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**FURTHER NOTE ON THE BUTTERFLYFISH (*PANTODON BUCHHOLZI*, PISCES,
PANTODONTIDAE)**

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Received October 6, 1980

Abstract. The butterflyfish (*Pantodon buchholzi* Peters, 1876) from Nigeria was examined using 6 meristic and 10 plastic characters. Obtained values were compared with published data. Special attention was devoted to the problem of sexual dimorphism not only in Nigeria, but also in further specimens from aquaria.

MATERIAL AND METHODS

All examined specimens were donated to the Department of Systematic Zoology, Charles University, through the courtesy of various Czechoslovak aquarium hobbyists. All measurements were made using the same method as in previous communication (Hanel and Novák, 1979). The material contains 7 specimens (87–103 mm of the total body length). Sexual dimorphism was also studied using 5 males, 2 females from Nigeria, 11 conserved specimens (1 male, 10 females) from aquaria and 4 living ones (2 males, 2 females). Sex was ascertained by means of the dissection.

RESULTS AND DISCUSSION

Our results together with the data of Boulenger (1909) and of the present authors (1979) are summarized in Table 1. We have found, as compared with Boulenger (1909), lower values in the head length in % of the total length, in the length of the pectoral fin, in % of the total length, in the body depth in % of the total length, in the eye diameter in % of the head length and in postdorsal distance in % of the predorsal distance.

As compared with Boulenger's (1909) and our own previous observations (1979) we found no substantial difference in plastic characters, but we have observed some differences in the meristic ones. Boulenger (1909) found 3 1/2 scales above the lateral line, we (1979) found 4 scales in aquaria specimens. But in the 7 specimens from Nigeria studied recently we found 5 scales above the lateral line. Similarly to Boulenger (1909) we also found 5 scales previously (1979), now in the recent material from nature we found only 4 scales below the lateral line. Differences between Boulenger's (1909) data and our values are probably caused by different conditions in the nature and in aquarium.

Data concerning sex dimorphism of the butterflyfish are summarized in Tables 2 and 3. According to our observation, the shape and structure of the anal fin is most reliable for the determination of sex. Rays in the anal fin are shortened from the fifth to the last in females (Fig. 1). In males the anal fin looks as composed of two somewhat different groups of rays: the first, at the beginning of the fin, is composed of 5–6 long and thick rays, the second of 4–9 thinner and shorter rays. In all examined males 9–14 rays, in females 14–15

rays were found in the anal fin. Boulenger (1909) found only 9–14 rays in the anal fin; he mentioned no sexual differences.

It is interesting that in one male from aquaria 14 rays were found in the anal fin, whilst in males from nature only 9–11 rays. No further differences were found among specimens of the identical sex of the butterflyfish from nature and aquaria (Tables 2 and 3).

Table 1. Plastic and meristic characters of *Pantodon buchholzi*

	Nigeria	Boulenger (1909)	Aquaria (Hanel, Novák, 1979)
No. of sp.	7	11	28
In % of total body length head length	16–20 (19)	23–25	17–26 (19)
In % of total body length length of pectoral fin	28–32 (30)	40–50	25–38 (31)
In % of total length body depth	19–22 (20)	27–30	16–23 (19)
In % of head length eye diameter	22–29 (26)	28	19–30 (25)
In % of predorsal distance postdorsal distance	14–17 (16)	25–28	14–25 (18)
In % of interorbital width eye diameter	47–59 (52)	37	39–63 (49)
In % of caudal peduncle depth length of caudal peduncle	81–102 (93)	100	90–140 (105)
Scales in lateral line	27–30 (29)	28–30	26–30 (28)
Scales above lateral line	5	3 $\frac{1}{2}$	4
Scales below lateral line	4	5	5
Scales in predorsal distance	21–25 (23)	22–23	22–26 (24)
Rays in dorsal fin	1 $\frac{1}{5}$	6	1 $\frac{1}{5}$
Rays in anal fin	2 $\frac{1}{7}$ –13 (2/9)	9–14	2 $\frac{1}{12}$ –2 $\frac{1}{13}$ (2/12)
Gill rakers	9–10 (9)	—	9–11 10

SUMMARY

7 specimens of the butterflyfish (*Pantodon buchholzi* Peters, 1876) from Nigeria were examined with regard to 6 meristic and 10 plastic characters. Considerable differences in the number of scales above and below the lateral line were found. Smaller differences in plastic characters were also noted in comparison with previous data concerning specimens living in captivity in aquaria and with Boulenger's (1909) description. The sex of living specimens of the butterflyfish is determinable according to the shape of the anal fin and its structure. In females, the lower profile of this fin is straight, in males it is evidently concave, which is caused by the different length of its rays. In males a considerably smaller number (9–14) of anal rays was found than in females (14–15).

Table 2. Plastic and meristic characters of *Pantodon buchholzi* originating from Nigeria and from aquaria breeding with regard to the sex

	Nigeria		Aquaria	
	males	females	male	females
No. of sp.	5	2	1	10
Total length (mm)	87-103	94-99	91	68-119
Body length (mm)	58-69	63-65	63	45-84
In % of total length head length	17-20 (18)	16-17 (17)	19	18-19 (19)
In % of total length length of pectoral fin	28-31 (30)	28-32 (30)	29	25-35 (31)
In % of head length eye diameter	27-29 (28)	22-27 (25)	23	21-28 (24)
In % of predorsal distance postdorsal distance	14-17 (16)	15-17 (16)	18	14-23 (19)
In % of depth of caudal peduncle its length	81-100 (93)	102	91	90-130 (114)
In % of interorbital width eye diameter	47-59 (52)	47-56 (52)	49	43-63 (52)
Scales in lateral line	27-30 (29)	28	30	26-29 (28)
Scales below lateral line	4	4	5	5
Scales above lateral line	5	5	5	5
Scales in predorsal region	21-25 (23)	24-25 (25)	24	22-25 (24)
Rays in dorsal fin	1/5	1/5	1/5	1/5
Rays in anal fin	2/7-9 (2/8)	2/12	2/12	2/12-13 (2/12)

Table 3. Plastic and meristic characters of *Pantodon buchholzi* (males and females from Nigeria and from aquaria altogether)

	Males	Females
No. of sp.	6	12
Total length (mm)	87-103	68-119
Body length (mm)	58-69	45-84
In % of total length head length	17-20 (18)	16-19 (19)
In % of interorbital width eye diameter	47-59 (52)	43-63 (52)
In % of total length length of pectoral fin	28-31 (30)	25-35 (31)
In % of total length body depth	19-22 (20)	16-23 (20)
In % of head length eye diameter	23-29 (27)	21-28 (24)
In % of predorsal distance postdorsal distance	14-18 (16)	14-23 (19)
Scales in lateral line	27-29 (29)	26-29 (28)
Scales below lateral line	4-5	4-5
Scales above lateral line	5	5
Scales in predorsal distance	21-25 (23)	22-25 (24)
Rays in dorsal fin	1/5	1/5
Rays in anal fin	2/7-12 (2/9)	2/12-13 (2/12)

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Hanel L., Novák J., 1979: Note on the butterflyfish (*Pantodon buchholzi*) (Pisces, Pantodontidae), *Věst. čs. Společ. zool.*, 43 (2): 104–106.

The Figure 1 will be found at the end of this issue.

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**ON THE INSECT BAT ECTOPARASITES OF COASTAL LIBYA (CIMICIDAE,
NYCTERIBIDAE, STREBLIDAE, ISCHNOPSYLLIDAE)**

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Received December 5, 1980

Abstract. Nine species from 3 insect orders and 4 families are recorded: *Caecodmus vicinus* Horv. (Heteroptera: Cimicidae); 4 species of the family Nycteribiidae (Diptera) — *Nycteribia (N.) latreillii* (Leach), *Nycteribia (Acrocholidia) vexata* Westw., *Styldia biarticulata* Herm. and *Basilisa (B.) mediterranea* Hürka; *Brachytarsina flavipennis* Macq. (Diptera: Streblidae); 3 species of the family Ischnopsyllidae (Siphonaptera) — *Ischnopsyllus (I.) consimilis* (Wahlgr.), *Ischnopsyllus (I.) intermedius* (Rothsch.) and *Rhinolophopsylla unipectinata arabs* Jord. et Rothsch. Four species have the Westpalearctic distribution, five belong to the Mediterranean fauna. The find of *B. mediterranea* represents the second report of this species. Notes on taxonomy, morphological features, bionomics, hosts and zoogeography of the ectoparasites found are mentioned.

I had the opportunity to examine some Lybian bats for ectoparasites in 1979 and 1980 during the stay of Czechoslovak zoologists from the Department of Systematic Zoology, Charles University, Prague in Tripolitania and Cyrenaica. Table 1 gives the survey of this examinations, showing that the representatives of 3 insect orders, e. g., Heteroptera (Cimicidae), Diptera (Nycteribiidae, Streblidae) and Siphonaptera (Ischnopsyllidae) have been ascertained.

No data are known about the insect bat ectoparasites from Libya except for the note by Hufnagl (1972: 32) and my preliminary information (Hürka, in print).

MATERIAL AND METHODS

98 ectoparasites of nine species have been found on 62 bat specimens of 7 species (Table 1) in April 1979 and in April-May 1980. The bats were collected either in their roosts, or they were captured by netting at following localities (Fig. 1):

Sabratha, 80 km W from Tripoli, Antique ruins; *Myotis blythi punicus* Felten — individually, *Pipistrellus kuhli* (Kuhl) — colony of about 35 specimens.

Tripoli, park in Sidi Mesri; *Eptesicus serotinus isabellinus* (Temminck) - netted.

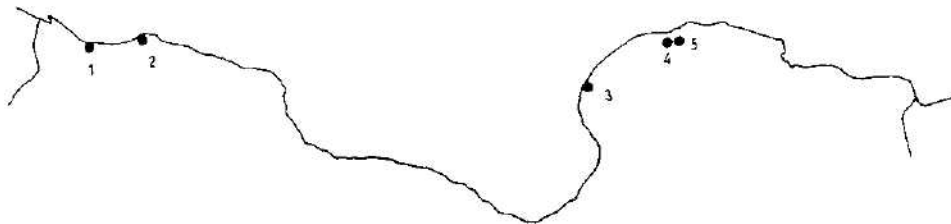


Fig. 1. Map of the coastal Libya: 1 — Sabratha, 2 — Tripoli, 3 — Ain Zeyanah near Benghazi, 4 — Vadi el Kuf, 5 — El Beida.

Ain Zeyanah, 15 km E from Benghazi, abandoned solitary house; *P. kuhli* — colony of about 50 specimens.

Vadi el Kuf, Cyrenaica, cave in the profound, broad vadi, *Rhinolophus mehelyi* Matschie — colony of about 50 specimens.

El Beida, Cyrenaica, vadi 4 km S from the town, *P. pipistrellus*, *P. kuhli*, *Nyctalus leisleri* (Kuhl) — netted.

RESULTS

Cimicidae

Cacodmus vicinus Horvath, 1934

1♂, 16. 4. 1979, *Pipistrellus kuhli* (Kuhl), Ain Zeyanah.

This Southmediterranean species was found in Jordan, Lebanon, Israel, Egypt, Tunis and Algeria, so that its finding in Libya is not surprising*.

The male specimen was found on one of four females *P. kuhli* from the colony of about 20 bats and agrees in the morphological features and in measurements (length: 5.0 mm, width of thorax: 1.38 mm, width of abdomen: 2.74 mm, measured on not mounted, in alcohol preserved specimen) with the data given by Usinger (1966: 401–404).

Nycteribiidae

Nycteribia (Nycteribia) latreillii (Leach, 1817)

1♂, 1♀, 2. 4. 1979, *Myotis blythi punicus* Felten, Antique ruins of Sabratha.

This Westpalaearctic species was known in North Africa from Morocco, Algeria and Tunis only. *Myotis blythi* is one of the principal hosts on the whole area of this fly. Nevertheless, the average infestation of the Libyan specimens was low. Only one adult female from five bats examined (3♂♂, 2♀♀) was infested.

In the morphological characters the Libyan specimens agree with those from Europe (dorsal genital plate of female with 11 spines; 5th abdominal sternum of male with a group of 16 spines).

Nycteribia (Acrocholidia) vexata Westwood, 1835

2♂♂, 1♀, 7. 4. 1979, *Myotis blythi punicus* Felten, Antique ruins of Sabratha.

This Westpalaearctic species was found, up to now, in all Northafrican countries excepting Libya. *M. blythi* is one of the principal hosts also for this fly; one female and one male from five bats were infested. Both male and female specimens of the fly agree in morphological characters with the European ones (dorsal genital plate of female with 4 short spines, 5th abdominal sternum of male with a group of 7 and 8 spines).

Stylidia biarticulata Hermann, 1804

3♂♂, 4♀♀, 23. 4. 1980, *Rhinolophus mehelyi* Matschie, cave in Vadi el Kuf, Cyrenaica.

The Libyan sample of this Westpalaearctic species also suggests that the infestation of host bats by this fly is markedly lower in North Africa (Morocco, Algeria, Tunis, Egypt) than in the southern part of Europe (7 flies on 23 host bats).

* Six bed bugs from *P. kuhli* (ruins at Sabratha) given by Hufnagel (1972: 32) as *Cimex lectularius* probably also belong to *C. vicinus*.

Table 1. Survey of bats and their ectoparasites

Ectoparasite	Rh. meh. 23	M. bl. pun. 5	E. ser. isab. 1	Psp. pip. 3	Pip. kuh. 27	Nyc. lei. 1	Pl. aus. 2	Total 62
<i>Cocodmus vicinus</i>	—	—	—	—	1	—	—	1
<i>Nycteribia (N.) latreillei</i>	—	2	—	—	—	—	—	2
<i>Nycteribia (A.) vexata</i>	—	3	—	—	—	—	—	3
<i>Stylidra biarticulata</i>	7	—	—	—	—	—	—	7
<i>Basilisa (B.) mediterranea</i>	—	—	—	1	—	—	—	1
<i>Brachytarsina flavipennis</i>	40	—	—	—	—	—	—	40
<i>Ischnopsyllus (I.) consimilis</i>	—	—	—	—	10	—	—	10
<i>Ischnopsyllus (I.) intermedius</i>	—	—	1	—	—	—	—	1
<i>Rhinolophopsylla u. arabs</i>	1	32	—	—	—	—	—	33
Total	48	37	1	1	11	—	—	98

Basilisa (Basilisa) mediterranea Húrka, 1970

1♂, 29. 4. 1980, *Pipistrellus pipistrellus* (Schreber) ♀, El Beida evn., Cyrenaica.

This is the second find of the species described from Mallorca and known only in the male sex. The specimen agrees well with the holotype; differences in chaetotaxy: ctenidium with 59 spines, 5th abdominal sternum bears 15 spines, third abdominal sternum with 3 rows of small bristles on the surface. Length 2.4 mm.

Streblidae

Brachytarsina flavipennis Macquart, 1851

17♂♂, 23♀♀, 23. 4. 1980, *R. mehelyi*, cave in Vadi el Kuf, Cyrenaica.

Circummediterranean cave-dwelling species described from Algeria and in the southern part of its area found also in Morocco, Tunis, Egypt and Israel. The average infestation of 23 examined bat specimens was 1.7, maximally 7 flies were found on one host bat.

Ischnopsyllidae

Ischnopsyllus (Ischnopsyllus) consimilis (Wahlgren, 1904)

1♂, 2♀♀, 16. 4. 1979, 1♂, 1♀, 20. 4. 1980, 4♀♀, 3. 5. 1980, *Pipistrellus kuhli* (Kuhl), Ain Zeyanah; 1♀, 7. 5. 1980, *P. kuhli*, Antique ruins of Sabratha.

Only 7 specimens (2♂♂, 5♀♀) of this rare species are mentioned in literature. Wahlgren (1904) described the species according to single female collected in the neighborhood of Cairo, Egypt, ex *Rhinopoma microphyllum* (this specimen is lost). Smit (1953) described the male (designated as neotype) of this species, found in Lower Egypt (Dakahlia Province) on *Pipistrellus kuhli* and the same author (Smit, 1954) redescribed the female from the sample of 1♂, 2♀♀ collected in Israel from *P. kuhli*. Last but not least Lewis (1962) recorded 2♀♀ from Lebanon, one from *P. kuhli*, the other from *P. pipistrellus*.

From the given data it seems evident that *I. consimilis* represents an East-mediterranean faunal element parasitizing *Pipistrellus kuhli* as a principal host. Lewis (1962: 56) supposes a low frequency of this flea in bat populations as he found only one flea specimen on over 70 *Pipistrellus kuhli*. Our sample of 9 fleas was collected on 24 specimens (5♂♂, 19♀♀) from a dispersed

colony of this species in an abandoned solitary house. The remaining female was found on one examined female from the colony of about 35 specimens in ruins of an ancient Roman town.

Two males and eight females from Libya agree very well with the redescription of this flea species by Smit (1953, 1954) except for the number of spines in the ctenidia, which are in average lower, mainly on terga 1 and 4–6. The counts of the spines in the ctenidia of the known specimens are as follows:

	males				females			
	Libya	Egypt	Israel	Libya	Ø	Egypt	Israel	
Pronotum	25 26	25	28	25–28	27	26	27 27	
Metanotum	24 28	25	27	22–29	25	24	26 28	
Tergum 1	6 8	12	12	6–10	8	12	12 10	
Tergum 2	22 24	22	29	18–25	22	20	24 23	
Tergum 3	20 20	20	26	16–21	19	18	20 18	
Tergum 4	15 17	17	21	14–17	16	18	18 16	
Tergum 5	12 13	13	15	10–13	12	14	14 11	
Tergum 6	9 11	13	15	9–11	10	12	12 10	

It seems, in spite of the rather limited material, that the counts of spines in the ctenidia increase in the eastern direction. Also the number of bristles on the sternum 7 in females is lower (7–12, aver. 9) in the Libyan sample than in two specimens from Israel (6 and 6 on one side — Figs. 9 and 10 by Smit, 1954). Under the collar of mesonotum there are 2–3 pseudosetae in the Libyan specimens. Body length of males 2.0 and 2.1 mm, of 8 females 2.1–2.4 mm (aver. 2.3 mm).

Ischnopsyllus (Ischnopsyllus) intermedius (Rothschild, 1898)

1♀, 6. 5. 1980, *Eptesicus serotinus isabellinus* (Temminck), Tripoli — Sidi Mesra.

Westpalearctic flea known in North-Africa only from Morocco (Grenier, 1957); 33 km SE Casablanca 1 male was found on *E. s. isabellinus*. Female from Tripoli agree in all features with the European specimens.

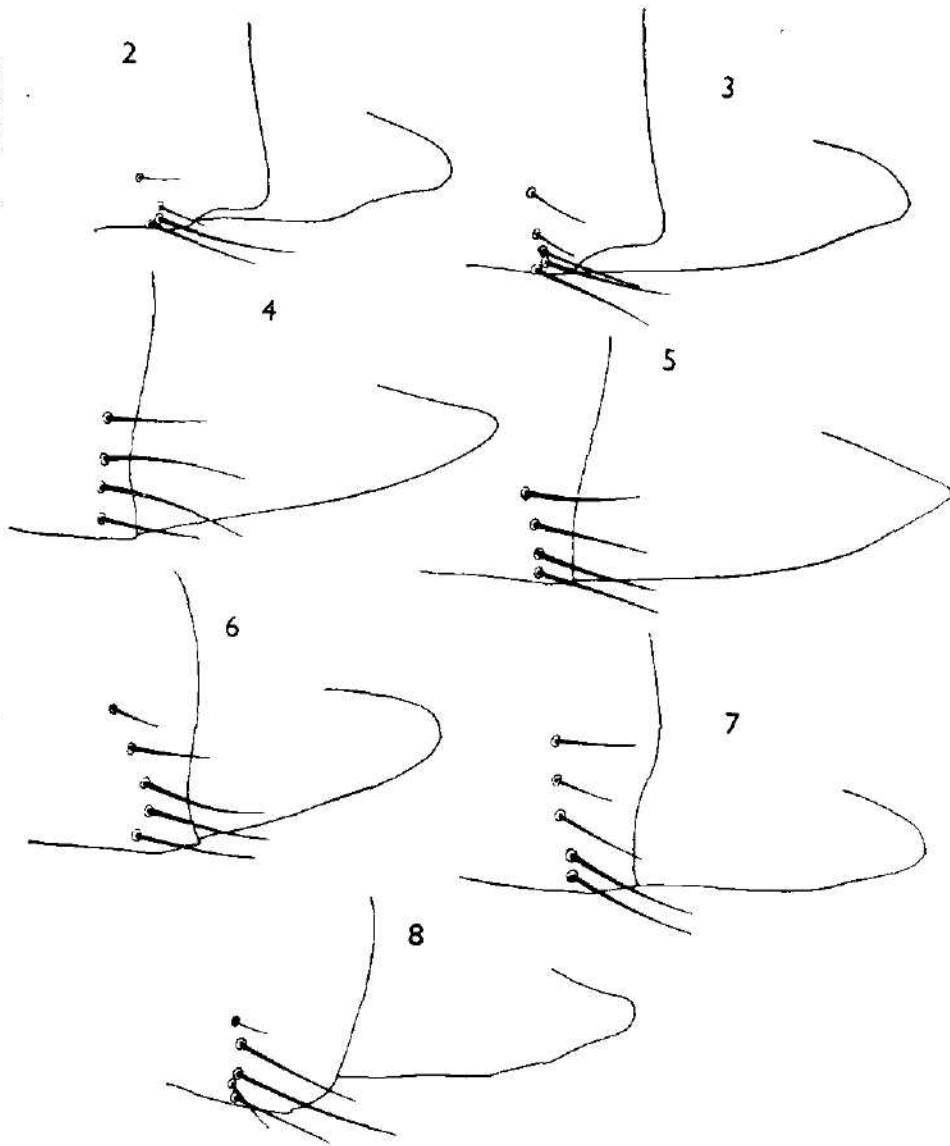
Rhinolophosylla unipectinata arabs Jordan et Rothschild, 1921

20♂♂, 12♀♀, 2. and 7. 4. 1979, *Myotis blythi punicus* Felten, Sabratha; 1♀, 23. 4. 1980, *Rhinolophus mehelyi* Matschie, cave in Vadi el Kuf, Cyrenaica.

Rhinolophosylla unipectinata (Taschenberg) is distributed in southern half of the Palearctic region and in the North-West Himalays. The Northafrican subspecies was described from Guelt-es-Stel and Qudna Mesnil in Algeria, reported from Tunis (Vermeil, 1961) and recently found also in Morocco (Rousselle, 1968; Beaucournu, Léger, Rosin, 1975; Hastriter, Tipton, 1975). The sample from Algeria was associated with *Rhinolophus ferrumequinum* and *Rhinolophus* sp., that from Tunis with *M. b. punicus* and in Morocco the subspecies was found on *M. b. punicus* (given as *Myotis myotis*) and *Rhinolophus ferrumequinum*.

The infestation of five examined *Myotis blythi punicus* from Sabratha ruins was relatively high: ♂ — 3, ♀ ad (pregnant) — 21, ♂ — 1, ♂ — 2, ♀ ad — 5, probably caused by the isolated occurrence of the hosts. On the contrary only one flea has been found on 23 examined *R. mehelyi* from the cave in Vadi el Kuf.

In the morphological characters the Libyan specimens agree with the original description by Jordan et Rothschild (1921) as well as with the drawings by Hastriter and Tipton (1975) based on specimens from Morocco. The body length of 20 males 2.10—2.70, in average 2.40 mm, that of 12 females 2.05—2.70, in average 2.45 mm.



Figs. 2—8: Sternum 7 and sternum 8 of females *Rhinolophopsylla unipunctinata*: 2 — *R. u. arabs*, Libya, Vadi el Kuf, 3 — *R. u. arabs*, Libya, Sabratha; 4 — *R. u. unipunctinata*, Albama mer.; 5 — *R. u. unipunctinata*, Czechoslovakia, Moravia mer.; 6 — *R. u. turcestanica*, Kirgizia, Osh env.; 7 — *R. u. turcestanica*, Uzbekistan, Samarkant env.; 8 — *R. u. indica*, allotype.

The differences in the shape of sterna 7 and 8 and in the chaetotaxy of sternum 7 in the female sex between all four described subspecies of *R. unipunctinata* (Tasch.) are evident from Figs. 2–8.

Zoogeographical comments

Only the coastal parts of Tripolitania and Cyrenaica have been investigated for insect bat ectoparasites. From the nine ascertained species the smaller part is of the Westpalearctic distribution (*N. latreillii*, *N. vexata*, *S. biaticulata*, *I.*

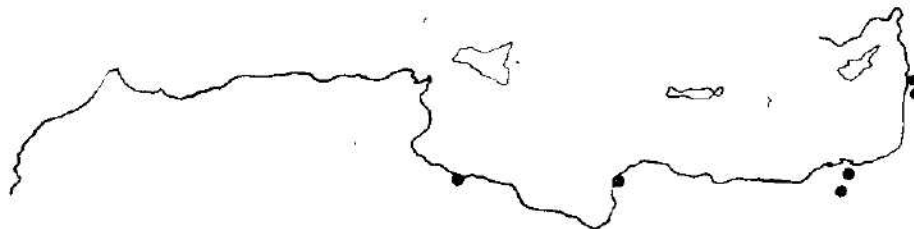


Fig. 9. Southeastmediterranean distribution of *Ischnopsyllus (I.) consimilis*.

intermedius), the remaining larger portion belongs to the Mediterranean fauna. From these *Brachytarsina flavipennis* and probably also *Basilisa mediterranea* are species with the Circummediterranean distribution, while *Cacodmus vicinus* and *Rhinolophopsylla unipunctinata arabs* are distributed only in the southern part of this area; *Ischnopsyllus (I.) consimilis* is a Southeast-Mediterranean element entering Tripolitania.

