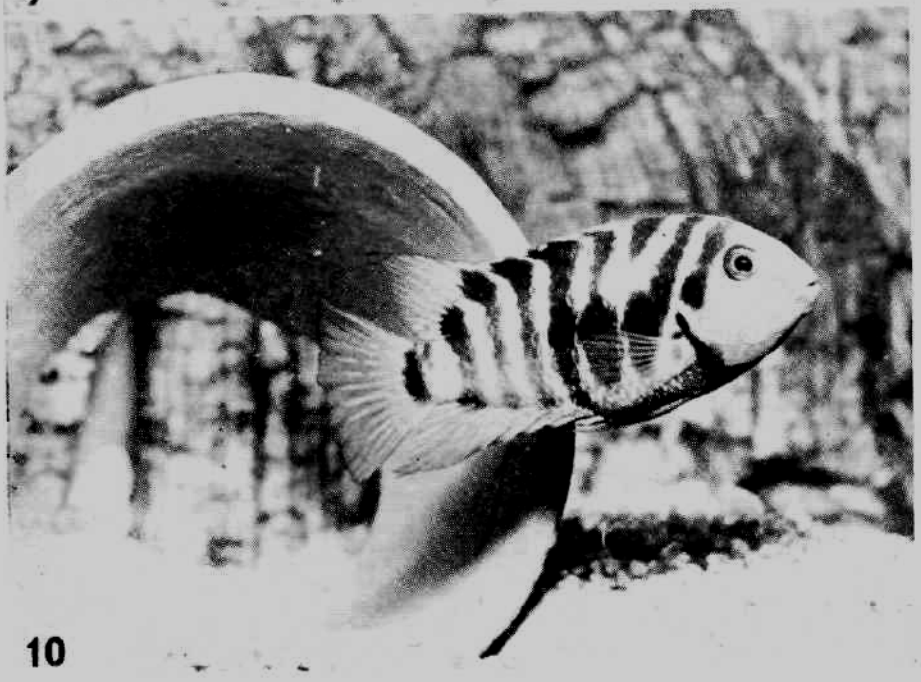

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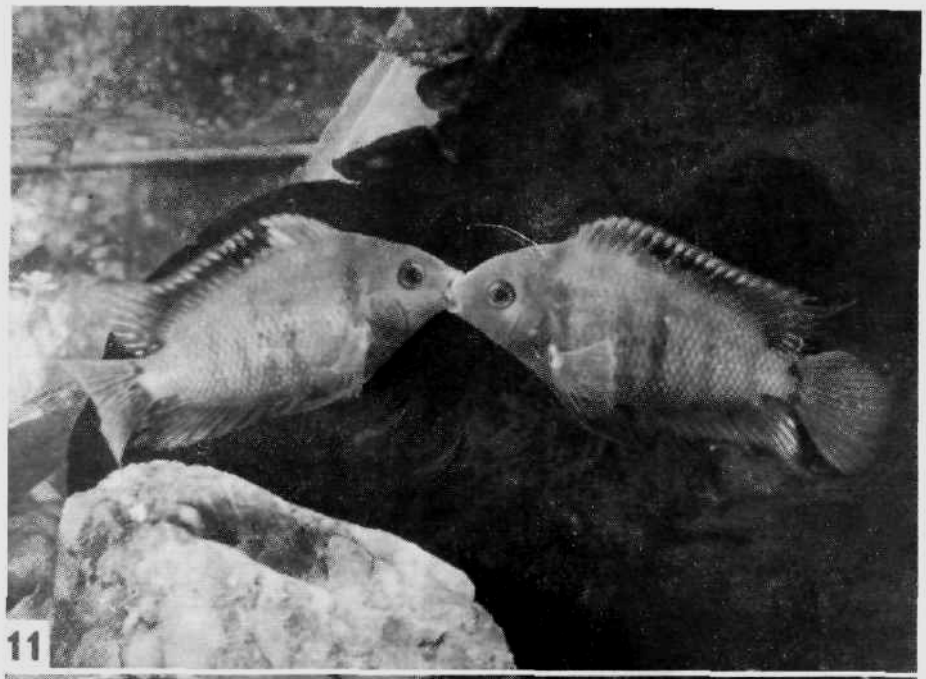
Fig. 9. *Cichlasoma spilurum*, living male, (photo R. Zukal).
Fig. 10. *Cichlasoma nigrofasciatum*, living female, (photo R. Zukal).



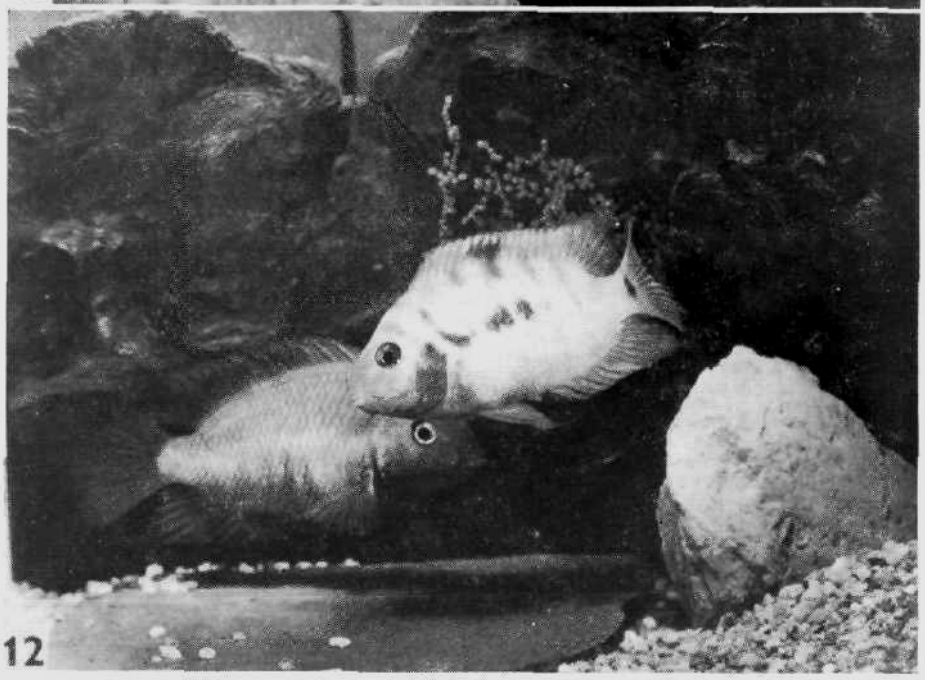


Fig. 11., Fig. 12. Hybrids of F_1 generation between *Cichlasoma nigrofasciatum* and *Cichlasoma spilurum*, living specimens. (photos R. Zukal).