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This paper is a contribution to Libyan fauna resulting from expeditionary activity of Czechoslovak zoologists from the Department of Systematic zoology, Charles University, Praha, backed by the Department of Zoology, Faculty of Science, Al-Fateh University, Tripoli and the Department of Zoology, Faculty of Science, Garyounis University, Benghazi. We are very grateful for a considerable assistance received from Heads of the respective faculties and departments, and from their staff members and technicians.

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RESPONSE TO PESTICIDES OF DIAPAUSING FEMALES TETRANYCHUS URTICAE (ACARINA, TETRANYCHIDAE)

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Abstract. Diapausing females *T. urticae* from a pesticide-susceptible population from Chelčice were more resistant to metidathion, monocrotophos, amidothion, azinphosethyl, vamidothion, diazinon, thiometon, mevinphos, dimefox, amitraz, dinocap, fenson, dicofol, CPCBS + BCPE, cyhexantin, chlorobenzilate, methomyl and carbofuran compared with active females of the same provenience. Tolerance to thiometon, found in diapausing females, disappeared throughout 6 days termination of diapause.

INTRODUCTION

Diapause in females of the two-spotted spider mite, *Tetranychus urticae* Koch, is characterized by some conspicuous features which made this species a favourable object of studies of its manifestations. The diapausing females differ distinctly from the active forms especially in colour: the active females which feed, lay eggs and discharge two types of excretions are greenish-yellow with two marginal black spots of the large mesenteral sacks while diapausing females are orange-red, transparent without any visible content in the digestive and reproductive organs. This orange-red colour is presumably due to high amount of carotenoids soluble in body fats (Veerman, 1977, 1980) while the change of colour from green to red indicates the entering of diapause.

The induction of diapause in females of *Tetranychus urticae* has been studied by several authors (Dubynina, 1965; Bondarenko, 1958; Veerman, 1977, 1980) all of whom consider the photoperiod the decisive factor inducing diapause. Only Bondarenko (1958) concedes that the quality of food may also induce diapause during the season when the host plant is heavily damaged by spider mites and its metabolism seriously changed.

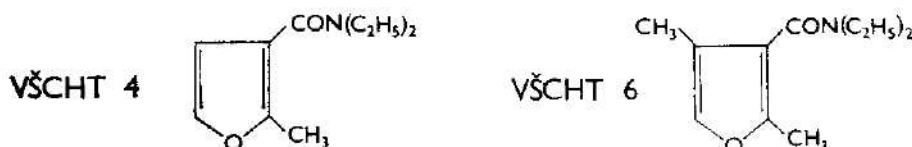
Whatever the factors inducing diapause, the orange-red coloured females of *T. urticae* are the forms capable of surviving unfavourable situations in the environment such as winter season in certain geographical latitudes, lack of suitable green food, increased humidity up to flooding or the action of pesticides (French & Lundlam, 1973; Houter, 1976; Hussey, 1977; Hůrková, 1978).

While monitoring the two-spotted spider mite for resistance in greenhouse (Hůrková, 1976) and hop-gradens populations (Hůrková, Gesner, 1978; Gesner, Hůrková, 1979) we sometimes found diapausing females of this species on heavily damaged host plants during the vegetation season (July through October) and observed great numbers of these forms to survive pesticide treatments. We found the diapausing females more resistant to some

acaricides (Hůrková, 1978). The active females were prone to rapid induction of diapause by some chemicals. The change was indicated by lowered egg-laying, discontinuation of feeding, reduced excretion and, especially, change of colour.

MATERIAL AND METHODS

Susceptible population of *T. urticae* was found in a 2-year old chemically untreated plum orchard in Chelčice (district Strakonice, Southern Bohemia). In September 1979, 100 strips of corrugated paper were placed in this orchard. During September and October, the decisive number of diapausing females took shelter for hibernation within the strips (about 10 000 individuals)



Figs. 4, 5 — Experimental compounds VŠCHT 4, VŠCHT 6

Intoxications of diapausing females *T. urticae* were carried out in January and February 1980 i. e. in the fourth and fifth month of diapause. The females transferred from the outside were allowed to acclimatize for 48 hours under room temperature and then exposed to pesticide-treated leave discs without preliminary feeding.

Intoxications of active females of the same population were performed during October 1979 through June 1980, while this population was bred on *Phaseolus vulgaris* under a temperature of $22 \pm 2^\circ\text{C}$ and a 16-hour photoperiod. The same conditions were used for diapause termination.

The method was based on the modified FAO standard testing method (Anonymous, 1974) as described previously by Hůrková (1977, 1978). The empirical mortality values counted after 48 hours of exposure were referred to statistical evaluation by probit analyse on a Hewlett-Packard 10-98 A calculator. In experiments, devoted to the effect of chemical treatment on the induction of diapause, the reduction of oviposition and the change of colour were compared with untreated control females.

Pesticides: Organophosphorous insecticides: Azodrin 60 (60% monocrotophos), Shell; Thiocron 30 EC (30% amidothion), Ciba-Geigy; Gusathion A (50% azinphosethyl), Bayer; Ultracid (40% metidathion), Ciba-Geigy. Ekatín (20% thiometon), Sandoz; Phosdrin 24 EC (24% mevinphos), Shell, Terra-Sytam (50% dimefox), Murphy; Diazinon 60 (60% diazinon), Ciba-Geigy; Kilval (40% vamidothion), Rhône-Poulenc.

Specific acaricides: Mitac 20 EC (20% amitraz), Chemie Linz; Milbol EC (25% dicofol), Delicia; Akar WP (25% chlorobenzilate), Ciba-Geigy; Rospin 25 EC (25% chloropropylate), Ciba-Geigy; Karathane FN-57 (25% dinocap), Rhom & Haas; Plictran 25 W (25% cyhexantin), Dow; Mitran (50% CPCBS + BCPE), Nippon Soda; Mitex (20% fenison), Murphy. **Fungicide:** Morestan (25% chinomethionat), Bayer. **Carbamate insecticides:** Furadan 75 WP (75% carbofuran), FMC; Lannate 90 WP (90% methomyl), du Pont.

Experimental compound: VŠCHT 4 (Fig. 4) and VŠCHT 6 (Fig. 5). These two compounds from a series prepared in the Institute of Chemical Technology in Prague were diluted in acetone and emulgated by 0.1% Tween 80. All other pesticides were either commercial products tested in the Central Agricultural Control and Testing Institute in Brno or samples provided by producers for experimental purposes.

Table 1. Response of the active and diapausing females *T. urticae* of a pesticide susceptible population (A = active, D = diapausing)

Active ingredient of pesticides	♀♀	Slope	LC 50	95% probability limits	LC 90	LC 50 D	
						LC50A	
1. metidation	A	1.47	0.0007	0.0006 - 0.0008	0.0052	—	
	D	2.64	0.0038	0.0029 - 0.0052	0.0122	5.4	
2. monocrotophos	A	3.13	0.0008	0.0007 - 0.0009	0.0022	—	
	D	4.13	0.0096	0.0085 - 0.0110	0.0197	10.9	
3. amidothion	A	3.24	0.0010	0.0008 - 0.0013	0.0026	—	
	D	3.56	0.0362	0.0299 - 0.0439	0.0829	36.2	
4. azinphosethyl	A	3.90	0.0011	0.0010 - 0.0013	0.0024	—	
	D	2.85	0.0022	0.0015 - 0.0030	0.0063	2.0	
5. vamidothion	A	4.86	0.0018	0.0016 - 0.0020	0.0084	—	
	D	5.11	0.0532	0.0478 - 0.0592	0.0806	29.5	
6. diazinon	A	2.76	0.0025	0.0011 - 0.0033	0.0074	—	
	D	3.72	0.0043	0.0037 - 0.0050	0.0096	1.7	
7. thiometon	A	8.89	0.0087	0.0086 - 0.0088	0.0121	—	
	D	5.08	0.0502	0.0444 - 0.0566	0.0897	5.7	
8. mevinphos	A	1.54	0.0227	0.0167 - 0.0437	0.1532	—	
	D	3.95	0.0955	0.0814 - 0.1121	0.2813	4.2	
9. dimefox	A	2.78	0.0295	0.0204 - 0.0284	0.0715	—	
	D	4.62	0.1172	0.0994 - 0.1415	0.2221	4.8	
10. amitraz	A	3.70	0.0048	0.0044 - 0.0053	0.0108	—	
	D	3.55	0.0345	0.0300 - 0.0398	0.0794	7.1	
11. chinomethionate	A	2.98	0.0052	0.0041 - 0.0067	0.0141	—	
	D	3.33	0.0044	0.0039 - 0.0050	0.0108	0.8	
12. dinocap	A	1.14	0.0094	0.0086 - 0.0195	0.0506	—	
	D	3.15	0.0290	0.0247 - 0.0367	0.0739	3.0	
13. chloropropylate	A	3.12	0.0168	0.0101 - 0.0212	0.0421	—	
	D	3.95	0.0162	0.0145 - 0.0180	0.0342	1.0	
14. fenison	A	3.48	0.0284	0.0254 - 0.0317	0.0662	—	
	D	1.62	0.0886	0.0671 - 0.0171	0.5464	3.1	
15. dicofol	A	2.36	0.0496	0.0387 - 0.0712	0.1734	—	
	D	2.53	0.0596	0.0478 - 0.0743	0.1030	1.2	
16. CPCBS + BCPE	A	2.20	0.0650	0.0453 - 0.0953	0.2481	—	
	D	1.56	0.3237	0.2301 - 0.4363	2.1334	5.0	
17. cyhexantin	A	2.30	0.0848	0.0646 - 0.2063	0.2355	—	
	D	2.33	0.3166	0.2541 - 0.3943	1.1233	3.7	
18. chlorobenzilate	A	2.84	0.0885	0.0648 - 0.1386	0.2496	—	
	D	2.88	0.1061	0.0833 - 0.1252	0.2929	1.2	
19. methomyl	A	3.62	0.0431	0.0376 - 0.0495	0.0974	—	
	D	1.80	0.1183	0.0912 - 0.1470	0.6055	2.7	
20. carbofuran	A	3.54	0.0745	0.0580 - 0.0901	0.1713	—	
	D	3.42	0.2717	0.2481 - 0.2974	0.6434	3.6	

RESULTS

1. The response of diapausing *T. urticae* females was compared with that of active females of the same population (Table 1). Higher LC 50 values 2 - 36X were found in diapausing females for all 9 tested organophosphorous compounds and for 7 specific acaricides out of 8 testes (1.2-7X higher LC 50). Only chinomethionate and chloropropylate exhibited equal toxicity to both diapausing and active females. Two carbamates were 3 or 4X more toxic to active females compared with diapausing ones.

Hence, a fresh evidence has been provided of higher tolerance in diapausing *T. urticae* females to organophosphorous insecticides which at the same time were more toxic to active forms of the used strain. On the other hand, lower tolerance was found to specific acaricides which were less toxic even to the active females.

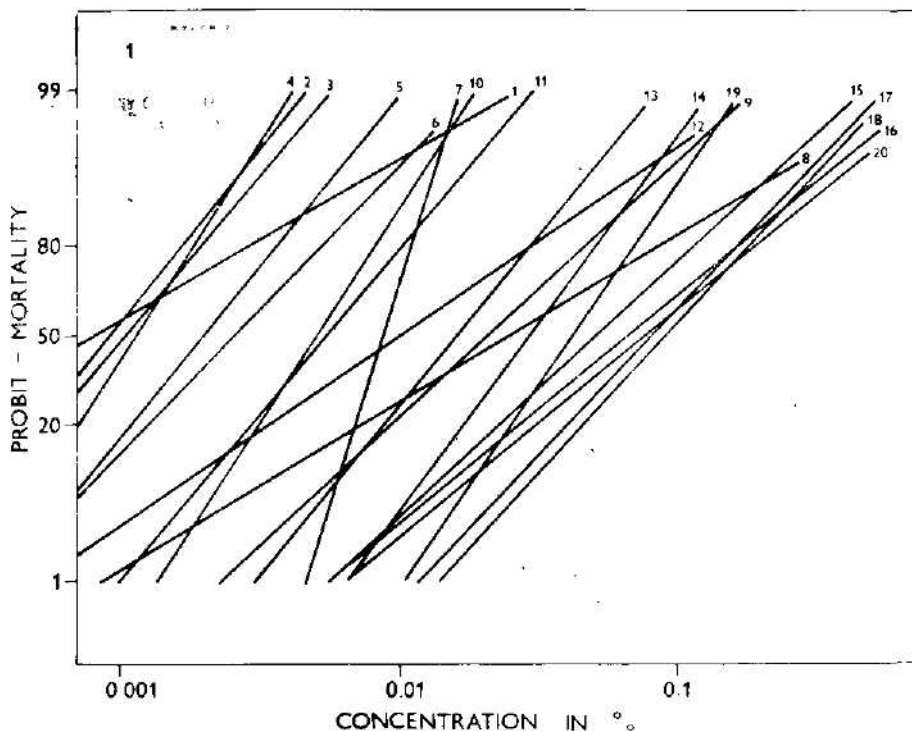


Fig. 1 - Probit-log regression lines for 20 pesticides tested on the active females *T. urticae* Koch of a pesticide susceptible population from an orchard in Chelčice

2. A gradual decrease of LC 50 values with thiometon was observed during 6 days of diapause termination in the two-spotted spider mite population from Chelčice (Fig. 3). LC 50 = 0.05% was determined in diapausing females 48 hours after their transfer to room temperature. These females had not fed for 6 months and in the following 48 hours when they began to feed on beans, LC 50 decreased to 0.01%. On the fifth termination day LC 50 decreased to 0.008% and on the sixth day it was even lower (0.007%) than in active females normally bred on the host plant (0.0085%). This gradually decreasing LC 50 proved that no real resistance is involved in the diapausing forms. Oviposition started within 36 hours after the beginning of feeding. On the tenth day, the natural mortality of the overwintering females reached 73.5% and the average number of eggs laid was about 50 per one female.

3. The induction of diapausal characters in active females of *T. urticae* from Chelčice is reviewed in Table 2. In females treated with a 2.5% concentration

of VSCHT 4 or VSCHT 6 oviposition reached only 13.3% or 16.0% and in females treated with 1.25% concentration 40.8% or 26.0% as compared with untreated females. Almost all surviving females were pink coloured (100% with 1.25% VSCHT 4 and 93.6% with VSCHT 6), they stopped feeding and oviposition and the content of digestive organs began to be reduced.

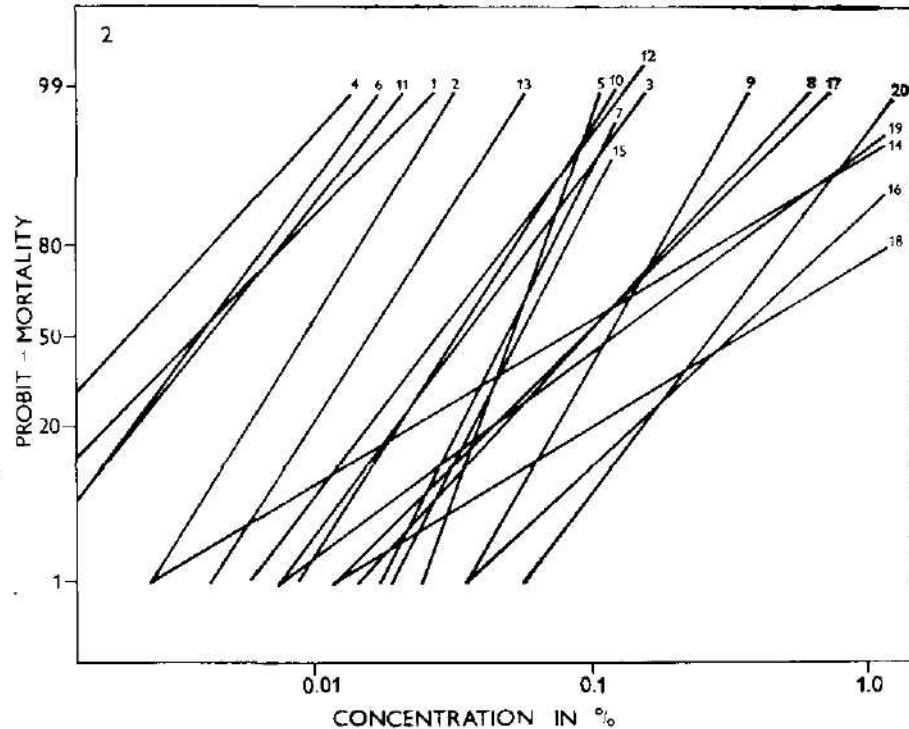


Fig. 2 — Probit-log regression lines for 20 pesticides tested on the diapausing females *T. urticae* of the same population

DISCUSSION

Diapause in the females of *Tetranychus urticae* is of substantial importance for the practical management of this secondary pest. French & Lundlam (1973) stressed the necessity of monitoring the presence of diapausing females in greenhouses when timing chemical treatment. The experimentally proved higher tolerance of diapausing females to most pesticides tested (Houter, 1976. Hůrková, 1978 and the present paper) may be responsible for the failure of chemical treatments especially in greenhouses where a part of the population is in diapause.

Diapausing females do not affect the host plant, because they neither feed nor reproduce; this should be taken into account in a more sophisticated integrated plant production management. It also seems that diapause in *T. urticae* is not obligatory and may be quickly induced by a complex of factors also

as a transient physiological state, manifested by a conspicuous change of colour and the discontinuation of feeding and oviposition. These problems have been studied also in further detailed studies directed especially at morphology, anatomy and physiology (W e y d a, 1982 in press).

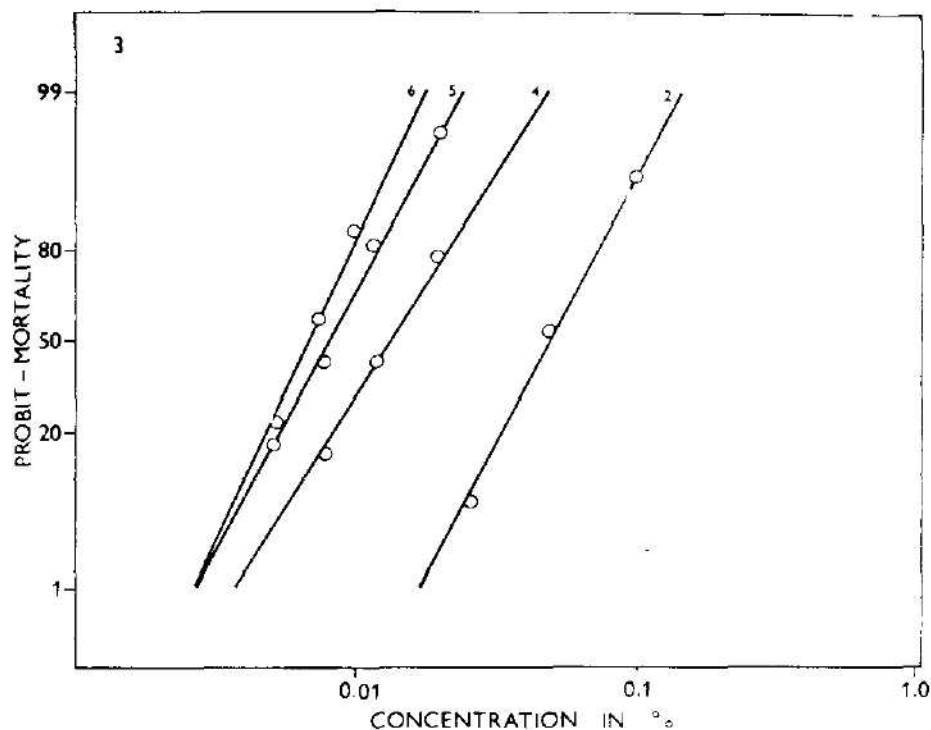


Fig. 3 — Decrease of thiometon-resistance in females *T. urticae* Koch during 6 days of diapause termination (2, 4, 5, 6 = days of termination)

Acknowledgement

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Table 2. Induction of colour change and the break of oviposition in active females *T. urticae*

Treatment	Concentration	Total ♀♀	Surviving		Colour change		Number of eggs		Eggs/♀		
			24 h	48 h	24 h	48 h	24 h	48 h	24 h	48 h	
Untreated control		282	280	99.2	280	99.2	0	1119	1932	3.99	6.9
VŠCHT 4	5%	296	2	0.6	0	0	0	0	0	0	0
	2.5%	368	226	61.4	186	45.1	154	60.3	72	154	0.31
	1.25%	284	235	82.7	235	82.7	221	94.0	235	100.0	1.94
VŠCHT 6	5%	384	0	0	0	0	0	0	0	0	0
	2.5%	393	256	65.1	178	45.2	159	62.1	159	89.3	1.1
	1.25%	411	338	82.2	299	72.7	277	81.9	280	93.6	0.65

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**SOME NEW DATA ON THE BIONOMICS OF CYSTIDICOLOIDES TENUSSIMA
(NEMATODA: CYSTIDICOLIDAE)**

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Abstract. Bionomics of the nematode *Cystidicoloides tenuissima* (Zeder, 1800), a parasite of trout, was studied in the Černovický Brook (the Elbe River basin) in Czechoslovakia in the years 1977–78. The mayfly *Ephemera danica* Mull was found to be the only intermediate host. No substantial seasonal changes were observed in the degree of infection of mayfly nymphs, but this remained high during the whole year. It was evidenced for the first time that the life cycle of this parasite involves natural paratenic hosts (the fish *Cottus gobio*). In contrast to other localities, *C. tenuissima* has no distinct generations here, but gravid females lay eggs throughout the year, seasonal changes are quantitative only. A comparison of data from the Černovický Brook with those obtained from another locality in Czechoslovakia (the Bystřice River) reveals that the seasonal maturation cycle of *C. tenuissima* is induced by ecological factors, particularly water temperature and seasonal changes in the populations of intermediate mayfly hosts.

The nematode *Cystidicoloides tenuissima* is a frequent and widely distributed parasite of salmonids in the Holarctic. Its life cycle involves obligatory intermediate hosts, which are various species of mayflies (Chouquette, 1955; Moravec, 1971 a, b; De and Moravec, 1979). The population biology of this species was studied for the first time by Moravec (1971 b) in the years 1967–68 in the trout river Bystřice in Czechoslovakia and later also by some other authors in Europe and North America (Awachie, 1973; Hare and Burt, 1975, Alvarez Pellitero, 1976). In 1977–78, the present authors carried out some observations on the biology and ecology of this parasite in the Černovický Brook near Tábor, Czechoslovakia, where ecological conditions for the development of *C. tenuissima* are quite different from those in the River Bystřice, the results obtained are presented in this paper. The seasonal maturation cycle of *C. tenuissima* was found to be of other type in this locality, compared to available records from other European localities (Moravec, 1971 b; Alvarez Pellitero, 1976) enabling thus a more precise determination of factors influencing the circulation of this nematode in the environment.

MATERIALS AND METHODS

The population dynamics of *C. tenuissima* was followed in brown trout (*Salmo trutta* m. *fario* L.) from the upper reaches of the Černovický Brook near Tábor (the Elbe River basin) in South Bohemia, Czechoslovakia. Fish samples were taken at regular monthly intervals by means of an electric fishing machine from a locality near the village of Mlýny from September 1977 to October 1978 (see Table 1). Immediately after the transfer to the laboratory in Prague the fish were examined for the presence of helminth parasites. In addition to 270 specimens of brown trout (*S.*

Table 1. Survey of *Salmo trutta m. fario* examined from the Černovický Brook and their infection with *Cystidicoloides tenuissima*

Year and Month	No. of trout examined	No. of trout infected	Incidence (%)	Intensity of infection (mean, range)	Body length of trout in cm (mean, range)
1977					
September	12	12	100	27 (2-108)	23 (14-34)
October	18	18	100	18 (4-63)	24 (8-39)
November	22	22	100	24 (1-64)	21 (8-27)
December	27	25	92.6	30 (1-90)	20 (6-29)
1978					
January	22	22	100	37 (1-111)	18 (6-26)
February	10	10	100	117 (17-424)	22 (14-27)
March	20	19	95.0	34 (7-210)	17 (7-23)
April	18	18	100	86 (8-383)	21 (15-25)
May	18	16	88.9	73 (6-223)	19 (7-25)
June	27	27	100	85 (16-199)	19 (13-25)
July	29	27	93.1	138 (6-415)	19 (5-37)
August	17	17	100	55 (12-216)	21 (18-25)
September	17	17	100	40 (1-132)	20 (18-23)
October	13	13	100	49 (6-98)	21 (11-30)
Total	270	263	98	58 (1-424)	20 (5-39)

trutta m. fario L.), also 1 brook trout (*Salvelinus fontinalis* (Mitchill)), 3 roach (*Rutilus rutilus* (L.)), 2 loach (*Noemacheilus barbatulus* (L.)), 1 eel (*Anguilla anguilla* (L.)), and 26 bullhead (*Cottus gobio* (L.)) were examined from this locality. Benthic invertebrates were sampled irregularly throughout the year and these were compressed and examined microscopically for the presence of helminth larvae. The following invertebrates were examined in this way: larvae of aquatic insects: Ephemeroptera 1080 specimens (*Ephemera danica* 657, *Baetis* 173, *Rhithrogena* 121, *Ecdyonurus* 59, *Paraleptophlebia* 39, *Habrophlebia* 13, *Ephemerella* 11, *Habroleptoides* 4, *Caenis* 1), Plecoptera 121, Trichoptera 71, Diptera 340, Megaloptera 5; Oligochaeta 33 specimens, Mollusca (*Ancylus*, *Pisidium*): 28 specimens. The characterization of the locality has been given in a previous paper by Moravec (1980) dealing with the biology of the nematode *Cucullianus truttae*.

OBSERVATIONS

1. Intermediate and paratenic hosts of *C. tenuissima*:

Mayfly nymphs *Ephemera danica* Müll., which are very abundant in this locality, were found to serve as the only intermediate hosts of *C. tenuissima*. Out of the 657 mayflies examined during the period from October to July of the following year, 80% were infected by *C. tenuissima* larvae, the intensity being 1-22 nematodes per mayfly. The nematode larvae were located free in the body cavity of the intermediate host, most often in the abdomen, but also in the thorax or even in the legs.

Owing to irregular sampling of invertebrates and due to unbalanced samples from individual months it is impossible to determine precisely seasonal changes in the degree of infection in the intermediate mayfly hosts; however, the results obtained indicate that the infection degree does not exhibit any substantial seasonal differences, but remains high throughout the year. In *E. danica* nymphs infected with *C. tenuissima*, the infection degree is directly related

to the body size of mayfly larvae. This relationship is obvious, e. g., in a mayfly sample collected in this locality in November 1977. In the size groups of mayflies with body lengths (without cerci) 21—25, 16—20, 11—15 and 6—10 mm the incidence was 91.8⁰₀, 78.6⁰₀, 68.7⁰₀ and 4.8⁰₀ and mean intensity of infection 3.7, 2.6, 1.7 and 1.0, respectively. Similar situation was in the other months, when a sufficiently large number of mayflies were collected. From October 1977 to July 1978, the incidence and mean intensity of infection in individual size groups of mayfly nymphs were as follows:

Mayfly size:	Incidence:	Mean intensity:
21—25 mm	87—100 ⁰ ₀	3.7—9.0
16—20 mm	50—95 ⁰ ₀	2.3—5.2
11—15 mm	68—69 ⁰ ₀	1.5—1.7
6—10 mm	5—67 ⁰ ₀	1.0—3.1

Even though the infective larvae of *C. tenuissima* were recorded only in *Ephemera danica* nymphs in this locality, it is probable that also other mayfly species (e. g. *Habroleptoides*, *Habrophlebia*) may become occasional intermediate hosts of this parasite; their significance for the local population of the parasite is, however, negligible.

Infective *C. tenuissima* larvae were recovered also from 2 of the 26 examined bullhead, *Cottus gobio* (body length 10—13 cm), which may be regarded as paratenic host. All the larvae (20 and 27) were of the third stage and were located like in the definitive host, i. e., they were attached to the mucosa of stomach. Since bullhead are often a prey of trout, they may thus represent a complementary source of *C. tenuissima* infection for trout.

2. Definitive hosts of *C. tenuissima* and their food:

Brown trout, *Salmo trutta* m. *fario*, were found to be the only definitive hosts in this locality. Although *Salvelinus fontinalis* may be considered a potential host, it is unimportant in this locality due to its rare occurrence.

The examinations of trout stomachs revealed that an important component of their diet are in the course of the whole year benthic invertebrates (larvae of aquatic insects, oligochaetes and mollusks), being dominant particularly in winter months. In the period from August to October, however, terrestrial insects and imagoes of aquatic insects prevailed. Bullhead and small trout were occasionally found in stomachs of larger trout. Mayfly nymphs (including *Ephemera*) were recorded in the trout diet all the year round.

3. Occurrence of *C. tenuissima* in trout:

A total of 270 trout were examined and 263 (98⁰₀) of them were found to be infected with *C. tenuissima* (a survey of trout examined and their infection in individual months is shown in Table 1). The incidence remained high during the whole year, but the curve of mean intensity (Fig. 1) shows two distinct peaks: after a sudden increase in February follows a strong decrease in March; since April the intensity is again increasing to attain the second, highest level in July; in August occurs a sudden drop which lasts till January.

There is a distinct relationship between *C. tenuissima* infection in trout and the size of trout body. This is due to the ability of these fish to swallow intermediate mayfly hosts and differences in the diet of individual size groups

of these hosts. The smallest trout in which *C. tenuissima* infection was recorded measured some 6 cm (O^+) only. As it is shown in Fig. 2, the incidence in trout smaller than 10 cm was only 73%, but in all larger size groups it was about 100%. However, the curve of mean intensity of infection shows that the intensity was gradually increasing to attain the peak only in trout measuring 20—25 cm (age 2—3 years) and again somewhat decreasing in fish of larger

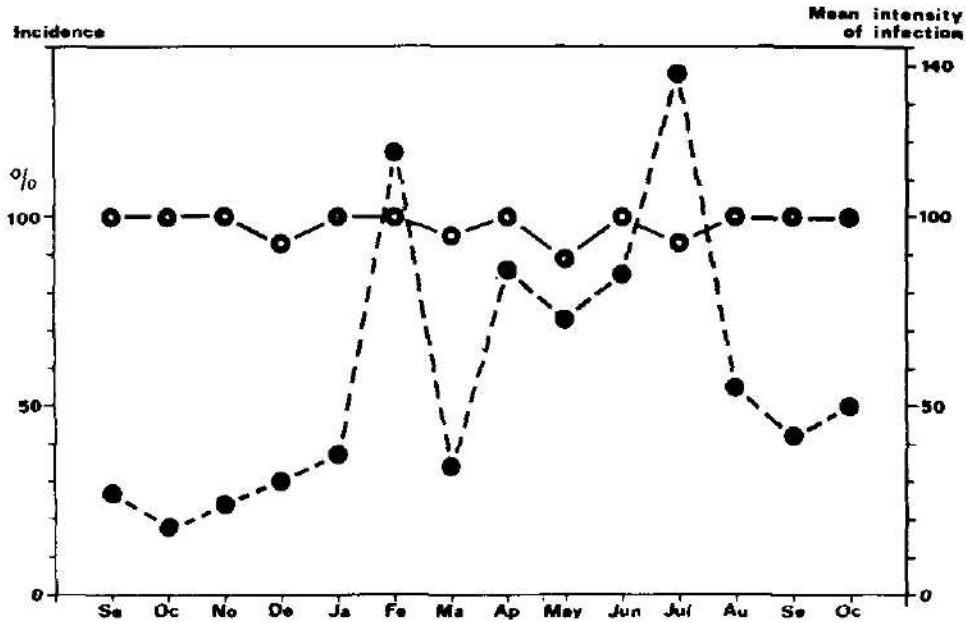


Fig. 1. Variation of incidence (—) and mean intensity (----) of *C. tenuissima* infection in brown trout of the Černovický Brook in the period from September 1977 till October 1978.

size groups. The decrease of mean intensity of infection in largest (oldest) trout seems to be due to the fact that the proportion of benthic invertebrates in their diet is smaller and these trout increasingly feed on small fish.

4. Seasonal changes in maturation of *C. tenuissima*:

It is evident from Fig. 3 that *C. tenuissima* larvae of the third and fourth stage are present in trout throughout the year and in winter months they represent the greatest part of the samples; their proportion in the sample markedly decreased only in May. The constant presence of third-stage larvae indicates that new infections occur in trout in all months. Males and females with immature eggs in their uteri were recorded in the course of the whole year, while gravid females with mature eggs (containing larvae) were present mainly in the period from May to December and occasionally also in February and March. The values obtained, however, suggest (Fig. 3) that gravid females may individually occur even in the remaining two months (January and

April). Consequently, the oviposition in this locality takes place practically during the whole year, but largely in warmer period from May to November. *C. tenuissima* does not create separated generations here, but its seasonal maturation cycle is manifested only quantitatively.

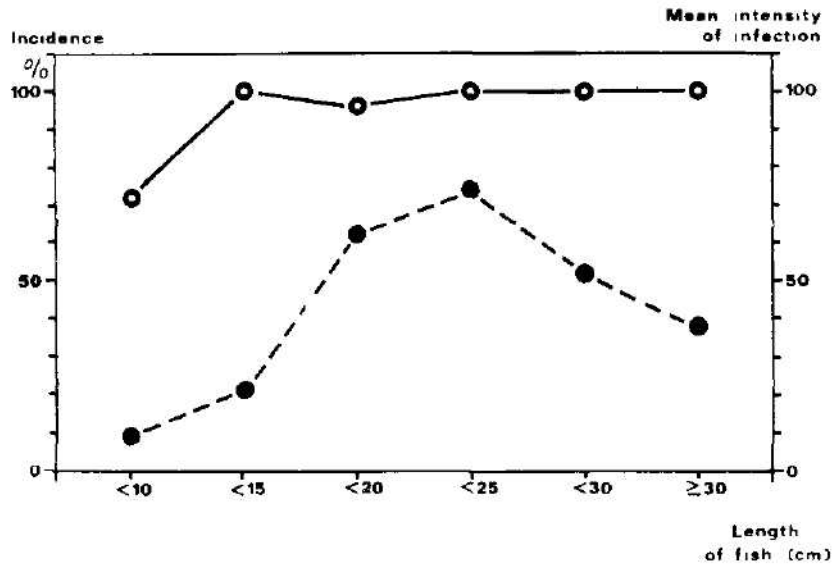


Fig. 2. Dependence of incidence (—) and mean intensity (-----) of *C. tenuissima* infection on the body length of brown trout.

DISCUSSION

Linstow (1872) seems to be the first author who found *C. tenuissima* larvae in the intermediate host. He described spiruroid larvae recovered from mayfly nymphs *Ephemera vulgata* and *Oligoneuria* (= *Oligoneuriella*) *rhenana* in Germany, designating them *Filaria ephemeridarum*; under this name he obviously included larvae of the genera *Cystidicoloides* (*C. tenuissima*) and *Rhabdochona* (see Moravec, 1972). More recently only Choquette (1955) recorded infective larvae of *C. tenuissima* from nymphs of two mayfly species in Canada, namely in 40% of *Hexagenia* (= *Litobrancha*) *recurvata* and occasionally also in *Polymitarcys* (= *Ephoron*) sp. In Europe, Moravec (1971 b) found the nymphs of *Habroleptoides modesta* and *Ephemera* sp. (probably *E. danica*) to serve as natural intermediate hosts of *C. tenuissima* in the River Bystřice in Czechoslovakia. Although in *Ephemera* sp. the incidence was markedly higher (40%) than in *H. modesta* (1.7%), due to different abundance of these species in the locality a decisive source of infection for trout was the species *H. modesta*. On the other hand, our results from the Černovický Brook suggest that *Ephemera danica*, which is very abundant here, is almost the only intermediate host of *C. tenuissima* in this locality, the incidence being nearly 100% in older nymphs and intensity of infection as much as 22 larvae per mayfly. Infective larvae of this nematode were found in *E. danica* nymphs

also by Vojtková (1971) in Czechoslovakia, Arvy and Sowa (1976) in Poland and Svensson (personal communication) in southern Sweden. Also Awachie (1973) mentioned a frequent occurrence of unidentified spiruroid larvae in *E. danica* in a trout stream in Great Britain where he studied the population dynamics of *C. tenuissima*. The records suggest that mayflies of the genus *Ephemera*, particularly the widely distributed and abundant species *E. danica*, belong to the most frequent intermediate hosts of *C. tenuissima* in

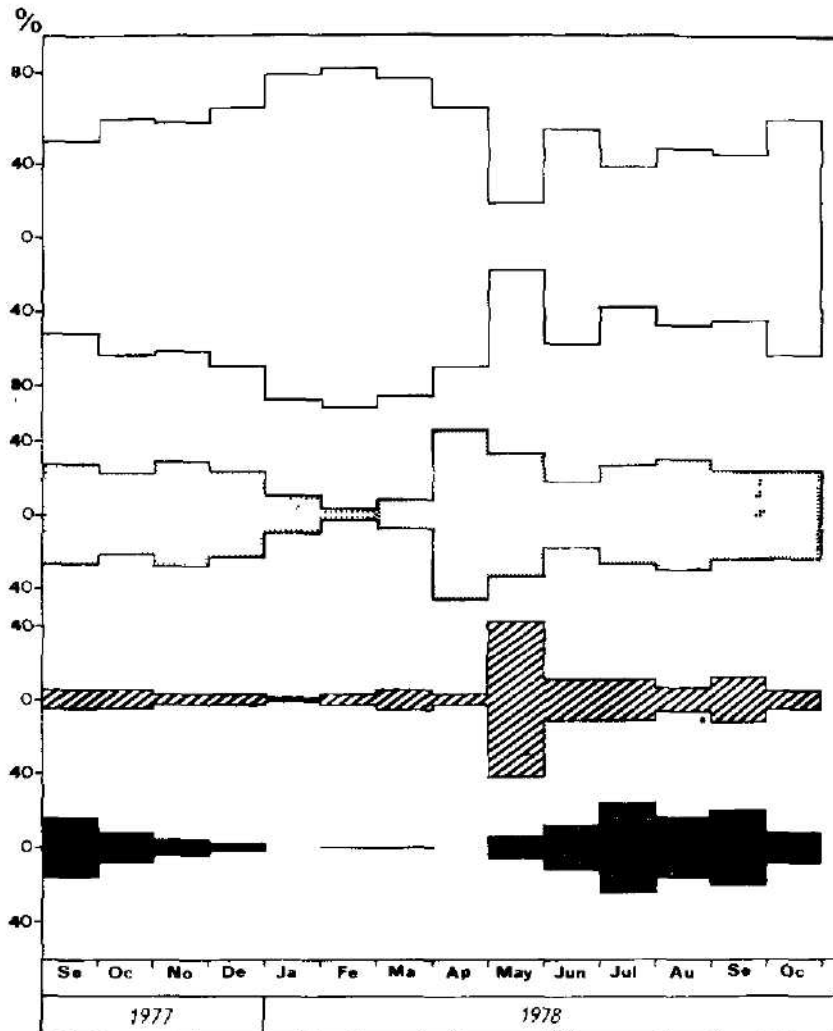


Fig. 3. Monthly changes in occurrence and state of maturity of *C. tenuissima* in brown trout of the Černovický Brook in the period from September 1977 till October 1978. The data are expressed as percentages of the total number of nematodes found per month: third- and fourth-stage larvae (unshaded), males (stippled), females containing immature eggs (obliquely hatched), and gravid females containing mature eggs (blackened).

Europe. In some localities, however, other mayfly species are the most important intermediate hosts.

So far, no paratenic hosts have been known to participate in the life history of either *C. tenuissima* or other related nematode groups and the intermediate hosts (mayflies) have been considered a single source of infection. Only the experiments of De and Moravec (1979) showed that loach (*N. barbatulus*) can become paratenic hosts of *C. tenuissima*. The finding of infective larvae of this nematode in bullhead (*C. gobio*) in the Černovický Brook (these larvae were recovered from the same host also by Moravec (1971 b) in the River Bystřice) confirms that paratenic hosts of *C. tenuissima* occur also under natural conditions. This fact is important from the epizootological viewpoint, as it indicates that though the intermediate mayfly hosts are the main source of infection for the definitive host, trout (particularly the older ones) may acquire *C. tenuissima* infection partly also through paratenic hosts — forage fish. Since both bullhead and loach often occur in the same places as trout, which are feeding on them, this way of infection is not quite insignificant. Only larger specimens of bullhead and loach can serve as paratenic hosts owing to their ability to swallow the intermediate mayfly hosts; this is confirmed also by our observations from the Černovický Brook. Also small specimens of trout may become a source of *C. tenuissima* infection in larger trout as a result of their frequent cannibalism.

The seasonal occurrence and maturation of *C. tenuissima* in trout from the River Bystřice in Czechoslovakia was studied by Moravec (1971 b) who found that this nematode has two distinct generations in this locality — a spring generation and a less numerous autumn one; gravid females producing eggs were present only in the periods May-July and September-October. The same results were later obtained by Alvarez Pellitero (1976) in trout from several rivers in Spain. On the other hand, Hare and Burt (1975) observed in salmon in Canada that gravid females of *C. tenuissima* were present during the whole period of investigation (May-November), but in August-September their proportion in the samples markedly declined. The authors did not differentiate females with mature eggs from those with immature eggs and therefore their data are not comparable with the ours. They state that "the sea-pattern of *C. tenuissima* is similar to that reported by Moravec (1971 b)". However, our observations in the Černovický Brook show that the parasite does not exhibit two generations a year here, but a single mixed generation, so gravid females with mature eggs are present in the locality mainly from May to November-December (maximum numbers being in July-September) and occasionally survive during following winter months till spring (Fig. 3).

A comparison of data from two different localities in Czechoslovakia reveals that the pattern of seasonal maturation of *C. tenuissima* may be different in different localities in dependence of local ecological conditions. The most important factor influencing the seasonal maturation cycle is undoubtedly water temperature affecting the length of *C. tenuissima* development in the intermediate and definitive hosts, as well as the survival of adult nematodes in the host. Alvarez Pellitero (1976) noted that in the lower reaches of rivers, where the water temperature raises earlier and more slowly, the maturation cycles of this nematode are more rapid than in the upper reaches. The direct effect of the temperature is apparent also from the fact that in some helminths parasitic in the fish digestive tract the increased water temperature (above

20 °C) induces their passing out of the host body which was evidenced experimentally also in *C. tenuissima*. In such cases the increased water temperature in summer months may cause that the old generation of the parasite rapidly leaves the host but a recruitment of the new one is still impossible. This seems to be one of the main causal factors responsible for the separation of spring and autumn generations e. g. in *Raphidascaris acus* (see Moravec, 1979). A similar situation is apparently with *C. tenuissima* in warmer localities as in the River Bystrice in Czechoslovakia (Moravec, 1971 b) or in the rivers of Spain (Alvarez Pellitero, 1976). However, in colder localities, where the maximum water temperatures are still suitable for *C. tenuissima*, this summer "interruption" does not occur, so the spring and autumn generations are not separated. Moreover, in contrast to warmer localities, the development of nematodes in the definitive host is slower and they reach maturity much later. Apparently this is the case in the Černovický Brook where, according to our measurements, the water temperature in the warmest season (July-September) reached only 12–14 °C.

In addition to the direct effect of temperature, which is given by the temperature régime in the respective locality, the seasonal rhythms in maturation of *C. tenuissima* are influenced as well by the species composition of intermediate hosts. The seasonal changes in the availability of infective nematode larvae for the definitive host, due to differences in the population dynamics of intermediate hosts, seem to be the second most important factor influencing the pattern of maturation in *C. tenuissima*. In the Černovický Brook, where *C. tenuissima* has no distinct generations, the mayfly *Ephemera danica* is the most important source of infection. The development of this mayfly lasts two years and so the advanced nymphs are present in the locality during the whole year enabling thus new infection of trout (Fig. 3). On the other hand, in the River Bystrice, where two *C. tenuissima* generations occur, a majority of its local population develops through the mayfly *Habroleptoides modesta*, which has a one-year life cycle and larger nymphs are lacking after hatching of imagoes. The recruitment of new infections in trout is thus interrupted for some time. A certain role is also played by differences in the periods of hatching of adult intermediate mayfly hosts which occurs in May and early June in *H. modesta*, whereas in *E. danica* it takes place usually by 1–2 months later (May-August) (Landa, 1969). Owing to the fact that mayfly imagoes are an important source of *C. tenuissima* infection for trout, new infections in fish occur in summer months in case of *E. danica* even though the proportion of benthic animals in the trout diet is usually low at this time; this source of infection in summer months is lacking in case of *H. modesta*.

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The plates will be found at the end of this issue

Addendum

Since this paper was submitted for publication, the first author's studies indicated that the valid name of the nematodes designated herein as *C. tenuissima* is *Cystidicoloides ephemeridarum* (Linstow, 1872) Moravec, 1981 *Fusaria tenuissima* Zeder, 1800 is considered species inquirenda (Moravec, F, 1981 The systematic status of *Filaria ephemeridarum* Linstow, 1872 *Folia parasit (Praha)* 28 377-379)

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DESCRIPTION OF HYBRIDS BETWEEN CICHLASOMA MEEKI AND CICHLASOMA NIGROFASCIATUM (PISCES: CICHLIDAE)

Dedicated to Professor A. P. Andrijašev, DSc, Corresponding Member of the Academy of Sciences of the USSR on the occasion of the 70th anniversary of his birthday

Jindřich NOVÁK

Received September 29, 1980

Abstract 3 specimens of F₁ hybrids between *Cichlasoma meeki* (Brind, 1918) and *Cichlasoma nigrofasciatum* (Gunther, 1869) and 13 specimens of *Cichlasoma meeki* from aquaria were examined with regard to 8 plastic and 9 meristic characters. Computed characteristics were compared with published data concerning both species.

MATERIAL AND METHODS

All specimens examined were originally kept in tank by Czechoslovak aquarium hobbyists, after death they were preserved in formalin and spirit. Measurements of plastic characters were made by means of dividers with the accuracy ± 0.5 mm, the eye diameter, the snout length, the length of the postorbital part of the head and the length of the last dorsal spine with the 0.1 mm accuracy. Meristic characters were counted using the binocular microscope following Regan (1905).

RESULTS AND DISCUSSION

Results are summarized in Table 1 and 2. Hybridisation of the female of the "scarlet chanchito" *Cichlasoma meeki* and the male of the "convict cichlid", *Cichlasoma nigrofasciatum* was described in the aquarium literature by Hroch (1976) and Sudík (1976).

According to these authors, the percentage of reared youngs is low (4—6%). Living hybrids, in their description, are greyish with black, sometimes indistinct cross bars. In the centre of the body a black spot is often found. Males have a high, precipitous brow, similar to *Cichlasoma spilurum*. According to Sudík (1976), females of hybrids are similar rather to *Cichlasoma nigrofasciatum*. Breeding of F₁ hybrids was not observed in aquaria. Breeding of both species in nature is not mentioned in literature. In aquaria *Cichlasoma nigrofasciatum* breeds on free surfaces (flat stones, glass walls of aquarium tanks). *Cichlasoma meeki* in hollows (the empty flower pot is often used in aquarium practice). The coloration of preserved hybrids of *Cichlasoma meeki* and *Cichlasoma nigrofasciatum* is yellowish to brownish with 3—7 cross indistinct blackish bars and a blackish spot in the centre of the body side. The pectoral fin is greyish, other fins are greyish-black (Fig. 1).

Hybrids are intermediate (Table 1, 2). They are nearer to *Cichlasoma nigrofasciatum* in the number of scales in the lateral line and in the longitudinal row, in the number of rays in the dorsal fin, in the body depth in %

Table 1. Meristic characters of hybrids between *Cichlasoma nigrofasciatum* and *Cichlasoma meeki*

	<i>Cichlasoma meeki</i>	<i>Cichlasoma nigrofasciatum</i> (Novák, 1981)	<i>Cichlasoma nigrofasciatum</i> × <i>Cichlasoma meeki</i>
Number of specimens	13	50	3
The body length in mm	47-94	28-86	58-76
Scales in the lateral line	18/9	19/9 (16-20/6-10)	19/11
Scales above 1st lateral line	6 (5-7)	4 (4-5)	6
Scales below 1st lateral line	15 (14-17)	10 (10-12)	14
Scales above the lateral line and the soft part of the dorsal fin	2	2	2
Scales in the longitudinal row	27 (26-29)	29 (26-31)	29
Rays in the dorsal fin	XVI/10 (XV-XVI/9-11)	XVIII/10 (XVI-XIX/8-10)	XVIII/9 (XVII-XVIII/9)
Rays in the anal fin	IX/8 (VII-X/7-9)	IX/8 (VIII-X/7-10)	IX/9
Rays in the pectoral fin	14 (13-14)	14	14 (13-14)
Gill rakers	16 (15-17)	8 (6-9)	13

Table 2. Plastic characters of hybrids between *Cichlasoma nigrofasciatum* and *Cichlasoma meeki*.

	<i>Cichlasoma meeki</i>	<i>Cichlasoma nigrofasciatum</i> (Novák, 1981)	<i>Cichlasoma nigrofasciatum</i> × <i>Cichlasoma meeki</i>
Number of specimens	13	50	3
The body length in mm	47–94	28–86	58–76
The head length in % of the body length	39 (35–44)	35 (27–41)	36 (36–37)
The body depth in % of the body length	45 (42–52)	44 (36–53)	44 (43–45)
The eye diameter in % of the head length	25 (21–27)	28 (22–34)	23 (22–24)
The interorbital width in % of the head length	31 (27–36)	37 (27–56)	38 (36–43)
The length of the last dorsal spine in % of the head length	36 (34–38)	40 (27–56)	38 (35–40)
The length of the pectoral fin in % of the head length	79 (71–85)	79 (52–96)	72 (64–76)
The length of the caudal peduncle in % of its depth	67 (59–75)	63 (42–85)	71 (55–83)
The snout length in % of the length of the postorbital part of the head	129 (108–147)	96 (73–125)	117 (100–130)

of the body length, the head length in % of the body length, the interorbital width in % of the head length (altogether 3 meristic and 3 plastic characters) and nearer to *Cichlasoma meeki* in the number of scales below the lateral line, the number of gill rakers, the eye diameter in % of the head length, the snout length in % of the length of postorbital part of the head and in the length of the caudal peduncle in % of its depth (altogether 2 meristic and 3 plastic characters).

In one specimen of *Cichlasoma meeki* from 13 investigated no lateral line was found. In 5 specimens only a few typically perforated lateral line scales were found (in the upper part 0–3, in the lower part 0–8). In other scales of the lateral line of these specimens the perforation was only indistinct. In 2 specimens with the normal number of lateral line scales (18/10 and 17/9) perforation was indistinct in all scales of the lateral line. Hubbs (1936) found, in specimens of *Cichlasoma meeki* from the Yucatan peninsula (Mexico), D XV (1 sp.) or XVI (17 sp.)/9 (13 sp.) or 10 (4 sp.), A VIII (2 sp.) or IX (16 sp.)/7 (5 sp.), 8 (12 sp.) or 9 (1 sp.). Holly, Meinken, Rachow (1934–1967) showed D XV–XVI/9–10, A VIII–IX/7–9, in longitudinal row 30–32, above lateral line 5–6, under lateral line 13–14, above lateral line to the origin of the soft part of dorsal fin 2–3 scales, body depth 44–47% of body length, head length 38–42% of body depth, eye diameter 25–30% of head length, interorbital width 26–28% of head length, length of the caudal peduncle a little more than 100% of its depth. Sterba (1977) showed D XV–XVI/9–10, A VIII–IX/7–9, P 12–13, scales in longitudinal row 28–32. No remarkable differences in plastic characters were found between aquarium specimens and published data mentioned above, except the relative

length of the caudal peduncle. But our aquarium specimens have a higher number of scales below the lateral line and a lower number of scales in the longitudinal row opposite to the description in Holly, Meinken, Rachow (1934—1967).

SUMMARY

The description of 3 specimens of F₁ hybrids between *Cichlasoma meeki* (Brind, 1918) and *Cichlasoma nigrofasciatum* (Günther, 1869) is given. Hybrids are intermediate in most of the characters studied. In 13 specimens of *Cichlasoma meeki* remarkable differences were found in the number of scales below the lateral line, in the number of scales in the longitudinal row and in the relative caudal peduncle length, as compared with published data.

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The Figures 1 and 2 will be found at the end of this issue.

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Novák J.: Description of hybrids between *Cichlasoma meeki* and *Cichlasoma nigrofasciatum*

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ON THE FIND OF BRANCHIATE SEGMENT WORM *BRANCHIURA SOWERBYI*
(OLIGOCHAETA, TUBIFICIDAE) IN SLOVAKIA

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Received November 25, 1980

Abstract. *Branchiura sowerbyi* Beddard (Oligochaeta, Tubificidae) was found in three water bodies belonging to the Tisa river basin (Danube river basin, Black Sea watershed), East Slovakia.

During the limnological research of the East Slovakia we were able to record the occurrence of the rare oligochaete *Branchiura sowerbyi* Beddard.

In Czechoslovakia this species has been known till now only from the Elbe river basin, where it was collected at two localities: blind arm of the Vltava river near Bráník (4 specimens collected in 1956) and the dead arm of the Elbe river, called Labičko (26 specimens sampled in 1962—1964) (Lišková 1964). Later on the species was not found any more despite a rather intensive hydrobiological research.

New findings from East Slovakia were made in the Tisa river basin, which is the part of the Danube river basin (the Black Sea watershed). This species was sampled at three stations, namely in the Laborec river at the village Ižkovce, Čierna Voda brook near the village Stretava and in the drainage

Table 1. Species composition and density of macrozoobenthos in the Laborec river at the village Ižkovce (about 300 m below the mouth of the channel leading the cooling water from the power plant Vojany). 17. 5. 1978, water temperature 15.2° C, depth 3.5—4 m, sandy bottom

Taxon	Abundance		Biomass	
	ex. m ⁻²	%	g. m ⁻²	%
Mermithidae g. sp. div.	9	0.23	0.00	0.00
Oligochaeta <i>Limnodrilus claparedianus</i>				
<i>Limnodrilus hoffmeisteri</i>	3 783	95.89	4.74	5.01
<i>Branchiura sowerbyi</i>	9	0.23	0.06	0.06
Hirudinea <i>Erpobdella octoculata</i>	9	0.23	1.53	1.62
<i>Glossiphonia heteroclita</i>	9	0.23	0.03	0.03
<i>Hellobdella stagnalis</i>	18	0.46	0.13	0.13
Mollusca <i>Anodonta complanata</i>	9	0.23	0.07	0.07
Isopoda <i>Asellus aquaticus</i>	9	0.23	0.07	0.07
Heteroptera g. sp. div. larvae	18	0.46	0.02	0.02
Chironomidae g. sp. div. larvae	27	0.68	0.03	0.03
pupae	9	0.23	0.01	0.01
Cocones varia	36	0.91	0.01	0.01
Macrozoobenthos together	3 945	100.00	95.53	100.00

channel near the village Bežovce. Further details with regard to the geographical position of localities sampled, their characteristics and composition of the benthic community can be found in Fig. 1 and Tables 1, 2 and 3.

In the Tisa river basin this species is known from the Tisa proper on the territory of Hungary (Ferencz 1974, Csoknya and Ferencz 1975, Adamosi and coauthors 1978), from the Danube River delta in Rumania (Popescu-Marinescu and coauthors 1966) and it has been found also in some tributaries of the Danube in Bulgaria (Russev and coauthors 1976).

Surprising is the high density of this worm in our localities 2 and 3. Because of the lack of quantitative data from the Danube river basin it is possible to compare our figures only with those introduced by Sokolska (1961)

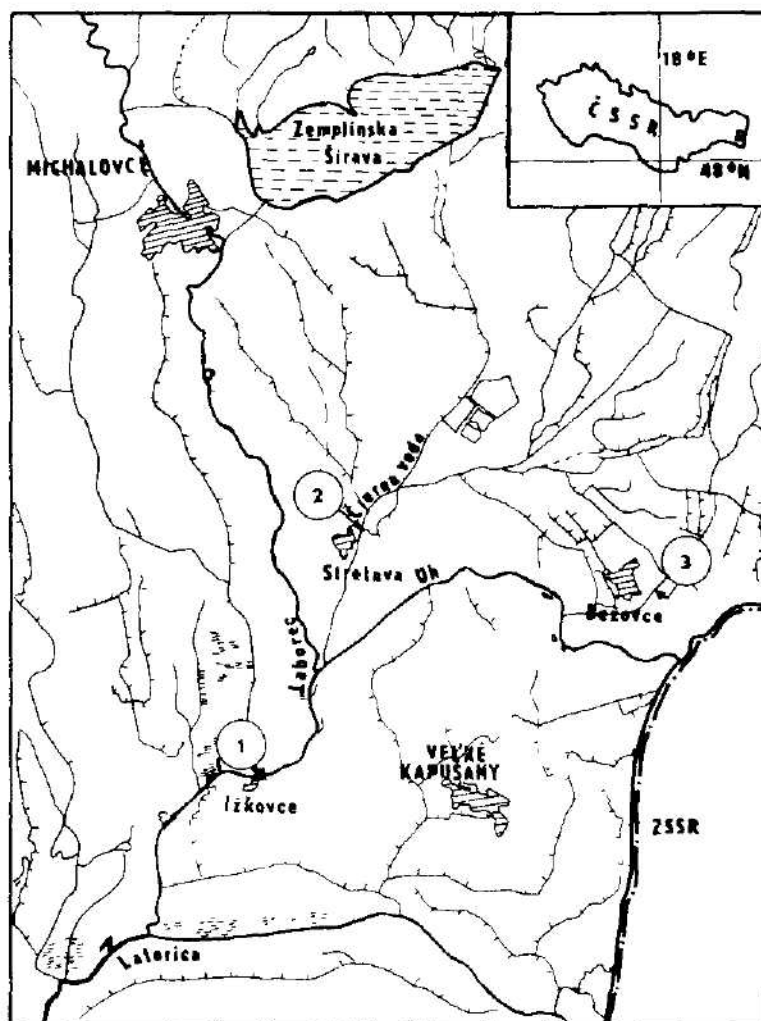


Fig. 1. — Localities in East Slovakia where *Branchiura sowerbyi* has been sampled.

Table 2. Species composition and density of macrozoobenthos in the Čierna voda brook near the village Stretava. 21. 5. 1978, water temperature 17.2° C, depth 0.5–1 m, bottom composed of mud and sand. The brook in this section is channelized

Taxon	Abundance		Biomass	
	ex. m ⁻²	%	g. m ⁻²	%
Oligochaeta				
<i>Limnodrilus udekamianus</i>				
<i>Peloscoides ferox</i>	244	15.06	2.89	0.10
<i>Branchiura sowerbyi</i>	844	52.10	61.34	2.16
Hirudinea				
<i>Erpobdella octoculata</i>	22	1.36	2.91	0.16
<i>Glossiphonia heteroclita</i>	67	4.14	0.38	0.01
<i>Piscicola geometra</i>	22	1.36	0.11	0.00
Mollusca				
<i>Viviparus viviparus</i>	67	4.14	310.80	10.82
<i>Anodonta cygnea</i>	44	2.72	2 053.50	71.47
<i>Unio pictorum</i>	44	2.72	437.34	15.22
Chironomidae g. sp. div. larvae	244	15.06	3.93	0.14
Ceratopogonidae g. sp. div. larvae	22	1.36	0.02	0.00
Macrozoobenthos together	1 620	100.00	2 873.22	100.00

from some lakes in the Amur river floodplain. She found the abundance of *B. sowerbyi* varying from 80 to 260 specimens per m², with maximum from 120 to 680 ind. m⁻². As follows from Table 2 and 3, our data (844 and 1655 ind. m⁻² respectively) seem to be significantly higher than those of Sokol'ska. Maybe that the high density of this worm is characteristic for the Tisa river basin as Ferencz (1974) writes that *B. sowerbyi* together with further oligochaete *Limnodrilus michaelsoni* predominates in the clay type of bottom, where the total abundance of macrozoobenthos was 1503 ind. m⁻².

Table 3. Species composition and density of macrozoobenthos in the Drainage channel near the village Bežovec. 4. 8. 1978, water temperature 22.8° C, depth 0.5 m, bottom composed of firm clay

Taxon	Abundance		Biomass	
	ex. m ⁻²	%	g. m ⁻²	%
Oligochaeta				
<i>Limnodrilus hoffmeisteri</i>				
<i>Limnodrilus udekamianus</i>	1 421	43.34	8.70	8.88
<i>Branchiura sowerbyi</i>	1 665	50.67	88.80	90.62
Hirudinea				
<i>Erpobdella octoculata</i>	22	0.67	0.27	0.28
Chironomidae g. sp. div. larvae	178	5.42	0.22	0.22
Macrozoobenthos together	3 286	100.00	97.99	100.00

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MORPHOLOGY OF THE POST-EMBRYONAL STAGES OF LIACARUS SUBTERRANEUS (ACARINA: ORIBATEI, LIACARIDAE)

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Abstract. A morphological description with measures and drawings of the developmental stages of *Liacarus subterraneus* (C. L. Koch, 1841) (Oribatei, Liacaridae) from larva to the adult stage, including leg-chaetotaxy.

INTRODUCTION

This article follows up a previous one (Trávníček, 1977), concentrating on the description of the developmental stages of *Liacarus coracinus* (C. L. Koch, 1841). The aim of my morphological studies was to establish differential characters of the corresponding immature stage between these species, and later on within the other species of the family Liacaridae. Morphological characteristics of the adult stage of *L. subterraneus* are also presented for the confrontation of morphological characteristics of the immature stages.

Morphology of the immature stages of the family Liacaridae has been published, up to the present, only in *Xenillus clypeator* Robineau-Desvoidy, 1839 and *X. tegeocranus* (Hermann, 1804) by Costesèque et Taberly (1961), *Liacarus cidarus* Wooley, 1968 by Arlian et Woolley (1969), and *L. coracinus* (C. L. Koch, 1841) in the above mentioned paper. Cultivation of immature stages of the family Liacaridae is difficult, hence the juvenile stages of other species of the family Liacaridae have not been described yet. Biological data of the forms I have cultivated will be treated in another article.

MATERIAL AND METHODS

All the examined larvae, nymphs and adults were obtained from the laboratory culture. The initial material — adult individuals of *L. subterraneus* — was picked up from the forest litter (*Acer sp.*, *Populus tremula*, *Sambuccus nigra*, *Corylus avellana* and herbal undergrowth) in Vrané n Vltavou, about 20 km south of Prague.

Preservation and treatment of the objects for examination by means of optic microscope, as well as measuring and drawing, were done identically with the same operations in *L. coracinus* (Trávníček, 1977). Designation of setae and organs is also the same as in this foregoing paper.

DESCRIPTION OF DEVELOPMENTAL STAGES

Larva (Fig. 1—2)

resembles the larva of *L. coracinus*, but this one is greater, rather wide. It belongs to the largest in the family Liacaridae. For the size of the body of larvae and their organs see Table 1. The smallest and the largest dimen-

Table 1. A comparison of sizes in developmental stages of *Liacarus subterraneus* (μm)

Organs measured	Larva	Protonymph	Deutonymph	Tritonymph	Adult
Length of the body (total)	301-338	494-583	616-869	860-1130	968-1265
Length of the body (from rostrum)	280-302	452-528	550-726	850-1067	924-1200
Width of the body	171-187	260-317	286-429	462-625	621-803
Height of the body	130-156	220-270	275-407	418-572	510-671
Length of the tarsus I without ambulatorium	37-39	45-47	57-60	67-73	104-121
Length of the chelicera	71-94	157-163	171-192	203-264	218-297
Length of the pedipalp	42-50	62-81	83-94	88-121	145-156
Width between setae <i>ro</i>	13-21	26-31	26-41	52-55	62-73
Width between setae <i>le</i>	42-58	57-63	58-73	78-88	39-52
Width between setae <i>in</i>	88-91	89-94	118-146	166-187	140-182
Width between sensilli	99-114	151-166	160-208	230-270	312-400
Diameter of the bothridiae	12-16	13-16	16-21	21-23	24-34
Diameter of the head of sensillus	7-7.8	7.8-7.9	7.8-7.9	8-9.3	7.9-10.5
Length of genital plates	-	46-57	73-83	99-158	94-150
Width of genital plates	-	21-26	26-52	52-57	116-145
Length of anal plates	68-84	104-145	145-182	198-250	192-264
Width of anal plates	21-31	46-52	46-52	62-77	176-242
Length of the setae <i>ro</i>	55-65	60-76	110-112	107-140	78-99
Length of the setae <i>le</i>	76-93	90-150	136-187	165-240	83-105
Length of the setae <i>in</i>	15.6-21	40-52	55-93	83-130	31-57
Length of the setae <i>ex</i>	5-5.2	7.8-10	9-13	16-23	-
Length of the sensillus ⁺	42-52	48-55	48-67	68-71	83-99
Length of the setae <i>c2</i>	68-92	74-120	140-157	182-215	3-5
Length of the setae <i>h</i>	21-34	27-37	39-57	47-93	42-62
Length of the setae <i>1a</i>	7-13	11-16	13-21	15-26	21-31
Length of the setae <i>1b</i>	26-34	37-42	44-62	45-80	52-60

⁺ over the top level of the bothridium

sions of 15 individuals is presented. The great diversity of size may have several causes, mentioned in the article concerning *L. coracinus*.

The body is wide egg-shaped, slightly flattened, tapering frontally. Sejugal furrow is very conspicuous along the whole circumference of the body, later on it fades on the hips, as usual in juvenile stages within the family Liacaridae.

Integument of the body is rather thicker than in *L. coracinus*. It is never glass-transparent, not even after hatching. At first it is yellowish, although it is glossy, usually with fine transversal wrinkles on notogaster. Later on larval integument darkens and progressively becomes mat. Pigmentation of the distal tips of chelicera and rutella is normal, i. e. very dark brown as early as before hatching.

Gnathosoma and proterosoma have a slightly thicker integument than hysterosoma. The boundaries of some segments are visible as shallow furrows in young larvae. They are especially prominent between segments C-D and D-E.

Gnathosoma

There are two apophyses carrying a spine-like point, designated *f*, at the paraxial side of each chelicera, instead of one only in *L. coracinus*. Other

characteristics of chelicerae are the same as in *L. coracinus*. Pedipalps and infracapitulum are also the same as in *L. coracinus*, but hysterosomal setae are long. Infracapitulum is anarthric with atelebasic implantation of rutells. This phenomenon persists in all immature developmental stages.

Proterosoma

is similar to the same part of the body in *L. coracinus*. But cuticular ribs *nl*, called so by Grandjean (1954b), are thin and short, not reaching to the

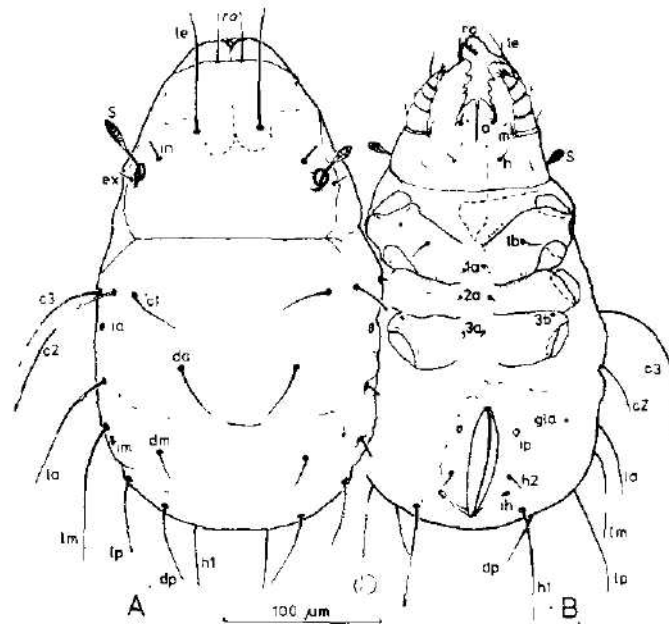


Fig. 1. Larva of *Liacarus subterraneus*, without legs. A - dorsal view, B - ventral view.

bothridiums, in contradistinction to *L. coracinus*, where they are strong and long, extending the bothridiums. Bothridiums and sensilli are the same as in *L. coracinus*.

Exobothridial setae are very short and thin. Lamellar setae are long, whip-like, weakly barbed, pointed at the tips, in contrast to the interlamellar setae. These are very short (0.25—0.50 lamellar), rough and blunt at the tips. Although they are very short, their diameter is the same as in lamellar setae. In *L. coracinus* they are weakly barbed and pointed at the tips. Rostral setae are short (0.5—0.6 lamellar), weakly barbed and pointed at the tips. The distance between implantations of rostral setae does not reach a half of the distance between implantations of lamellar setae.

Notogaster

is not discernible from the ventral plate. Future circumarthrodial membrane and fissure of the scalp are not even indicated. Notogastral setae have normal

implantation, as in *L. coracinus*, but they are long (about a half of width of the body), whip-like, glabrous, and pointed at the tips. Centrodorsal setae are present. As in larva *L. coracinus*, the seta which should have the implantation under the seta *la*, in the same distance as that between setae *da* and *la*, is not developed. This seta on segment *D* is probably *D3*, as it was marked by Grandjean (1934a). Equally the seta *h3* is not developed, consequently

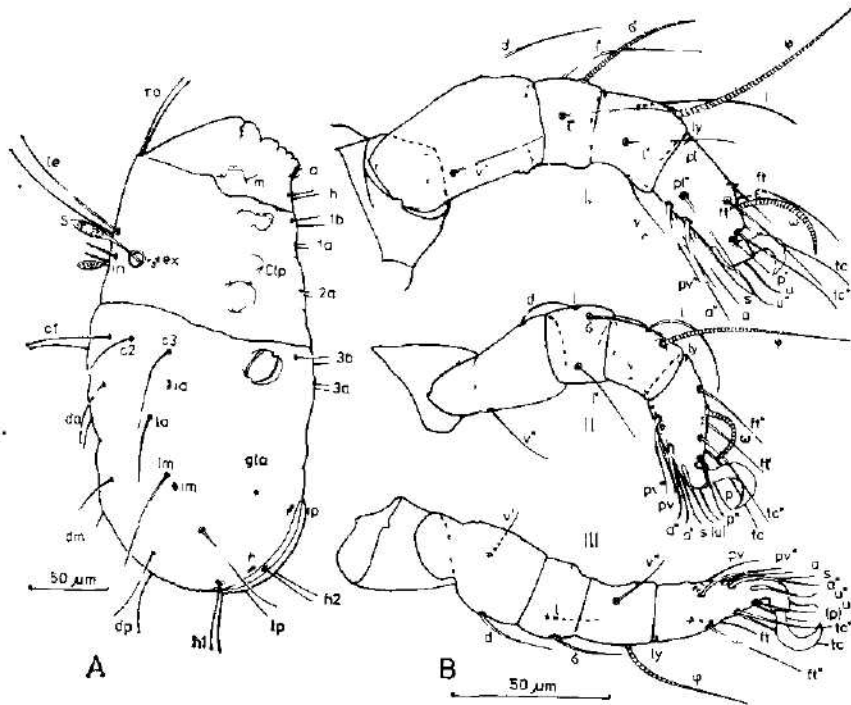


Fig. 2 Larva of *Luacarus subterraneus*. A - lateral view, without legs and palps, B - legs I-III.

larva is **bidificent** The implantation, mutual position, length and shape of notogastral setae is shown in Figs. 1-2. No seta is vestigial. All setae grow from round pores.

Cupules *ia*, *im*, *ip*, *ih* are normally situated and have usual form of funnel-shaped cups, inserted into the integument. Cupulus *ip* lays in the ventral plate.

Ventral plate

fuses with notogaster. In epimeral region propodosoma is a little more sclerotised than metapodosoma, which is soft with transverse wrinkles such as in notogaster. Apodemes are long, but they do not merge in the middle. Acetabulas have similar structure. Epimeral formula is normal (2-1-2). Epimeral setae are long, even in paraxial rows quite long Paraxial rows of epimeral setae take characteristic barrel-shaped course diverging in the middle,

Table 2. Formulas of the leg-claetotaxy of the developmental stages
of *Liacarus subterraneus*
(Without solenitons and famulus)

Leg	Larva	Protonymph	Deutonymph	Tritonymph	Adult
I	0-2-2-3-15-1	0-2-2-3-15-1	0-4-2-3-15-1	1-4-2-4-17-1	1-5-3-4-19-3
II	0-2-2-2-13-1	0-2-2-2-13-1	0-2-2-2-13-1	1-4-2-3-15-1	1-4-2-4-15-3
III	0-2-1-1-13-1	0-2-1-1-13-1	1-2-1-1-13-1	2-3-1-3-15-1	2-3-1-3-15-3
IV	-	0-0-0-0-7-1	0-2-2-1-12-1	1-2-2-2-12-1	1-2-2-3-12-3

because of the longer distance between setae 2a and the smaller one between setae 1a and 3a (see Fig. 1B). All epimeral setae are glabrous and pointed at the tips in the same way as the setae on infracapitulum. Claparede's organ is short, conic, terminally oval. Its size is 14-19 × 6-8 μm.

Genito-anal region has the similar structure as in *L. coracinus*. Its description has been presented in my preceding work (Trávníček, 1977, p. 289)

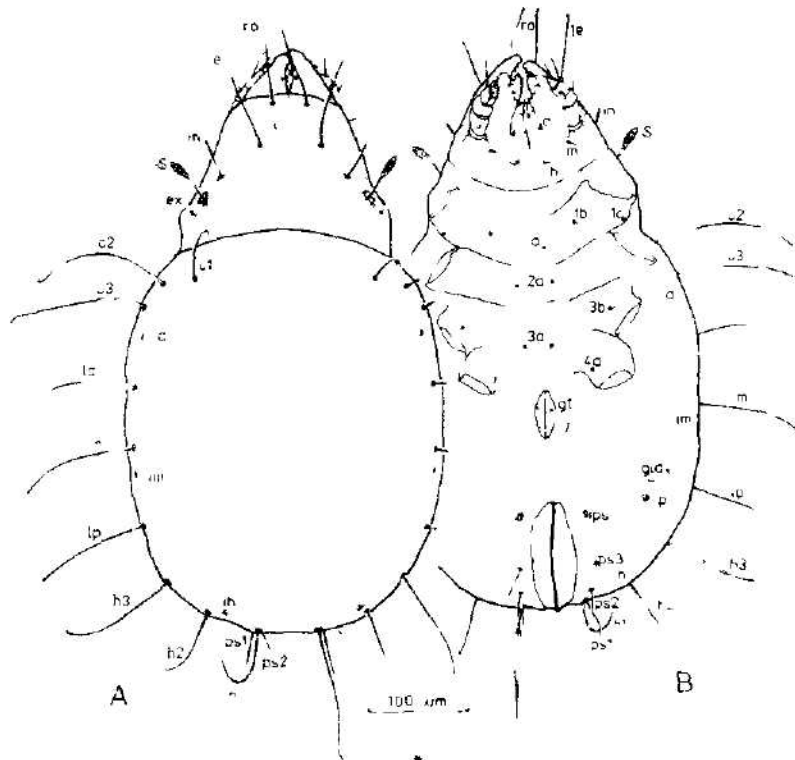


Fig. 3. Protonymph of *Liacarus subterraneus*, without legs. A - dorsal view, B - ventral view.

Table 3. Leg-chaetotaxy of the developmental stages of *Leacarus subterraneus*.
Notations of solenidions, famulus, eupathidia, and true setae

Leg Segment	Larva	Protonymph	Deutonymph	Tritonymph	Adult
I Trochanter					
Femur	d, v ^o	d, v ^o	d, l, l', v ^o	l	l
Genu	σ, l', l'	σ, l', l'	σ, l', l'	σ, l', l'	σ, l', l', v ^o
Tibia	φ, l, l', l', v'	φ, l, l', l', v'	φ, l, φ, l, l', l', v', v ^o	φ, l, φ, l, l', l', v', v ^o	φ, l, φ, l, l', l', v', v ^o
Tarsus	ω, l, s, p', p', tc', tc'	ω, l, ω, l, s, p', p', tc'	ω, l, ω, l, s, p', p', tc', tc'	ω, l, ω, l, s, p', p', it', it'	ω, l, ω, l, s, p', p', it', it'
	ft', ft', u', u', s,	tc', ft', ft', u', u',	tc', ft', ft', u', u',	it', tc', tc', ft',	it', tc', tc', ft',
	a', a', pv', pv', pl',	s, a', a', pv', pv',	s, a', a', pv', pv',	ft', u', u', s, a', a',	ft', u', u', s, a', a',
	pl'	pl', pl'	pl', pl'	pv', pv', pl', pl'	pv', pv', pl', pl',
					A, A ^o
II Trochanter					
Femur	d, v ^o	d, v ^o	d, v ^o	l	l
Genu	σ, l', l'	σ, l', l'	σ, l', l'	σ, l', l'	σ, l', l', v ^o
Tibia	φ, l, v'	φ, l, v'	φ, l, l', v'	φ, l, l', v'	φ, l, l', v', v ^o
Tarsus	ω, l, p', p', tc', tc'	ω, l, ω, l, p', p', tc', tc'	ω, l, ω, l, p', p', tc', tc'	ω, l, ω, l, p', p', it', it'	ω, l, ω, l, p', p', it', it'
	ft', ft', u', u', s,	ft', ft', u', u', s,	tc', ft', ft', u', u',	it', tc', tc', ft',	it', tc', tc', ft',
	a', a', pv', pv'	a', a', pv', pv'	s, a', a', pv', pv'	ft', u', u', s, a', a',	ft', u', u', s, a', a',
				a', pv', pv'	pv', pv'
III Trochanter					
Femur	d, v'	d, v'	l	l, v'	l, v'
Genu	σ, l'	σ, l'	σ, l'	σ, l'	σ, l'
Tibia	φ, v ^o	φ, v ^o	φ, v ^o	φ, l, v', v ^o	φ, l, v', v ^o
Tarsus	p', p', tc', tc'	p', p', tc', tc'	p', p', tc', tc'	p', p', it', it'	p', p', it', it'
	ft', ft', u', u', s,	ft', ft', u', u', s,	ft', ft', u', u', s,	tc', tc', ft', ft',	tc', tc', ft', ft',
	a', a', pv', pv'	a', a', pv', pv'	a', a', pv', pv'	u', u', s, a', a',	u', u', s, a', a',
				pv', pv'	pv', pv'
IV Trochanter					
Femur			d, v'	v'	v'
Genu			d, l'	d, l'	d, l'
Tibia			φ, v', v ^o	φ, v', v ^o	φ, l', v', v ^o
Tarsus			p', p', tc', tc'	p', p', tc', tc'	p', p', tc', tc'
			ft', u', u', s,	ft', u', u', s, a', a',	ft', u', u', s, a', a',
			pv', pv'	pv', pv'	pv', pv'

Protonymph (Fig. 3—4)

For the dimensions of the body see Table 1. 15 individuals were measured.

Grathosoma

is the same as in larva, but an additional seta *v*" appears on the femur of pedipalp. That is why the formula of the pedipalpal chaetotaxy, except solenidion *ω*, is (0—2—1—3—9). It is the same phenomenon as in *L. coracinus*.

Proterosoma

is relatively shorter, but its shape is the same as in larva. An egg-shaped "rostral body" appears only, below a slightly developed naso. Rostral body (Trávníček, 1977, p. 292) persists in all nymphal stages.

Hysterosoma

extends more with slight dorso-ventral flattening. There are no visible boundaries of any segment, not even after moulting. Integument of notogaster and genito-anal region is very soft, thin, easily deformable. At the beginning it is corrugated around the anal and newly formed genital opening. Later on the corrugation disappear.

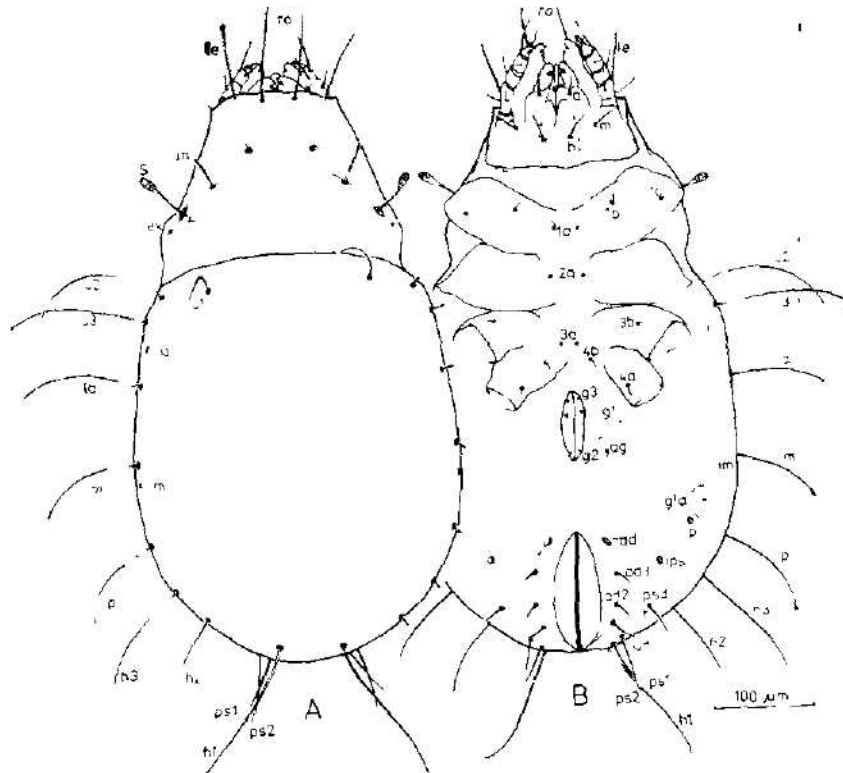


Fig. 5 Deutonymph of *Li acarus subterraneus*, without legs. A — dorsal view, B — ventral view.

Anal opening slides normally a little ventrally, in comparison with larva. The rise of cupules *ips* on the level of anterior edge of anal opening and sliding the cupules *ip* dorsolaterally is normal. Apodemes 1—3 are long, but they do not merge in the middle. Apodemes 4—5 are very short

Centrodorsal setae disappear normally, but seta *h3* and protonymphal setae also appear normally. That is why protonymph is *quadrideficient* in the same way as other nymphs. Setae on notogaster remain long, fairly strong, glabrous and pointed at the tips.

One pair of genital disc-suckers arise. Setae *1c* are forming in the place of disappeared Claparède's organ, and setae *4a* appear simultaneously on the newly formed epimeras 4. Setae *4a* have insertion in the median rows (see Fig. 3B), whereas setae *1c* are the beginning of the future antiaxial rows. Epimeral formula is (3—1—2—1). Epimeral and genital setae are glabrous, pointed at the tips. Their mutual size is the same as in larva.

Legs

are relatively smaller than in larva. There are 7 setae on each tarsus of the newly formed fourth pair of legs. Seta *ft'* does not develop normally on the tarsus IV in the course of ontogeny. Solenidial formula (1—1—2) (1—1—1) (1—1—0) (0—0—0) and tarsal formula (15—13—13—7) are normal.

Characteristic form of tarsus I as well as forms of solenidions ϕ and σ remain the same as in larva. Solenidions ω are almost cylindrical with the blunted tips. The same as in larva are the mutual lengths of proral and tectal setae of tarsus I. Almost all setae of legs are glabrous with pointed tips. Exceptions are dorsal setae on femur I, II, and setae *l'* on genu I, II. These setae are thorn-like at the top (see Fig. 4B).

Deutonymph (Fig. 5—6)

Five obtained deutonymphs were measured for taking data presented in Table 1.

Proterosoma is relatively shorter than in protonymph, but hysterosoma is more voluminous. Visible changes concern only organs subjecting to alteration in the course of ontogeny.

Newly appeared setae *4b* are not implanted behind the setae *3a*, which are clustering together, but outside. The distance between the setae *4b* is the same or longer than between the setae *2a*, whose mutual distance is longer than between the setae *1a* and *3a* (see Fig. 5B). Epimeral formula is (3—1—2—2). Hysterosomal setae tend to be the longest, but sometimes the setae *1b* can be longer than the former ones.

Genital setae *g2* and *g3* arise. Implantation of 3 pairs of genital setae and location of 2 pairs of genital disc-suckers see in Figs. 5B and 6A. Newly formed adgenital setae have normal position beside the rear third of genital valves. Simultaneously arised adanal setae are fairly short, glabrous, with the pointed tips, likewise the other setae on the lower part of the body.

Lateral glands move slightly forward. Cupules *iad* replace cupules *ips* at the level of anterior edge of anal opening. Cupules *ips* move dorsolaterally and slightly backward to the former position of cupules *ip*, which also change their position by following the lateral glands (cf. Figs. 3B, 4A with Figs. 5B, 6A). Genital opening grows, anal too.

Tarsus I retains its characteristic shape, but its lyrifissure looks shallower. Three solenidions and 13 true setae arise normally on the leg I—IV. Tarsal formula (15—13—13—12) and solenidial formula (1—2—2) (1—2—2) (1—1—0) (0—1—0) are normal. Formulas of setae on all segments of leg I—IV are presented in Table 2, designation of all setae and solenidions in Table 3. Legs of a deutonymph are depicted in Fig. 6B.

Thorn-like at the top are only the same setae as in protonymph. Seta *pv* on tarsus II is slightly thorn-like at the bottom. The other leg-setae remain glabrous. All leg-setae are pointed at the tips, with exception of solenidions ω .

Tritonymph (Fig. 7–8)

Dimensions indicated in Table 1 were established from 8 individuals measured.

Gnathosoma

looks the same as in the preceding developmental stages, having long setae on infracapitulum, but distal part of gnathosoma begins to slope downwards (Fig. 8A).

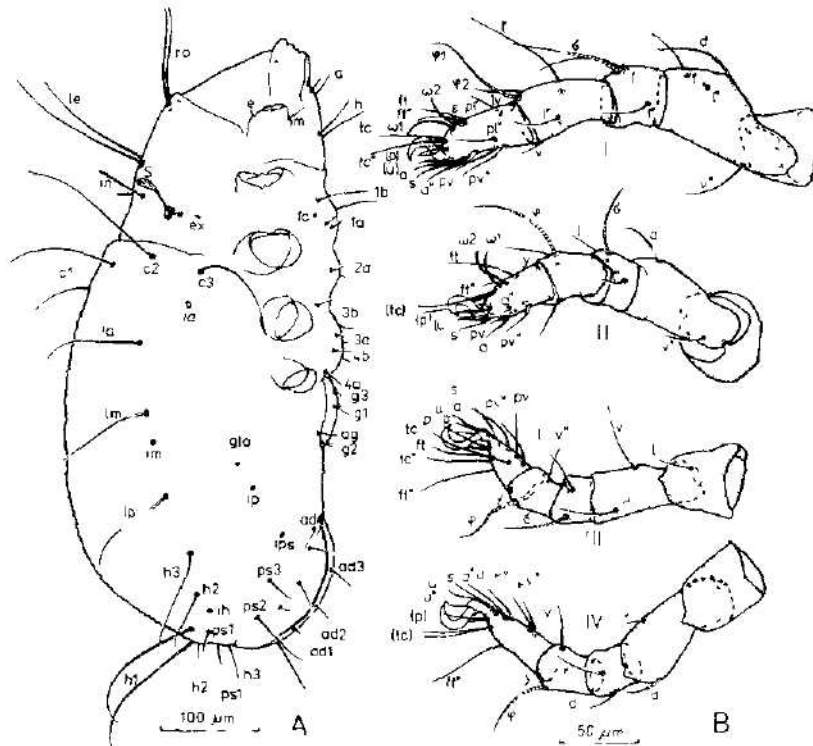


Fig. 6 Deutonymph of *Liacarus subterraneus*. A — lateral view, without legs and palps, B — legs I—IV.

Proterosoma

is again relatively shorter. It occupies about 1/4 of the length of the body. The feature of proterosoma is the same as in deutonymph, with only a small change. Interlamellar setae become longer, but they do not exceed a half of lamellar setae.

Hysterosoma

bulks large, remaining slightly flattened egg-shaped in dorso-ventral direction. Integument of hysterosoma is thicker and darker in relation to its size and the size of hysterosoma in preceding developmental stages. It is neither transparent, even after the moulting from deutonymphal exuvia, nor translucent after some time. Colour of hysterosoma is white-yellowish up to brownish.

Notogastral setae remain long, but, with regard to the increased width of the body, they seem to be relatively shorter. Their length is about 1/3 of the width of notogaster. They remain glabrous, pointed at the tips. Newly appear-

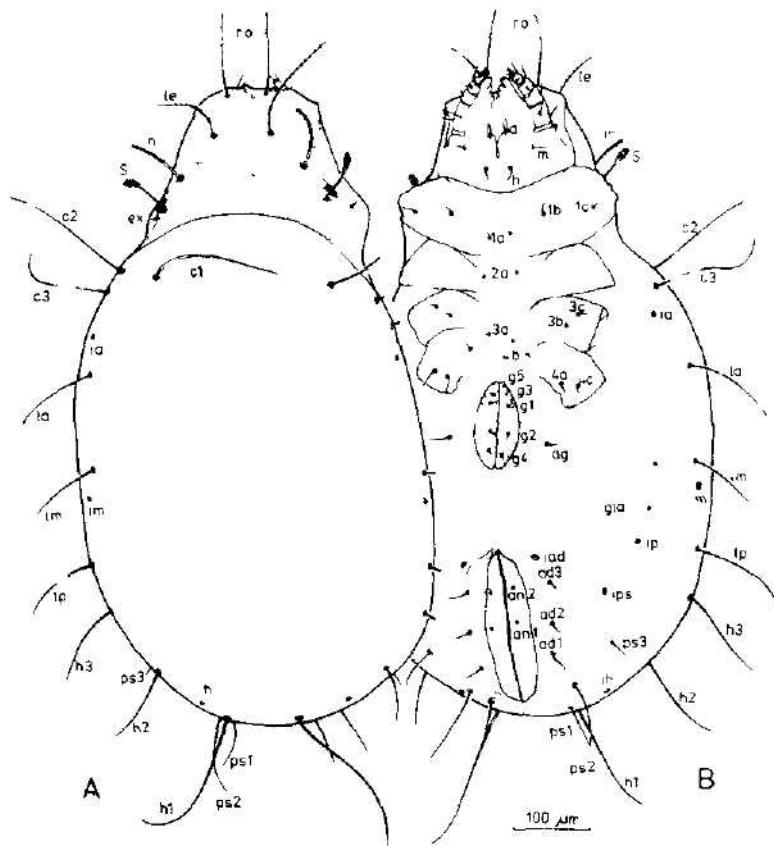


Fig. 7 Tritonymph of *Liacarus subterraneus*, without legs. A - dorsal view, B - ventral view.

red epimeral setae 3c and 4c in antiaxial rows are brought near to setae 3b and 4a in median rows (see Fig. 7B). Paraxial rows of epimeral setae retain their characteristic barrel-shaped course, except setae 4b, which are put off themselves. Epimeral setae are fairly long, glabrous, pointed at the tips. Epimeral formula is (3-1-3-3).

Anal opening is situated almost ventrally. Two pairs of anal setae arising normally, are very short and approached each other in the front half of anal valves. Lateral glands shift again a little forward, approximately in the middle of hysterosoma. Genital setae g4 and g5 arise in the front and equally at the rear edge of genital valves (Figs. 7B, 8A). The third pair of genital disc-suckers originates normally. Adgenital setae persist in the position occupied in deutonymph. They may be almost as long as the epimeral setae, but longer than the genital ones. All these setae remain glabrous and pointed at the tips.

Legs

retain unchanged shape, but sclerotisation increases in comparison with the legs of preceding developmental stages. Chaetotaxy is progressive. 18 new true

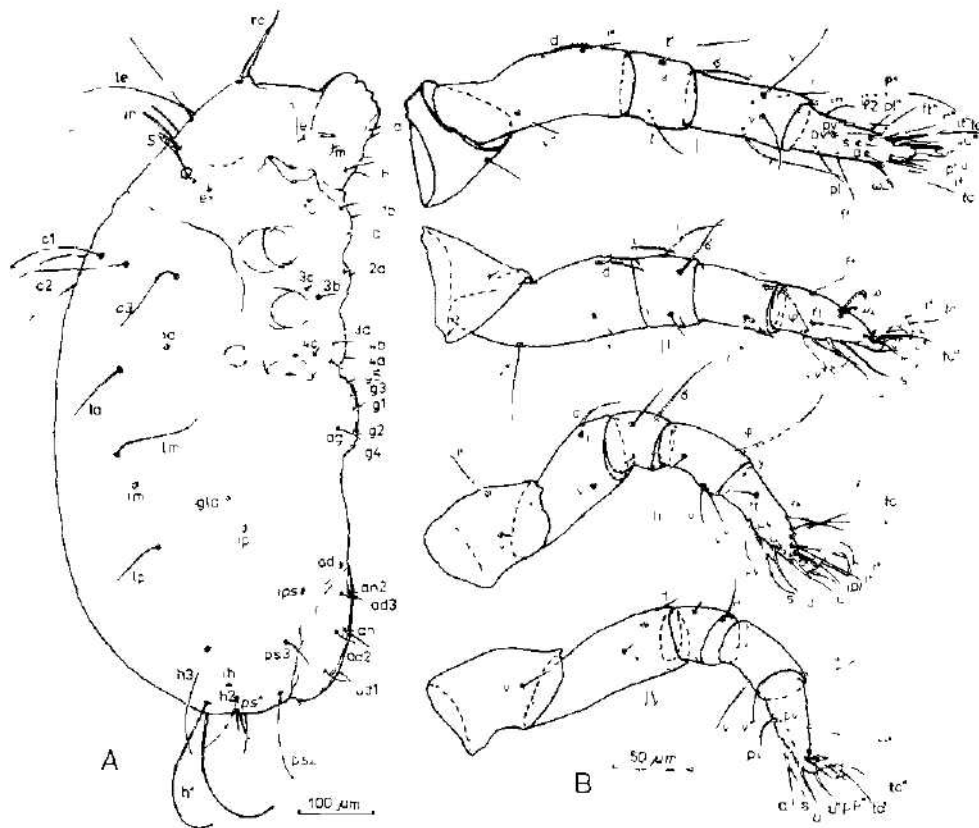


Fig. 8. Tritonymph of *Liacarus subterraneus*. A - lateral view, without legs and palps, B - legs I-IV.

setae arise on legs I—IV. Tarsal formula is (17—15—15—12), iter formula (n3—n3—n3—0), solenidial formula is the same as in deutonymph. Formulas of chaetotaxy on all segments of legs I—IV are indicated in Table 2, designation of all setae and solenidions in Table 3. Tritonymphal legs are depicted in Fig. 8B.

Thorn-like at the top or thorned on external side are setae mentioned in proto- and deutonymph, as well as setae *l'* on femur I, II, and *l'* on trochanter III. Thorn-like at the bottom persists seta *pv''* on tarsus II. Newly thorned are both antelateral and primiventral setae on tarsus I. Other setae remain glabrous. All setae of legs are pointed at the tips, with the exception of solenidions ω .

Adult (Fig. 9—10)

Dimensional data from 20 measured individuals are presented in Table 1.

The body is widely egg-shaped up to globoid (therefore one of his synonyms is *L. globosus*), slightly flattened dorso-ventrally. The colour of an adult after the moulting from tritonymphal exuvia is pargamen-like till brownish, except the dark brown tips of chelicers and rutells. But the surface of the whole body is quickly becoming dark and sclerotised. After about 2 days it becomes darkly brown, even black-brown. Its surface is lustrous up to semi-mat.

Gnathosoma

Infracapitulum is diarthric with pantelebasic implantation of rutells, in contradistinction to juvenile stages. Setae on infracapitulum are fairly long, glabrous, pointed at the tips. Gnathosoma is, in the remaining aspects, identical with that of the preceding nymphal stages, except for immersion in camerostome and slanting down.

Prodorsum

Lamellae are of middle width, fairly flat with thickened external edge. They are long, stretching to the bothridiums under the notogastral shield, frontally almost converging and joining with a translamella in the middle of prodorsum. Translamella has a short, roundly pointed small tooth (mucro), protruding slightly upwards. Cuspids are fairly short and wide. There is a long and sharp tooth on each inner side of implantation of lamellar setae, but the external ending of cuspid is round, or with a small tooth only.

Lamellar setae are short, but they always overlap the rostrum. They are strong, long conical, shortly tipped and strongly barbed. Interlamellar setae are inserted on the inner edge of lamellae, almost under the notogastral shield. They are very short, thin, glabrous and shortly tipped. Rostral setae are slightly longer than lamellar setae. Their surface and shape is the same as in lamellar setae. Their tips may reach over the tips of lamellar setae.

Notches at the sides of rostrum are wide and deep up to the implantation of rostral setae. A conspicuous tooth is present on each external side of these notches. Ribbed tutoriums extend from the mentioned teeth backwards almost to the bothridiums. There are also two conspicuous small teeth protruding obliquely upwards from the distal part of rostral nose at its sides.

Exobothridial setae are vestigial in contradistinction to those in immature stages. Shape of bothridiums are very similar to these in adult *L. coracinus*, sensilli have the same form. Pedotectum I is of usual shape, fairly wide.

Hysterosoma

Its surface seems to be glabrous and lustrous, but detailed observation reveals it to be covered with irregularly dislocated fine pores. Some places are glabrous, others may be even slightly grained.

Notogaster

Anterior edge of notogastral shield is always arched forward. Sometimes it may be ribbed and it extends in shoulder edges. Contrary to the immature

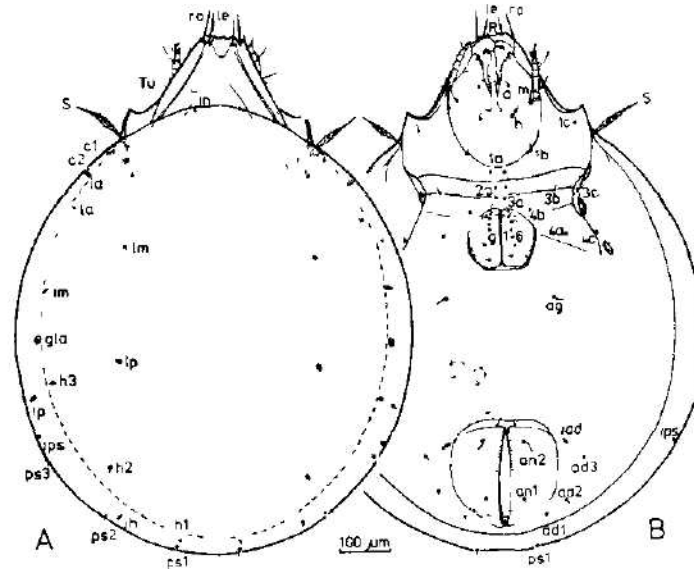


Fig. 9. Adult of *Liacarus subterraneus*, without legs. A — dorsal view, B — ventral view.

stages the lateral glands lay dorso-laterally in the middle of the notogastral shield, in the lateral view. Their openings are conspicuous — round with a low ridge. Cupules having normal position and fissure openings are inconspicuous.

Notogastral setae ($Ng = 11$) are very fine and short, almost inconspicuous under worse conditions of observation. Clearly visible are always setae *ps1*, alone surpassing the outline of notogaster. Coronal setae are brought near, setae *c3* in adult stage disappear. Insertional pores of notogastral setae are small, but deep.

Epimeral region

Apodemes 1--3 are long and merge in the middle. Apodemes 4 and 5 are short, not even reaching genital opening. Epimeres 1 and 2 are well divided in contradistinction to epimeres 3 and 4. Boundaries are not well developed neither between them, nor between epimera 4 and genito-anal region. Carina circumpedialis extends from acetabulum of leg II to that of leg IV, but it does not exceed it.

Setae 3c and 4c are implanted on the outer side of carina circumpedialis, seta 1c on the bottom of pedotectum I. Implantation of epimeral setae is not quite regular, some of them may lay out of the level of symmetry, especially in the anterior-posterior direction. Epimeral setae are fairly long, glabrous, pointed at the tips. Their formula is the same as in tritonymph. Similarly their insertional pores are the same as in notogastral setae, but more distinct.

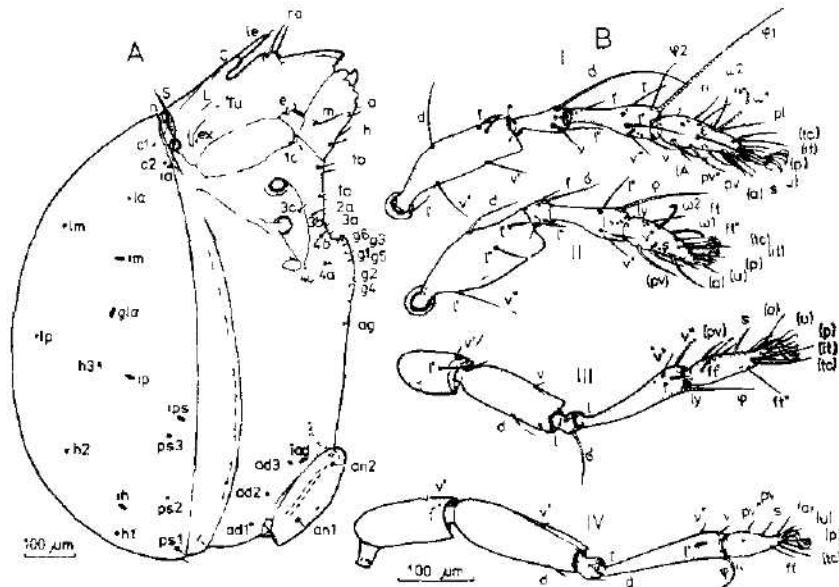


Fig. 10. Adult of *Liacarus subterraneus*. A – lateral view, without legs and palps, B – legs I–IV.

Genito-anal region

Both genital and anal openings have normal position. The shape of the former is pentagonal, of the latter oblong with rounded corners. Sliding forward of the genital opening occurs during the metamorphosis of the tritonymph. Setae *g6* arise in adult stage. For the insertion of genital setae see Figs. 9B, 10A. Adgenital setae do not follow genital opening in adult stage. They are implanted about in the first third of the distance between the genital and anal openings. Also their mutual distance increases. The same phenomenon appears in anal setae. Both the length and the shape of genital, adgenital and anal setae resemble the epimeral setae in praxial rows. Setae *ad1* are of the same length as anal setae, but setae *ad2* and *ad3* are shorter and thinner, as about setae *ps1*. Praeanal clasp is pear-like.

Legs

Form of leg-segments differs conspicuously from those in immature stages, as well as the sclerotisation. Legs of adult resemble the legs of adult in *L. coracinus* (Trávníček, 1977, p. 299) and other species within the family

Liacaridae. Cuticle of leg-segments has fine pores, but no pore-field is present. Legs of adult are heterotriadactylous with glabrous claws, ambulacrum does not form a cuff.

Six true setae arise on segments of leg I–IV. Formulas of leg-chaetotaxy see in Table 2, in which also tarsal formula (19–19–15–12) can be seen. Solenidial formula does not change from deutonymphal stage, iter formula from tritonymphal one. Notations of all true setae, solenidions, eupathidiums and famulus are indicated in Table 3. Their implantations and form of legs see in Fig. 10B.

Thorn-like at the top remain all such setae from precedent developmental stages. In addition to them seta *l'* on femur I, on tibia III, IV, and seta *l''* on femur II, on genu I, II, are added. Thorn-like on the bottom are setae *v'* on genu I, *v'* and *v''* on tibia I, II, *v''* on tibia III, accessorical, primiventral and antelateral setae on tarsus I, II, setae *pv'* and *s* on tarsus IV. Thorn-like on external side is seta *pl''* on tarsus I. Other setae are glabrous, at utmost very fine and shortly barbed. All leg-setae are pointed at the tips, except blunt-pointed subunguinal seta on tarsus I. This seta becomes the third eupathidium in addition to proral setae of the same tarsus. Famulus is very thin thread-like.

Post-embryonal development and exuviae

Post-embryonal development resembles in all aspects that of *L. coracinus*, published earlier (ibid., pp. 301–303).

Exuviae of nymphs and adult stage of *L. subterraneus* are analogical to those of *L. coracinus*. Because of greater size of their body they are more distinct, not to speak of a little thicker wall of exuvia in *L. subterraneus* than in *L. coracinus* of corresponding developmental stage.

SUMMARY

In many characters *Liacarus subterraneus* and *L. coracinus* are identical and conclusions presented in the article regarding *L. coracinus* are valid for *L. subterraneus*. However, there are following differences for *L. subterraneus*:

1. Two spear-like points *f* are present on each chelicera in all developmental stages.
2. Rostral body present in nymphs is pear-like to ovoid.
3. Interlamellar setae are blunt pointed, strong, short and rough in immature stages. In adult stage they are fine and weakly barbed.
4. Cuticular ribs *nl* are thin and short in immature stages.
5. Hysterostomal and epimeral setae are long. Paraxial rows of epimeral setae *1a–2a–3a* take characteristic barrel-shape course in immature stages. Setae *1b, 3b, 4a* are twice as long as setae in paraxial rows in nymphs.
6. Notogastral setae are very long, whip-like in immature stages, in adult stage they are almost inconspicuous.
7. Tarsus I of immature stages is cylindrical in lateral view, with vaulted distal upper part.
8. Solenidion σ on the genu I is long, conical, pointed at tip in immature stages. Solenidions and setae of legs are conspicuously long in immature stages.

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**NOTE ON THE VARIABILITY OF MESOGONISTIUS CHAETODON
(PISCES: CENTRARCHIDAE)**

Josef ZÁVĚTA

Received March 14, 1980

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

Abstracts: 34 specimens of *Mesogonistius chaetodon* from the aquaria of Czech hobbyists were examined and compared with the description of nominal subspecies and subspecies *M. C. elizabethae* Bailey, 1941. Remarkable differences were found in the form of caudal peduncle, body depth, dorsal spines length, interorbital width. The aquarium specimens are slender. This is due probably to life conditions in aquaria in higher water temperature during the 78 years of breeding.

INTRODUCTION

Mesogonistius chaetodon (Baird, 1854), the Black Banded Sunfish or the "Poor Man's Scalare", was imported into Germany as the aquarium fish already in 1897 by W. Geyer in Regensburg (Reuter, 1911; Meinken, 1932; Hykeš, 1937—44), at first only in 6 specimens, in the year 1900 anew. In 1902 the fish spawned in aquaria for the first time (Reuter, 1911). This species became very attractive and popular among aquarium hobbyists in Europe. Many observations have been published in aquarium literature (see e.g. Reuter, 1911; Meinken in Holly—Meinken—Rachow, 1932; Hykeš, 1937—44). In Czech literature, this species was mentioned first by Pokorný (1911).

Aquarium hobbyists in Europe supposed that for successful keeping the fish needed warm temperature, and sometimes breeding water temperatures up to 20 °C were recommended (Reuter, 1911). But in the localities where the fish occurs the average annual air temperature ranges from 20 °C (Florida) to 10.9 °C (New York).

It may be supposed that the long breeding in European aquaria have changed, to some extent, the plastic and meristic characters of the Black Banded Sunfish; therefore with regard to Bailey's study (1941) aquaria specimens were examined.

MATERIAL AND METHODS

All specimens of Black Banded Sunfish examined were obtained after perishing from Czech fish hobbyists, preserved in formalin solution. Measurements were made with the accuracy ± 0.1 mm by means of dividers. The method used by Bailey (1941) was followed (for details see Fig. 1).

Methods of Hubbs and Bailey (1940) were used for counting and measuring. The scales are counted: a) along the lateral line from the last one in contact with the shoulder girdle to the structural base of the caudal fin; b) above the lateral line, downward and backward from the origin of the dorsal fin to, but not including, the lateral-line row, and including the smaller scales near the origin of the fin;

c) below the lateral line, from the origin of anal fin including the smaller scales, upward and forward to, but not including, the lateral-line row; d) around the caudal peduncle, enumerating the minimum number of rows around the slenderest point of the caudal peduncle; e) on the cheek counting the rows which cross the shortest line from the eye to the posteroventral angle of the preopercle. The last ray of the dorsal and anal fins is always treated as a double ray divided to the base of the fin. In the both pectoral fin all rays are enumerated, including short uppermost ray which closely adheres to the second one (the first well-developed ray) and all small rays and the ventral end of the fin. The length of the caudal peduncle is taken from the posterior end of the anal base to the base of the caudal rays at the lateral line. The length of the pectoral fin is taken from the base of the uppermost ray to the tip of the fin; that of the pelvic fin is the distance from the base of the spine to the tip of the fin. The head is measured from the front end of the upper jaw to the tip of the opercular membrane. The length of the orbit is obtained by placing the tips of the dividers at the edges of the eye and spreading them with a gentle pressure. The interorbital width is measured by pressing the points together to approximate as nearly as practicable the least bony width. The length of the lower jaw is taken from its anteriormost tip to the posterior end of the angular.

RESULTS AND DISCUSSION

My results as compared with Bailey (1941) are summarized in Tables 1—10.

Coloration of examined specimens from formalin solution was yellowish to greyish on sides, the dorsal part brownish, the belly yellowish.

The first band passes vertically through the eye, the second passes from the hind part of the head, it is interrupted on the lower edge of the opercle and continues downwards. The third extends from the beginning of the dorsal fin downwards to the ventral fin. The fourth extends from the 7th dorsal spine to the insertion of anal spines. The fifth begins at the anterior soft dorsal rays and is directed vertically to the anal soft rays. The sixth extends from the last soft dorsal rays towards the last anal rays. The seventh passes through the posterior margin of the caudal peduncle. In adult specimens this band is rather composed of spots, in juvenile specimens those spots form two bands. On the rays of the dorsal, anal and caudal fins I observed rows of dark spots. The first and second dorsal spine was dark brown or blackish. The third and fourth ray had a dark brown margin. The coloration in living specimens was not noted, because recently this species almost disappeared from aquaria in Prague.

Bailey (1941) describes the third band as the broadest, in my specimens the fourth was slightly broader; in my specimens the third band ends ventrally behind the lower margin of the pectoral fin and does not reach the ventral fin base. In my specimens the fourth band is shifted forward; Bailey (l. c.) describes it as passing from the third and fourth dorsal soft rays to the second to fourth anal soft rays. Also the fifth band is shifted forward in my material, while in Bailey's description it encircles the body just behind the dorsal fin. The same shifting forwards was observed in the sixth band. Bailey (1941) does not mention the seventh or eight bands. In formalin specimens no red in the dorsal fin was observed. The coloration of the Black Banded Sunfish in European aquaria was described by Zolotnickij (1904), Schreitmüller (1928), Bade (1934), Engmann (1934), Stoye (1935), Frey (1952), Höpfner (1954), Polák (1954), Vogel (1955), Andódi (1961), Andódi-Frank (1969); Frank (1977) brought the original photo of the specimen with interrupted vertical bands (except the first one passing through the eye), the other bands are formed rather by spots.

Table 1—10. Frequency distributions of fin ray and scale row counts in the subspecies of *Mesogonistius chaetodon*

Subspecies	1. Number of dorsal spines				2. Number of dorsal soft rays				3. Number of anal soft rays												
	8	9	10	11	n	Ave.	9	10	11	12	13	14	n	Ave.							
<i>M. c. chaetodon</i> (Bailey, 1941)	—	18	122	1	141	9.88	—	—	58	78	4	140	11.6	—	—	1	67	78	1	147	12.54
<i>M. c. elizabethae</i> (Bailey, 1941)	—	6	—	—	6	9.0	1	1	4	—	—	6	11.5	—	—	4	1	1	1	6	12.5
<i>M. c. chaetodon</i> (author)	4	17	13	—	34	9.26	2	7	12	11	2	34	11.1	1	5	7	13	6	—	32	11.6

Subspecies	4. Number of pectoral rays				5. Number of lateral line scales				6. Number of scales above lateral line					
	10	11	12	13	n	Ave.	25	26	27	28	29	30	n	Ave.
<i>M. c. chaetodon</i>	16	216	18	—	250	11.01	—	5	18	33	39	8	103	28.26
<i>M. c. elizabethae</i>	—	5	7	—	12	11.58	—	—	1	5	—	—	6	27.83
<i>M. c. chaetodon</i> (author)	9	11	7	1	28	11.0	4	2	1	—	1	1	9	26.44

Subspecies	7. Number of scales below lateral line				8. Number of rows of scales on cheek				9. Number of scales around caudal peduncle										
	10	11	12	13	n	Ave.	2	3	4	n	Ave.	17	18	19	20	21	22	n	Ave.
<i>M. ch. chaetodon</i>	—	11	44	4	59	11.88	3	110	6	119	3.03	—	2	23	20	18	2	85	19.92
<i>M. ch. elizabethae</i>	1	4	1	—	6	11.0	3	3	—	6	2.5	1	5	—	—	—	—	6	17.83
<i>M. ch. chaetodon</i> (author)	—	6	5	2	13	11.69	—	3	9	12	3.75	2	4	1	2	—	—	9	18.33

Subspecies	10. Meristic index (This index is the sum of the number of dorsal spines, scale rows below lateral line, scale rows on cheek, and scale rows around caudal peduncle)										
	39	40	41	42	43	44	45	46	47	u	Ave.
<i>M. ch. chaetodon</i>	—	—	—	1	6	2	9	16	3	37	45.14
<i>M. ch. elizabethae</i>	2	1	2	1	—	—	—	—	—	6	40.33
<i>M. ch. chaetodon</i> (author)	—	—	—	2	4	1	—	—	—	7	42.86

Table 11. Proportionate measurements of six specimens of *Mesogonistius chaetodon elizabethae* (Bailey, 1941) and 34 specimens of *Mesogonistius chaetodon* from aquaria of Czech hobbyists

	Bailey 1941	Author
Standard length (in mm)	38.6 (32-46)	24.5 (18.6-57.4)
In % of standard length:		
Length of head	36.8	40.0
Depth of body	53.6	43.5
Length of caudal peduncle	18.9	18.3
Length of pectoral fin	29.1	23.8
Length of caudal fin	34.9	34.5
In % of caudal peduncle length:		
Depth of caudal peduncle	91.6	83.0
In % of body depth:		
Width of body	30.0	34.5
In % of highest dorsal spine:		
Lowest dorsal spine	73.2	58.8
In % of distance from tip of snout to origin of dorsal fin:		
Highest dorsal spine	38.9	52.6
In % of base of dorsal fin:		
Highest dorsal soft ray	55.5	58.0
In % of highest anal spine:		
Lowest anal spine	46.7	47.6
In % of distance from origin of anal fin to insertion of pelvic:		
Highest anal spine	96.0	83.3
In % of base of anal fin:		
Highest anal soft ray	90.2	90.9
In % of head length:		
Width of head	48.4	40.0
Length of orbit	33.1	37.0
Width of bony interorbit	24.7	32.0
Length of snout	24.3	25.0
Length of upper jaw	26.5	25.3
Length of lower jaw	39.1	37.7

For calculation 9 meristic and 20 plastic characters were used. Most of my specimens have 9 dorsal spines: in numerous specimens of nominal subspecies Bailey (1941) found 10 spines (Tab. 1). In my specimens a very small number of dorsal spines (8) was found, not cited by Bailey (1941).

Similarly as Bailey (1941), also other authors such as Boulenger (1895), Sterba (1959), Bade (1934), Andódi-Frank (1969) cited 10 spines.

Some difference can be found also in the number of soft dorsal rays (mostly 11 in my specimens, 12 in nominal subspecies; 11 is the dominant number in subspecies *elizabethae*, see Tab. 2). In about 26% of my specimens there are 9 and 10 soft dorsal rays, also not found by Bailey (1941). Sterba (1959), apparently following Bade (1934), cited 10-12, the same number appeared in Andódi-Frank (1969).

A similar difference can be seen in the number of anal soft rays (Tab. 3). In 19% of my specimens there are 9 and 10 soft anal rays. In 81% 11-13 soft anal rays were found; Bailey (1941) found 11 rays only in one specimen of the nominal form. Most frequently there occurred 12-13 rays. Similarly, dominant number 12 is cited by Boulenger (1895), while Bade (1934),

Sterba (1959), Andódi-Frank (1969) gave smaller numbers of these rays (9—10).

The dominant number of the pectoral rays is the same in my specimens and in the nominal form, slightly differing from subspecies *elizabethae* (Tab. 4).

The lateral line scales were counted only in 9 specimens, the remaining specimens were damaged and scales were lacking. In the nominal form most specimens had 28—29 lateral line scales; I did not find 28 at all, 29 only in one case (Tab. 5). The dominant number in my material was 25; this number is not given by Bailey (1941), Boulenger (1895) found 26—28 scales. Number of scales above lateral line coincides (Tab. 6) with Bailey, Boulenger found also 4 scales, not observed in my material. Very slight differences can be observed in the number of scales below lateral line (Tab. 7).

In my material, the number of rows of cheek scales could be observed only in the third of specimens, in most cases I found 4 rows in the nominal form there are 3 rows (Tab. 8). The number of scales around the caudal peduncle substantially coincides in all three samples. Meristic index was determined in 7 specimens only, the widest ranges can be found in the nominal form (42—47). The shift to lower values 39—42 is evident in subspecies *elizabethae*. In my material the range is 42—44 (Tab. 10).

Unfortunately, plastic characters can be compared only with 6 specimens of the subspecies *elizabethae*, because Bailey (1941) not furnished any plastic characters for specimens which he studied as the nominal form (see Tab. 11).

I had at my disposal material of broader length ranges than Bailey; most of my specimens (91%) were smaller, measuring 18.6—24.5 mm of standard length, only 3 specimens 46.3—57.4 mm were comparable in size with Bailey's sample. My specimens are considerably slender. The depth of the caudal peduncle is smaller in my sample and the relation of the length of the longest dorsal spine to the shortest one shows a diminishing tendency. The length of the longest dorsal spine in the predorsal distance showed a difference, this spine being shorter in my sample. The considerable difference appeared in the length relation of the longest anal spine in the distance between ventrals and anal fin, these spines being longer in my sample. The width of the head is smaller in subspecies *elizabethae*, the interorbital width is greater.

Bailey (1941) had a more numerous material of the nominal form than myself, and this fact could influence meristic counts. Unfortunately, the new subspecies *elizabethae* was described using 12 specimens, most characters are based on 6 specimens only. The value of the length of the head in the body length, 28.6—33.3%, cited by Meinken (1932) does not coincide with my and Bailey's findings. The lower range of the value of the body depth given as 20—55% of the body length by Meinken (l. c.) is apparently erroneous.

The number of the lateral line scales, 26—28 at Meinken, is identical with both forms at Bailey; I found the range of 25—30.

With regard to the distribution of this species ranging from Maryland, New York and New Jersey southwards along the eastern slopes of the Appalachian Mountains to northern Florida it seems probable that the southern populations can differ from the northern ones. The form and meristic characters of European aquarium specimens could be influenced by the higher temperature in tanks, which proved to be more profitable for spawning and reproducing, which is the aim of fanciers.

Some authors, e.g. Bade (1934), Meinken (1932), Andódi-Frank (1969), Sterba (1977), published broad ranges of temperature for breeding in captivity from 0–25 °C. Höpfner's (1954) lower limit was 8 °C. Further authors cited only narrow ranges for breeding, e.g. Jakubowski-Ring (1969) 18 °C, Zolotnickij (1904) 19–22 °C, Zúkal (1976) 18–22 °C and lower, Schreitmüller (1928) 13–21 °C, Andódi (1961) for specimens from Florida 16–22 °C; Polák (1954) supposed the Black Banded Sunfish hardly to survive 18 °C. For spawning higher temperature are preferable, after Andódi-Frank (1969) 15–25 °C, Vogel (1955) 14–20 °C; Schreitmüller (1928) cited 15 °C, Jakubowski-Ring (1969) 20 °C, Polák (1954) 20 °C and more, Bade (1934) 22 °C, Stoye (1935) 21 °C.

In any case, some important differences between the wild and domesticated population of the Black Banded Sunfish are evident.

Acknowledgements

Thanks are due to Dr. O. Oliva who recommended me this problem for study and furnished comments, literature and encouragement. The material was obtained and kindly preserved by several persons, e.g. Dr. S. Frank, M. Chvojka, I. Petrovický, K. Polák and others, and donated to further studies to the collections of the Department of Systematic Zoology, Faculty of Science, Charles University, Prague.

SUMMARY

In 34 specimens of *Mesogonistius chaetodon* 20 plastic and 10 meristic characters were studied using acclimatized specimens from aquaria.

Considerable differences were found in the body depth (in aver. 43.5⁰/₀ of body length, wild ones in aver. 53.6⁰/₀); in the interorbital width in the head length (32⁰/₀, wild ones 24.7⁰/₀), in the depth of the caudal peduncle (83⁰/₀ of its length in aquaria specimens, 92⁰/₀ in wild ones), in the length of dorsal spines (the ratio of the length of the shortest and longest spine 58.8⁰/₀ in aquarium specimens, 73.2⁰/₀ in wild ones), in the length of the longest dorsal spine, in the predorsal distance (52.6⁰/₀ in aquaria specimens, 38.9⁰/₀ in wild ones). The length of the longest anal spine in the distance between the ventral and anal fins was found to be 83.3⁰/₀ in aquarium population, in wild specimens 96⁰/₀.

The width of the head in its length is 40⁰/₀ in my sample, in the North American specimens 48.4⁰/₀; also the interorbital distance is smaller in my specimens (32⁰/₀, 24.7⁰/₀) in comparison with the wild ones. Differences could be due to the 78-year long aquarium breeding in Czechoslovakia.

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Fig. 1 and Plate 1 will be found at the end of this issue

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ON THE EFFECT AND THE NATURE OF GROWTH COMPENSATION OF FISH

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Abstract. This paper reports the results from growth compensation studies on populations of five cyprinid species. The author has the aim to contribute to the explaining of the causes for the versatility and the contradictions in the concepts on growth compensation and to the solving of the problems of determination effect, nature and causes of this phenomenon.

The growth of organisms is one of the most important problems of modern fundamental and applied developmental biology. Growth compensation has been of special interest during the last two decades. The investigations concerning growth compensation have been extensively reviewed and analysed by Zamachaev (1964, 1967), Ricker (1969, 1975), Ivanov (1973), Mina and Klevezal (1976) and Živkov (1980a). Some authors make rather contradictory conclusions and suggestions about the nature of growth compensation, its causes and about its very existence as well.

MATERIAL AND METHODS

The regularities and peculiarities of growth compensation were studied using 5 cyprinid species from the Batak dam: the carp, *Cyprinus carpio* L., the goldfish *Carassius auratus gibelio* (Bloch), the chub *Leuciscus cephalus* (L.), the roach *Rutilus rutilus* (L.) and the bleak, *Alburnus alburnus* (L.). The materials were collected 1970 through 1978 in spring (April–May) and autumn (end of August, September–October). The body length was measured till the end of the scale cover. Scales were used to determine the age by means of a projector model Dokumator, Lesegerat manufactured by VEB Carl Zeiss Jena (GDR) at a 9X magnification for the carp and 17.5X— for the other species. A total of 1000 specimens of each species were studied.

The methods were developed and discussed in detail in a previous publication (Živkov 1980a). Separate empirical regression lines based on the body length (L) and scale radius (S) were drawn either for each age-group or for two adjacent age-groups (Figs 1–5). Then the S-values of the selected generations (age-groups) in which the growth compensation was studied were combined according to Table 1. The back calculations of L by S were done as follows: all average S_1 values (Table 1) were plotted on the graph with the regression line of the first age-group (Figs 2, I for example) and the corresponding L_1 values were written in Table 1 next to the S_1 values. All S_2 values were plotted on the graph with the regression line of the second age-group (Fig 2, II for example) and the corresponding L_2 values were written in the table next to the S_2 values, etc. Then the average values of the absolute annual increments ($t_1 = L_1$, $t_2 = L_2 - L_1$, etc.) were calculated within each size group (a, b, etc. Table 1).

Only the L and t-values were used to establish the growth compensation and its effect. The age-dependent changes in L and t within each size-group (i.e. within the horizontal lines of Table 1) were traced and compared to the changes in L and

t in other size-groups. Because of technical reason the tables are not published. The results are presented graphically

In order to take into account the eventual influence of the size-selective mortality on the process of diminishing of the age-dependent size differences (growth compensation) the model was applied several times to the same generation in several consecutive phenological years.

RESULTS

Figures 6, 7, 8, 9 represent the growth regularities of different species traced in several consecutive years. The average initial lengths are different but the generation is the same (1969). No diminishing of the age-dependent differences in the average body length were observed in the second and the third carp age-groups (Fig. 6, II, III). The process of convergence of the L-values began only after the third year (Fig. 6, IV, V). The results of the studies on the goldfish are similar (Fig. 7). They differ only by the vague tendency towards convergence. The initial length differences are almost the same even in the fifth and the sixth years. Instead of the expected convergence the chub exhibited a well expressed divergence of the L-values at the ends of the second and the third years (Fig. 8, II, III). Obviously this was due to the shift of the chub diet to fish (Dimitrov and Ljudskanova, 1967, Živkov, 1974). The

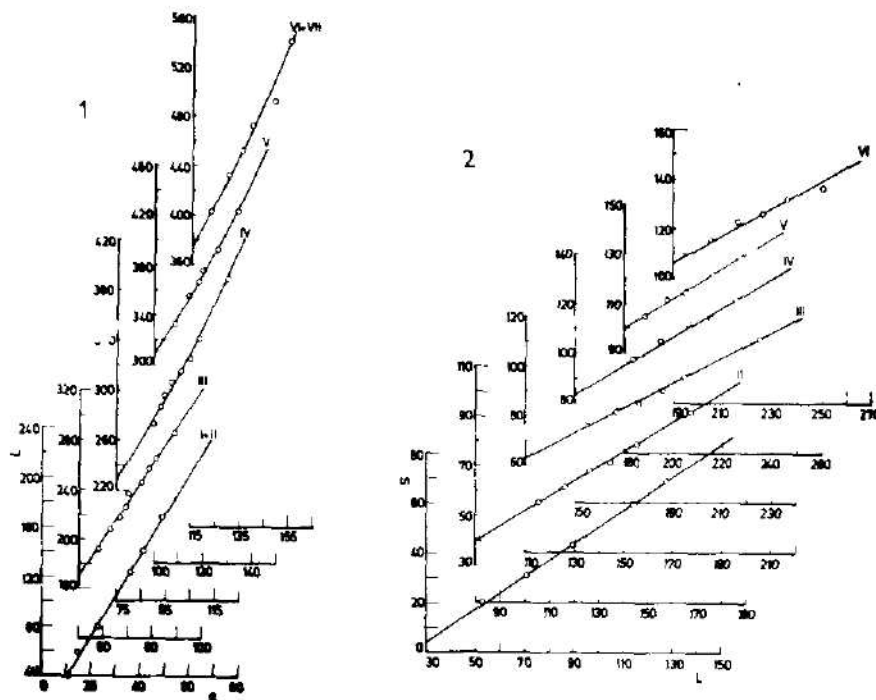


Fig. 1 Correlation between body length (L, mm) and diagonal scale radius (S, in dials of the ocular-micrometer) of the different age-groups of the carp (I, II, ...). Fig. 2 Correlation between body length (L, mm) and oral scale radius (S, in dials of the ocular-micrometer) of different age-groups of the goldfish (I, II, ...).

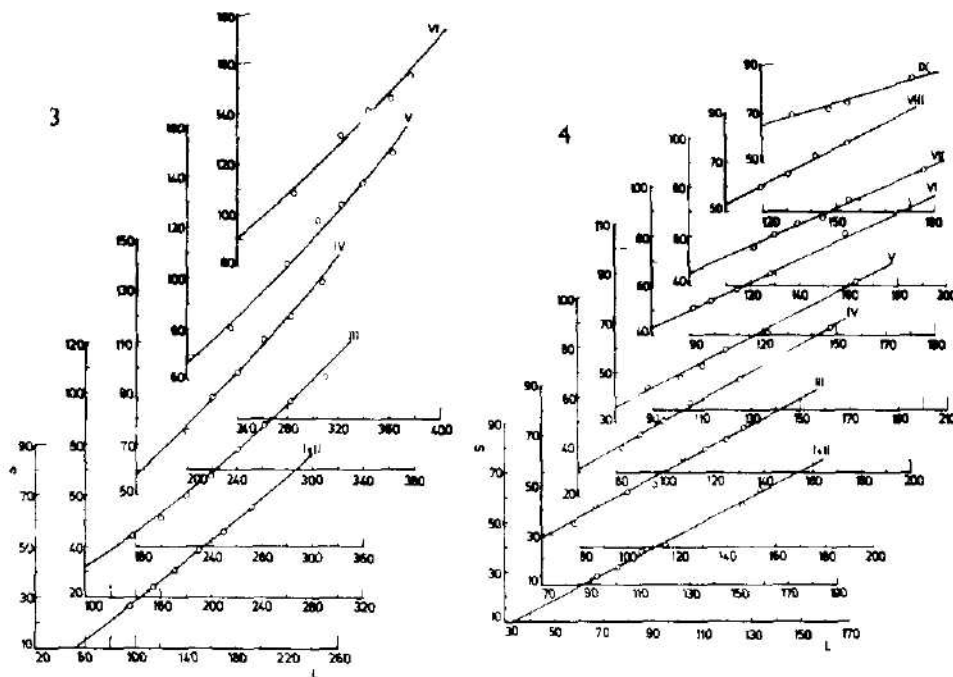


Fig. 3. Correlation between body length (L, mm) and diagonal scale radius (S, in dials of the ocular-micrometer) of different age-groups of the chub (I, II, ...).
 Fig. 4. Correlation between body length (L, mm) and caudal scale radius (S, in dials of the ocular-micrometer) of different age-groups of the roach (I, II, ...).

largest individuals shifted first and there rate of length and weight increase was even more rapid (Fig. 8, II, III). The length differences within all size-groups between the third and the fourth years almost did not change. Only after the fourth year an obvious convergence occurred (Fig. 8, VI).

The initial differences in the average lengths of the roach were maintained through the ninth year. A certain convergence was observed at the end of that year (Fig. 9). The 1969 roach generation had a very low for this dam growth rate because of its very large number. The share of this generation in the annual catches (around 50 Tt a year) during the following 7—8 years was over 50%.

A better idea about the changes in the average initial lengths during the process of growing as well as about the very nature of growth compensation can be obtained by comparing the L-value of generations growing under different conditions and at different rates. When doing this it is adequate to divide the fish into two size-groups — with smaller and larger average initial lengths

The average L-values of the 1969 carp generation became completely equalized between the fifth and the sixth years. (Fig. 10). We do not have enough specimens from the other generations of this species.

The average lengths of the more rapidly growing 1971 generation of the goldfish became equalized at the end of the fifth year (compare to the 1969

Table 1. Grouping of average sizes of annual scale rings (S, diam of the ocular-micrometer) and the corresponding back calculated body length values (L, mm) in the study on the growth compensation of fish within a certain generation, $t_1 = L_1$; $t_2 \approx L_2 - L_1 \dots$ - absolute annual increments within size groups (a, b, ...)

Generation	Age group	Average values of S, L and t at the ends of each growth period										Number of specimens						
		1 (1967)		2 (1968)		3 (1969)		4 (1970)		5 (1971)								
1967	V	a	S ₁	L ₁	t ₁	S ₂	L ₂	t ₂	S ₃	L ₃	t ₃	S ₄	L ₄	t ₄	S ₅	L ₅	t ₅	n
		b	S ₁	L ₁	t ₁	S ₂	L ₂	t ₂	S ₃	L ₃	t ₃	S ₄	L ₄	t ₄	S ₅	L ₅	t ₅	n
		c	S ₁	L ₁	t ₁	S ₂	L ₂	t ₂	S ₃	L ₃	t ₃	S ₄	L ₄	t ₄	S ₅	L ₅	t ₅	n
		d	S ₁	L ₁	t ₁	S ₂	L ₂	t ₂	S ₃	L ₃	t ₃	S ₄	L ₄	t ₄	S ₅	L ₅	t ₅	n
		e	S ₁	L ₁	t ₁	S ₂	L ₂	t ₂	S ₃	L ₃	t ₃	S ₄	L ₄	t ₄	S ₅	L ₅	t ₅	n
		f	S ₁	L ₁	t ₁	S ₂	L ₂	t ₂	S ₃	L ₃	t ₃	S ₄	L ₄	t ₄	S ₅	L ₅	t ₅	n
.
.
.

Size groups based on grouping of fish according to their radii of first annual scale rings

generation. Fig. 11, 1971). The 1972 generation of the chub exhibited the most rapid rate of convergence of the L-values (Fig. 12, 1972). It was completed at the end of the third year. The roach exhibited the same phenomenon (Fig. 13, 1971, 1972). The more rapidly growing generations of the bleak had their L-values equalized at the end of the second year (Fig. 14, 1973, 1974). The 1970 generation grew at lower rate and even at the end of the fifth year the tendency towards convergence of the L-values was hardly observable.

The effect and rate of growth compensation are best shown by means of the absolute linear increments (t). Even during the second year fish with bigger average initial length (solid lines, Fig. 15) grew relatively faster than fish with smaller initial length. As we mentioned above this regularity could not be shown using the L-values (Fig. 6. II, III). Between the second and the third years the t-values were already equalized. After the third year this tendency was reversed and fish with smaller initial length ($t_1 = L_1$), had bigger increments (in absolute values) than fish with bigger initial length (Fig. 15, III, IV, V).

This regularity can be even better illustrated if the entire generation is divided only into two size-groups (Fig. 16).

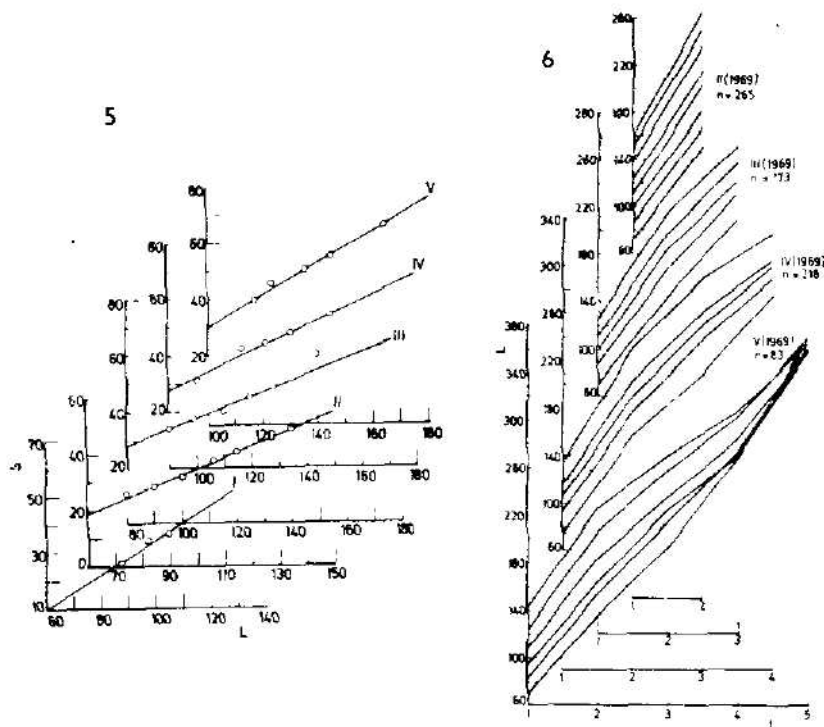


Fig. 5. Correlation between body length (L, mm) and caudal scale radius of (S, in dials of the ocular-micrometer) of different age-group of the bleak (I, II, ...).
Fig. 6. Growth curves of specimens with different average initial lengths of the 1969 carp generation. L — body length, mm; t — age, years; II, III, ... — age groups.

In the case of the goldfish the position of the intersection between the t-curves (equalizing of the t-values) depended on the growth rate of the generations and was either between the first and the second year (Fig. 17, 1972, 1971, 1970) or between the second and the third year (Fig. 17, 1969). Between the fourth and the fifth years and between the fifth and the sixth years the t-values were equalized once again (Fig. 17, 1970, 1969). The initially larger

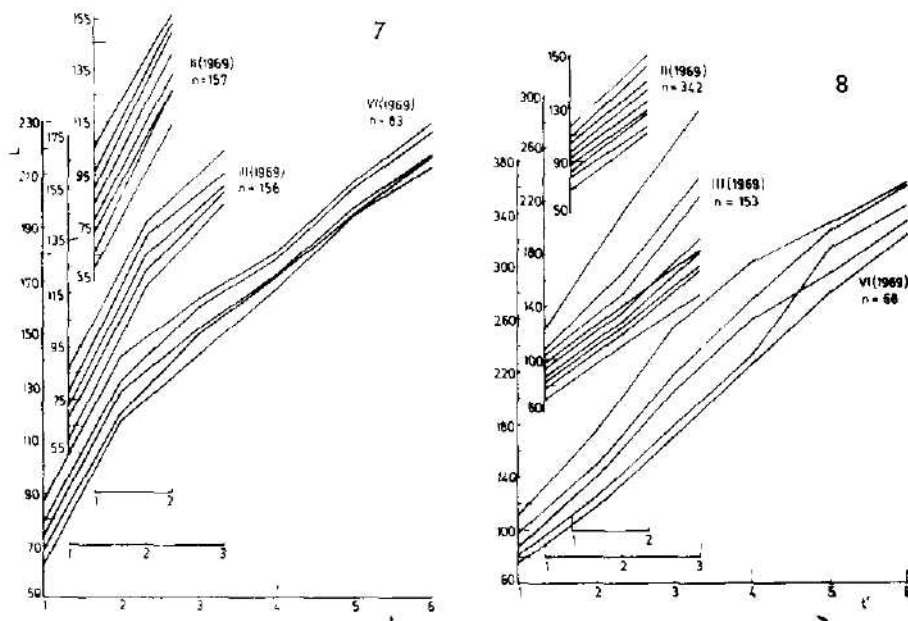


Fig. 7. Growth curves of specimens with different average initial lengths of the 1969 goldfish generation. L — body length, mm; t' — age, years; II, III, ... — age groups

Fig. 8. Growth curves of specimens with different average initial lengths of the 1969 chub generation. L — body length, mm; t' — age, years, II, III, ... — age groups.

chubs of the 1969 generation maintained their higher growth rate through the third year (Fig. 18, III, VI). This was due to the nutrition type shift of this species referred to already. The earlier position of intersection of t-curves of more rapidly growing generations (between the first and the second year, Fig. 18, 1972, 1967) can be explained by means of the earlier transition to predation.

Another regularity can be observed in the roach population, as well as to a certain degree (depending on the age and growth rate) in some other populations. After the first intersection of the t-curves there is another one between the fourth and the fifth years (Fig. 19, 1972, 1971, 1969). The 1969 and 1971 generations exhibited a third intersection occurring between the sixth and the seventh years. The shape and size of the figures formed at every intersection of the two growth curves of a certain generation reveal a gradually fading process. The growth rate (t) approaches a probably genetically determined value (see also Fig. 16, III, IV, VI, Fig. 17, Fig. 18, V, VI).

The t-curves of the more rapidly growing bleak generations intersect between the first and the second year (Fig. 20, 1974, 1973, 1971) and those of the slower growing ones — between the second and the third year (Fig. 20, 1969, 1970, 1972).

Similar results can be obtained from plotting the t-values against the L-values (Figs. 21—25). At the same L-values fish with smaller initial length later grew more rapidly (Fig. 21, VI, Fig. 22, V — up to 180 mm, Fig. 23, III [1972], VI, Fig. 24, II, Fig. 25, II, III, IV [1971]). This did not concern all generations and sizes. In slower growing generations as well as after the second intersection of the t-curves there was only a trend towards equalizing of the t-values (Fig. 22, V, VI, Fig. 23, V, VI, Fig. 24, VII, IX, Fig. 25, V).

DISCUSSION

Sund (1911) for the first time and Gilbert (1914) noted that individuals which were small during the formation of the first annual mark grew relatively faster during the second year. Hodgson (1929), Van Oosten (1929), Ford (1833), Hubbs and Cooper (1935), Hile (1941), Scott (1949), Ric-

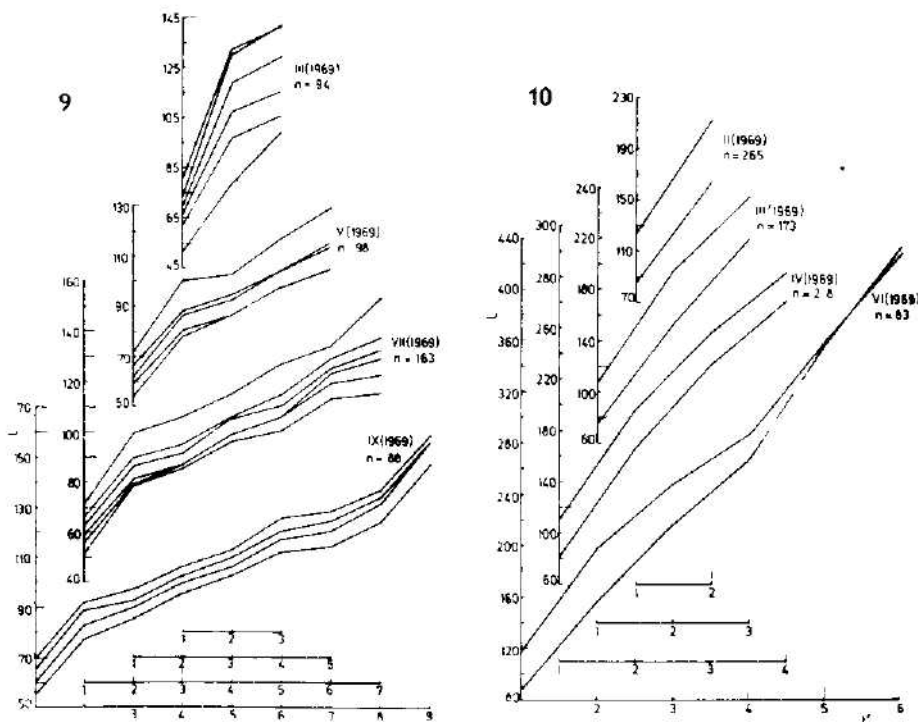


Fig. 9. Growth curves of specimens with different average initial lengths of the 1969 roach generation. L — body length, mm; t' — age, years; II, III, ... — age groups.

Fig. 10. Growth curves of specimens with different average initial lengths, of the 1969 carp generation. L — body length, mm; t' — age, years, II, III, ... — age groups.

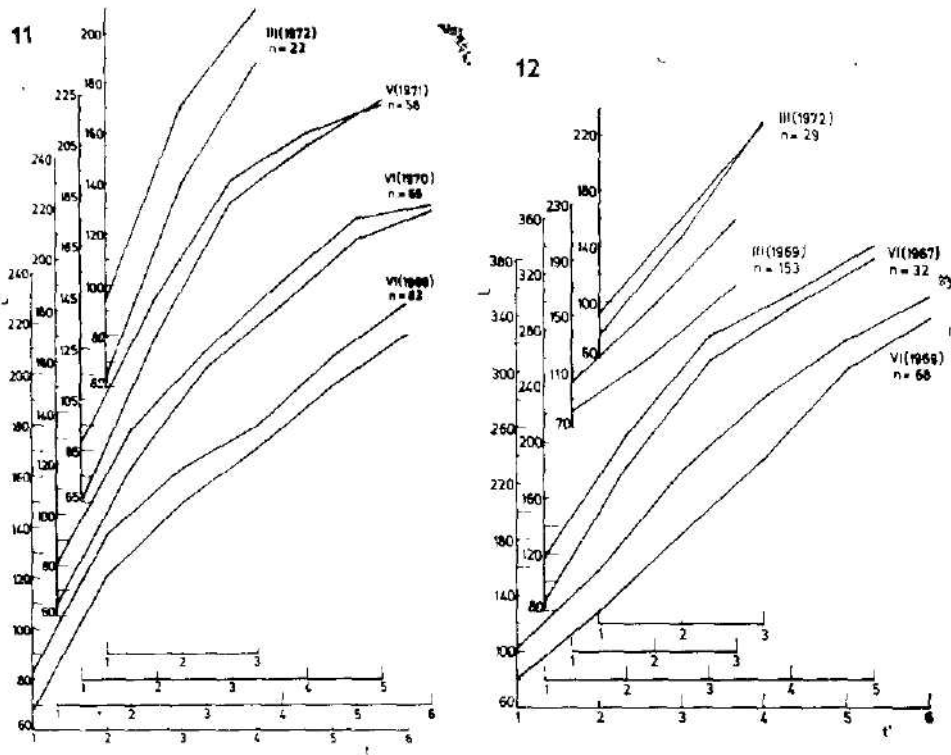


Fig. 11. Growth curves of specimens with different average initial lengths of various generations (1969, 1970, ...) and age groups (II, III, ...) of the goldfish. L — body length, mm; t — age, years.
 Fig. 12. Growth curves of specimens with different average initial lengths of different generations (1967, 1969, ...) and age groups (III, VI, ...) of the chub. L — body

ker (1969, 1975) considered the growth compensation as a correlation between the linear (weight) increments of a particular generation in several consecutive years. The negative correlations exhibit the growth compensation, i.e. smaller fish tend to catch up with larger ones. The positive correlations indicate a reverse growth compensation, called growth depensation (Scott, 1949; Neave, 1954). Hodgson (1929) illustrated the growth compensation by means of the convergence of two identical linear growth curves one of which was shifted along the time axis. Ford (1933) suggested that the reason for the growth compensation might be the change in the growth curve shape. Ivanov (1973) pointed out that with a certain weight increment, the t-value would be inversely proportional to the body length before the weight increase. This is because of the nonlinear correlation between length and body weight. Kuznetsov (1957) determined growth compensation as diminishing of increments of larger fish and their relative increasing in smaller one-year-old fish. He explained this by means of higher survivability and growth rate of the latter as adaptations towards unfavourable conditions during the egg and larval stages of development. Belyj (1950, 1960) explained growth compensation

as an interaction between internal and external factors of growth. The internal ones slow down growth but their influence on younger fish is limited. That is why those lacking behind in size catch up with the others due to a more rapid growth. According to Kiselevič (1922), Čugunova (1951, 1961), Čugunova et al. (1961), Hunt and Jones (1972) the fast growing one-year-old fish keep growing faster during the following years. Čugunova (1951)

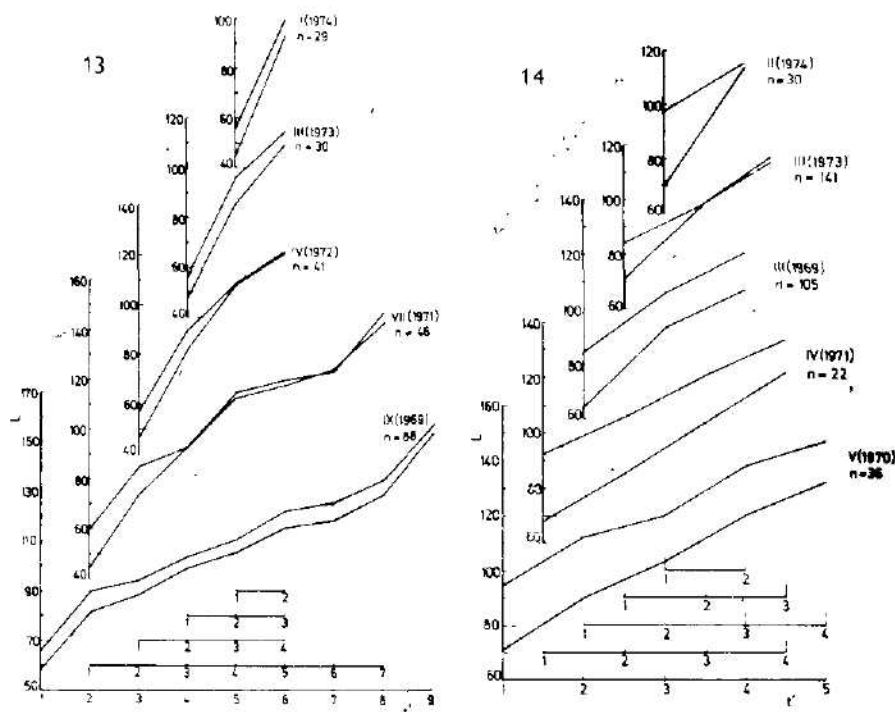


Fig. 13. Growth curves of specimens with different average initial lengths of different generations (1969, 1971, ...) and age groups (II, III, ...) of the roach. L — body length, mm; t' — age, years.
 Fig. 14. Growth curves of specimens with different average initial lengths of different generations (1969, 1970, ...) and age groups (II, III, ...) of the bleak. L — body length, mm; t' — age, years.

pointed out that larger fish are more active in searching for and utilizing food. Ivanov's opinion is contrary (Ivanov, 1973). He suggested that the capabilities for finding and utilizing of food by individuals from different size and weight were gradually equalized during the process of growth and this was the main reason for the growth compensation. According to Zamachayev (1967) the idea that larger individuals have an advantage in searching for and particularly in utilizing food compared to smaller ones can not be accepted without scientific argumentations. By the same manner we can suggest that smaller fish utilize more food for growing and less — for producing energy. In mammals some (Widowson and McCause, 1960, Widowson, 1968) found an increase in the effect of utilizing food during the period

of growth compensation and others (Mina and Klevezal, 1976) did not. The latter think that the most important factor determining the animal's capability for growth compensation is its age and/or the stage of development during which the growth retardation begins. According to Wilson and Osborn (1960) after the beginning of the growth retardation caused by malnutrition, growth can be influenced also by the type of malnutrition, duration and intensity of growth retardation, etc.

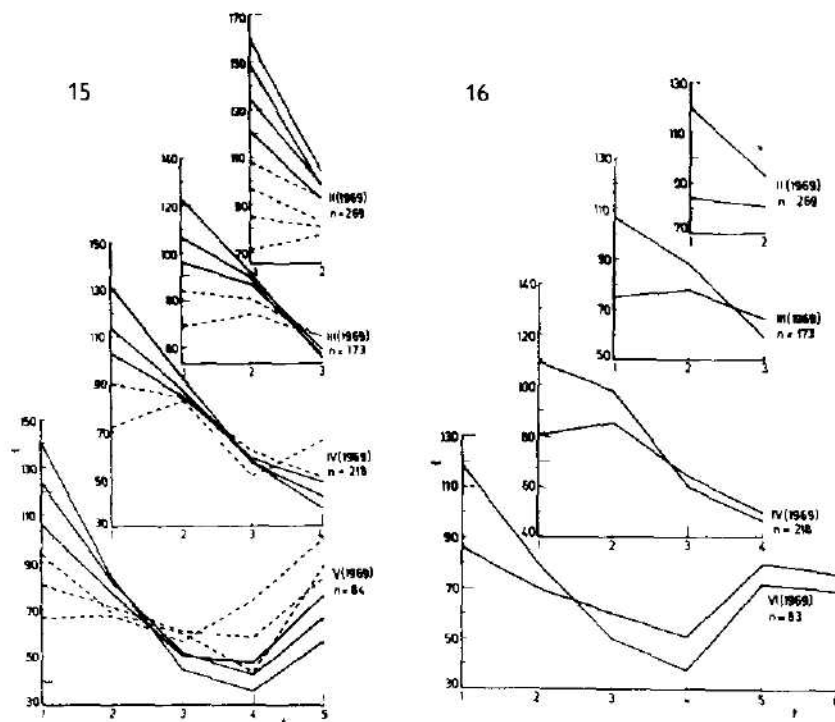


Fig. 15. Changes in the absolute increments (t , mm) of specimens with bigger (solid lines) and smaller (dotted lines) average initial lengths of the 1969 carp generation. t' — age, years, II, III, ... — age groups.
 Fig. 16. Changes in the absolute increments (t , mm) of specimens with different average initial lengths of the 1969 carp generation. t' — age, years; II, III, ... — age groups.

Zamachayev (1967) pointed out that besides other reasons the living conditions and the initial length were obligatory growth affecting factors.

Lapin (1969, 1971) suggested that the equalizing of sizes was not genuine. During certain periods of their life cycle fish are grouped according to similar biological properties and above all according to their sizes. Ivanov (1971) suggested that the main reason for regrouping of fish within the age-groups was the growth compensation. Its influence increases with reaching the maximum number and normal age structure of the population. Some other authors (Bilko, 1965, Korotković, 1965, Poltavčuk, 1965, Bruenko, 1968

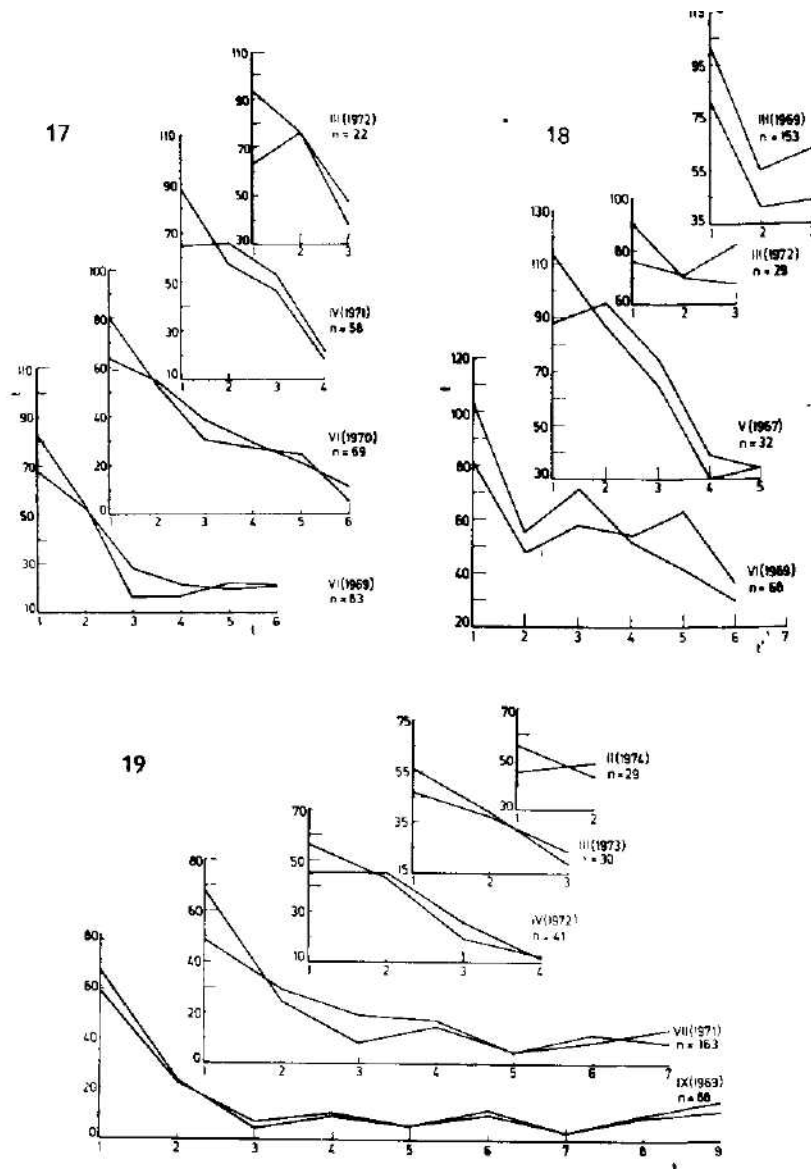


Fig. 17. Changes in the absolute increments (t , mm) of specimens with different average initial lengths of various generations (1969, 1970, ...) and age groups (III, IV, ...) of the goldfish. t' - age, years.
 Fig. 18. Changes in the absolute increments (t , mm) of specimens with different average initial lengths of various generations (1967, 1969, ...) and age groups (III, V, ...) of the chub. t' - age, years.
 Fig. 19. Changes in the linear increments (t , mm) of specimens with different average initial lengths of various generations (1969, 1971, ...) and age groups (II, III, ...) of the roach. t' - age, years.

after Stražnikova and Djačuk, 1976) consider the growth compensation as a biological and ecological phenomenon. The concepts of Čugunov (1928) and Zamachayev (1967, concerning growth compensation in different populations) are similar. They consider the growth compensation as an accidental and not a regular phenomenon.

Zamachayev determined the relative decrease of the growth rate of larger fish and the relative increase of the growth rate of smaller fish as growth compensation. Fish that were larger at the age of one year kept being larger during the following years although their increments were smaller. He suggested that the decrease of the size variability within a particular generation exhibited during the first several years of life was due to growth compensation. Mina and Klevezal (1976) also considered growth compensation as a decrease of the size differences among individuals. They concluded that the lengths convergence could be predicted in advance. The mechanism of growth compensation is more interesting. Do initially smaller individuals reach a certain length and weight with the rate of initially larger ones (nonreal growth compensation — type 1) or their rate is higher (real growth compensation — type 2)? The authors used the example of Hodgson (1929) to demonstrate the nonreal growth compensation. They considered their own attempt to prove the real growth compensation as inconvincing.

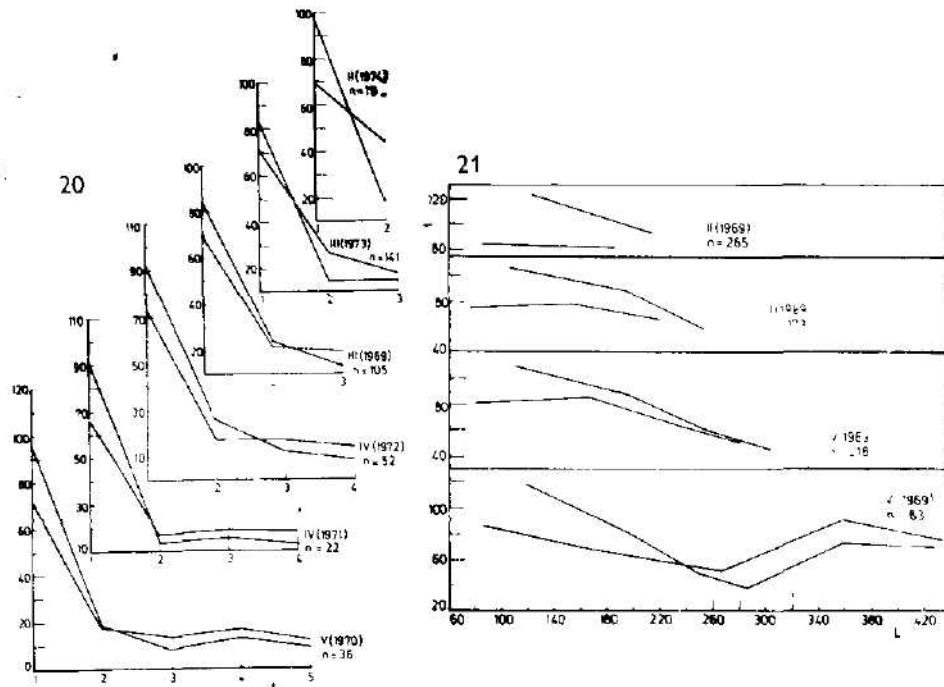


Fig. 20. Changes in the absolute increments (t , mm) of specimens with different average initial lengths of various generations (1969, 1970, ...) and age groups (II, III, ...) of the bleak. t — age, years.
 Fig. 21. Changes in the absolute increments (t , mm) of specimens with different average initial lengths of various age groups (II, III, ...) of the 1969 carp generation depending on their length (L , mm).

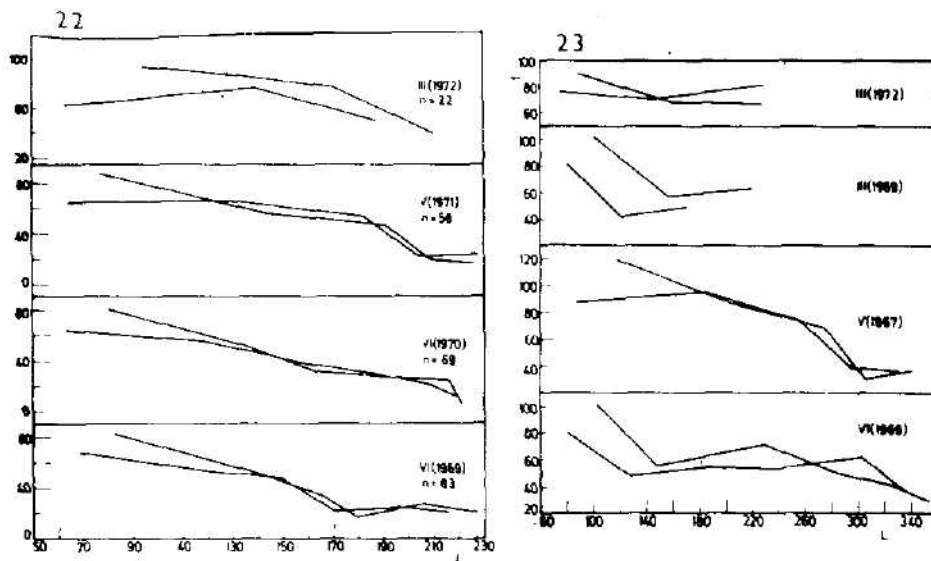


Fig. 22. Changes in the absolute increments (t , mm) of specimens with different average initial lengths of various generations (1969, 1970, ...) and age groups (III, V, ...) of the goldfish depending in their lengths (L , mm).
 Fig. 23. Changes in the absolute linear increments (t , mm) of specimens with different average initial lengths of various generations (1967, 1969, ...) and age groups (III, V, ...) of the chub depending on their lengths (L , mm).

Earlier Živkov (1972) discussed the regularity of the growth compensation, the periodicity of fish growth and the influence of living conditions and maturity on the pattern and rate of growth of different bream (*Abramis brama* L.) populations. He pointed out that the biological growth although extremely complex was an integral process. That is why the various endogenous and exogenous factors affecting growth rate and the pattern of their influence are to be studied simultaneously and as whole unit. Stražnikova and Djačuk (1976) made the same conclusion.

This review indicates the contradictory opinions on the determination, essence and reasons of the growth compensation. We still do not have a general and universally acceptable theory explaining the growth compensation. This paper presents some of our concepts on the discussed problems.

Above all the considering of growth compensation as diminishing with age of size differences is not quite correct, because this includes the size-selective mortality (Lee's phenomenon). In order not to be confused by the effects of the two phenomena growth compensation was studied also within age groups in which the lack of size-selective mortality was established in advance. The Lee's phenomenon was not typical for the populations studied or its effect was insignificant. That is why the two-year-old fish (three years for the roach) and the older ones were not affected by this phenomenon (Živkov, 1980b).

The fish were grouped according to the radius of the first annual ring and not according to their sizes at the time of collecting (Table 1). This as well as our results do not confirm the concept of Lapin (1969, 1971) who concluded

that the size equalizing was not genuine and was due to a natural grouping of fish by size.

Another controversial and essential problem is the growth rate of fish with different initial lengths. In some cases the growth compensation can be defined as a tendency towards convergence of the L-values (Fig. 6, IV, V, Fig. 7, VI, Fig. 8, VI, Fig. 9, IX, Fig. 11, VI, Fig. 12, VI, Fig. 13, IX, Fig. 14, IV, V). Obviously this was the reason for Z a m a c h a e v (1967) to generalize that larger one-year-olds kept being larger during the following years. This conclusion is not confirmed by our results (Fig. 10, VI, Fig. 11, V, Fig. 12, III, Fig. 13, IV, VII, Fig. 14, II, III).

The problem is whether the growth compensation is just a tendency towards convergence of the L-values or initially smaller fish do grow at higher rate during the following years.

The first condition needed to solve the problem is to find an adequate growth rate index. Some of our previous studies (Z i v k o v, 1972) revealed that the L-values can not be used as such an index. They do not contain informa-

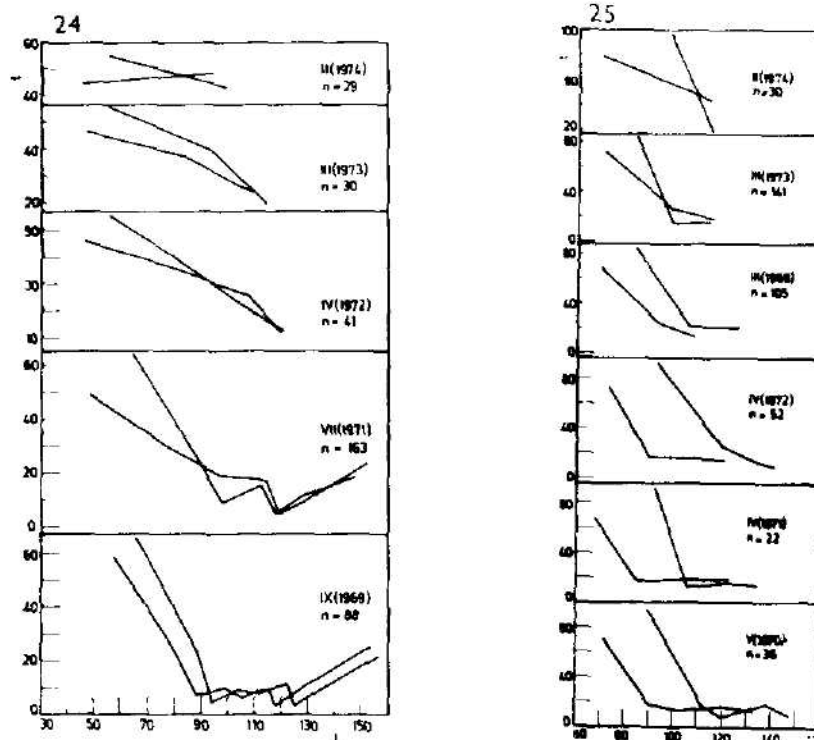


Fig. 24. Changes in the absolute linear increments (t, mm) of specimens with different average initial lengths of various generations (1969, 1971, ...) and age groups (II, III, ...) of the roach depending on their lengths (L, mm).

Fig. 25. Changes in the absolute increments (t, mm) of specimens with different average initial lengths of various generations (1969, 1970, ...) and age groups (II, III, ...) of the bleak depending on their sizes (L, mm).

tion about the growth rate at the end of each growth period but only about the average rate during all preceding years. That is why some times the L-values can not even reveal the tendency of the changes in the growth rate (compare Fig. 6, II, III and Fig. 15, II, III). The best idea about the growth rate and the tendencies of its changes is presented by the absolute annual length increments (t) (Živkov, 1972). The relative value of the growth rate gives a distorted idea (Zamachaev, 1967, Živkov, 1972, Djačuk, 1974) although some authors are not convinced of this (Brjuzgin, 1960, 1963, 1969, Winberg, 1966, Mina and Klevezal, 1976). We should have in mind the difference between growth rate and tendency of change of this rate (increasing or diminishing). For example the trend towards diminishing of the t -values of larger fish and a respective diminishing of the growth rate does not mean that they grow slower. The actual growth rate of initially larger fish keeps being higher until their t -values are bigger than those of initially smaller fish, i.e. until the intersection of the growth curves (Figs. 15—20). The actual growth rate (absolute t -values) should not be confused with the trend of changes in these values. This can cause incorrect conclusions and inadequate implementation of the effect of growth compensation in determining the standard of the artificially introduced fish.

Initially larger chubs of the 1969 generation maintained higher t -values and the same trend of change in t (towards increasing) through the third year, i.e. they exhibited growth depensation (Fig. 18, III).

Hence the concepts of those authors who conclude that initially larger fish keep growing at a higher rate are correct in some cases and to a certain age.

Our results revealed the opposite phenomenon as well. Among all species studied some initially smaller fish reached a certain age (Figs. 15—20) and length (Figs. 21—25) at a higher rate (bigger t -values) than initially larger fish. According to the methodically correct conclusions of Mina and Klevezal (1976) this is the condition to recognize the real growth compensation.

The variability of the growth rate of fish with different initial lengths renders the studying of the essence of the growth compensation and its causes and mechanism more difficult. At least three basic circumstances are to be paid attention to in order to successfully study the problem.

Growth compensation must not be considered something different from "normal" growth. That is why factors influencing these "two" phenomena and their mechanisms can not be of different nature. Under certain conditions though these factors affect the growth of fish to different extends and in different trends. The understanding of the nature of growth compensation and its causes is based on the understanding of the entire process of growth of organisms.

The second circumstance is related with the necessity of a simultaneous studying and analyzing the strength and trend of internal and external growth factors.

It is necessary to distinguish between the causes of growth compensation, its consequences and/or other phenomena. This is the third circumstance. For example changes in shapes of growth curves are not causes (Ford, 1933) but consequences of different growth rates of fish with different average initial lengths (Figs. 6—14).

Such an approach to the analysis of the regularities illustrated by figures 6—25 renders the possibility to establish that the changes in the growth curves

(L and t) of fish with different initial lengths are directed towards the rectifying (overwhelming) of the deviations from "normal" (genetically determined) dimensions (Figs. 6—14) and growth rate (Figs. 15—20) typical of the particular stage of development. This can be considered as a process of growth regulation. The rate of convergence of the deviations depends on the strength and direction of the internal and external factors during the following ontogenetic stages. As we mentioned above the equalizing of sizes (Figs. 6—14) and growth rates (Figs. 15—20) of generations living under better conditions and growing at higher rate takes place much earlier than slower growing generations. The more rapid growth of initially smaller fish under good conditions is not contrary to the genetically determined for the particular age metabolism and size. Their relative and later their absolute growth rates increase. Meanwhile prolonged rapid growth of initially larger fish is not supported by the genetically predetermined growth capability and from a certain moment on a growth retardation takes place (Fig. 15). After the first equalizing the deviations of the L-values (Figs. 10—14) and t-values (Figs. 16—19) tend to diminish. The "normal" growth is almost entirely restored during the following years.

The process of regulation under unfavourable conditions is slower. Differences between growth rates of fish with different average initial lengths are smaller (Fig. 19, IX). That is why the first equalizing of the t-values takes place later (Fig. 17, 1969, Fig. 18, 1969, Fig. 19, 1969 and 1973, Fig. 20, 1969, 1972). The L-values are equalized much later or only a trend towards equalizing is observed (Figs. 6—14). The L-values of slower growing generations are not equalized even when the individuals have reached or exceeded the size at which the L-values of faster growing generations have already been equalized (compare the L-values of 1969, 1971 and 1972 generations in Fig. 13 as well as to the generations in Fig. 14). This is very interesting and is probably related to the mechanisms of growth regulation. Hence the reaching of a certain size is not the only reason to activate the growth regulating mechanism based on the feedback principle as stated by Chaljavkin 1975. The reaching of a certain metabolism (growth) rate is probably the main signal to activate the stimulating and/or inhibiting internal factors of growth.

The partitioning of fish with different average initial lengths within a certain generation into large and small is quite relative. In another generation and/or another population the fish of all size groups may be smaller or larger than the "normal" (genetically determined for the first age group) size. In the first case the fish of all size groups will grow like fish with smaller average initial length. The t-values and particularly the L-values may not converge during the first one or two years and they may even diverge at a certain age (growth depensation). In the second case all fish will grow like fish with bigger average initial length but the growth of larger ones will be more retarded. This is the case in most of our materials (Fig. 20).

The variety of the growth rate curves is due also to the fact that not all years of life of the different generations have been just favourable or just unfavourable. Nevertheless the validity of growth regularities of fish with different average initial lengths can be established in each particular case.

Hence growth compensation and growth depensation are two opposites in a unity — the unity of the process of growth rate regulation. They have to be studied simultaneously and in their unity. This corresponds to the basic con-

cepts on the nature of biological growth although there are some contradictions among authors (Fedorov, 1973, Klevezal, 1975, Mina and Klevezal, 1976, Weatherley and Rogers, 1978). There are many common ideas in recent publications.

The biological growth is a process of increasing of: structurally and functionally active living substance (Rössle, 1923); the active parts of the organism (Smalgausen, 1935); the whole living system due to the dominating of anabolism over catabolism (Bertalanffy, 1957); number and size of reproductable and differentiable biological structures (Magakjan, 1975). Most authors think that not any increase in size is growth (for example the body size increase due to increase of fats and/or water content). Klevezal (1975) considers the skeletal, i.e. the linear growth as most indicative while Weatherley and Rogers (1978) rely on the protein increase as the most important growth criterion. According to Winberg (1975) growth is a process of weight increase and not length increase. Zotin discussing with Klevezal (1975) looks for a compromise by pointing out the rather strict allometric correlation between weight and length; it does not matter which of these is measured.

The correlation between weight (G) and length (L) can be determined in each moment by means of the equation $G = kL^n$. But this correlation will differ each time because of the variation of k (condition coefficient) and n during the different seasons, phenological years and ages. That is why here we use only the linear dimension when studying growth compensation.

Many scientists accept the molecular genetics growth theory. According to it the specific and individual peculiarities of growth, metabolism and differentiation are preprogrammed in the genome, and growth is a predetermined, selfregulating process. The growing organism is a realisation of the genetic information, based on the feedback principle (Fedorov, 1973, Gofman — Kadošnikov, 1975, Winberg, 1975, Chaljavkin, 1975, Magakjan, 1975, Mina and Klevezal, 1976).

There are several hypotheses about cellular growth regulation mechanisms (Weiss, Kavanau, 1957, Kavanau, 1960, 1961, Tanner, 1963) but they are not widely accepted. They are used by some authors to explain the regeneration of partially removed tissues and organs (Ibert, 1968, Fedorov, 1973, Chaljavkin, 1975, Mina and Klevezal, 1976). According to Mina and Klevezal (1976) the Tanner hypothesis can be used to explain the growth compensation.

Some authors disagree with the hypotheses and the principle of growth selfregulation (look for more details in Chaljavkin, 1975), mainly because of the lack of experimental data. Weatherley (1972) thinks that the fish inherits only its maximum possible size unless proved otherwise by means of detailed experiments. The L and t variations in different generations and under varying conditions during the fish ontogenesis reported herein do not support this concept. The growth of fish with different initial lengths is a natural regulation process. This concept confirms the principles of the modern molecular genetics growth theory. The pattern of variation of growth curves is one of the few experimental evidences on organism and population levels illustrating the selfregulation and predetermination of growth during the various ontogenetic stages of fish.

CONCLUSIONS

1. The concept of growth compensation as a process of diminishing with age of size differences of fish is not quite correct because it incorporates the effect of size-selective mortality. Fish with smaller average initial length exhibit growth compensation only if at a particular age their sizes and growth rates are higher than those of fish with bigger average initial length.

2. The growth rate of fish with bigger average initial length should be considered higher only until their absolute increments (t) are bigger than those of fish with smaller initial length regardless of the trend of change (towards decrease or increase) of the t -values until that moment. The trend of change should not be confused with the growth rate (absolute t -values); otherwise incorrect conclusions may be made and unreal results from the practical implementation of the growth compensation effect may be expected.

3. Until certain age and size fish with bigger average initial length keep growing faster with the L and t -values even diverging in some cases (growth depensation) At a certain age and size fish with different average initial lengths equalize their growth rates and only after that they exhibit the real growth compensation which in some generations causes equalizing of the L -values as well.

4. When studying growth compensation it is necessary to take into consideration that: it does not differ from "normal" growth; the strength and direction of the internal and external growth factors should be studied simultaneously and in their unity; the causes of growth compensation should not be confused with its consequences and/or with other processes or phenomena

5. The changes in the growth curves of fish with different average initial lengths exhibit a process of convergence of the deviations from "normal" (genetically determined) size and growth rate typical of the particular ontogenic period, i. e. a process of growth regulation. Growth compensation and growth depensation are opposites in a unity. They are two parts of the process of regulation.

6. The rate of the process of regulation depends on the strength and direction of the internal and external growth factors influencing fish growth during the particular ontogenic periods. The equalizing of L and t -values of faster growing generations, living under better conditions takes place much earlier and at smaller fish size than slower growing generations. These facts are a good ground to suggest that the growth regulating mechanism based on the feedback principle is triggered not only by the reaching of a certain size, but also (and probably above all) by the reaching of a certain metabolic (growth) rate typical of the particular ontogenic period.

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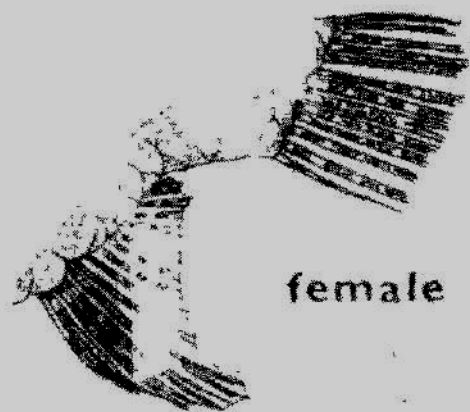
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1



male



female

Fig. 1 — above the detail of the anal fin, male 60 mm of the body length from Nigeria. Below the detail of the anal fin, female 71 mm of the body length from aquaria

1



2

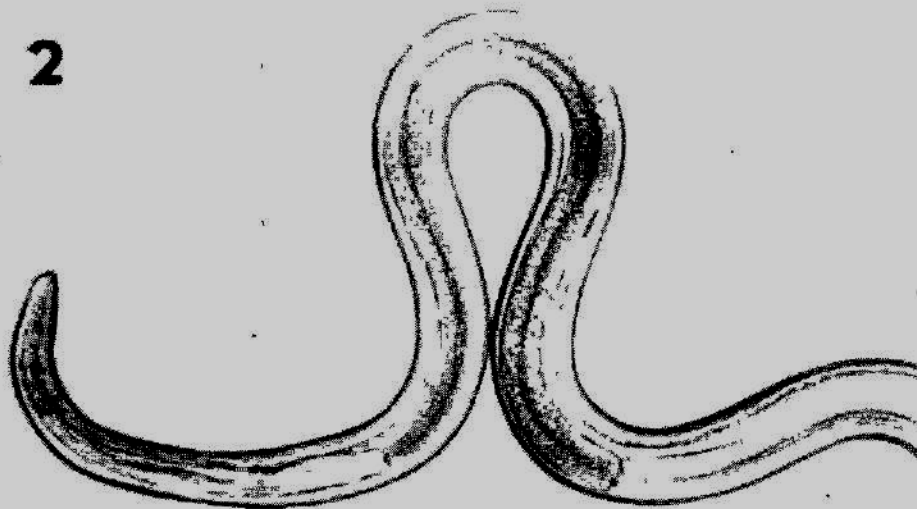


Fig. 1. Infective larva of *Cystidicoloides tenuissima* released from body cavity of intermediate mayfly nymph — total view ($\times 300$).
Fig. 2. Anterior end of the infective larva of *Cystidicoloides tenuissima* ($\times 750$).

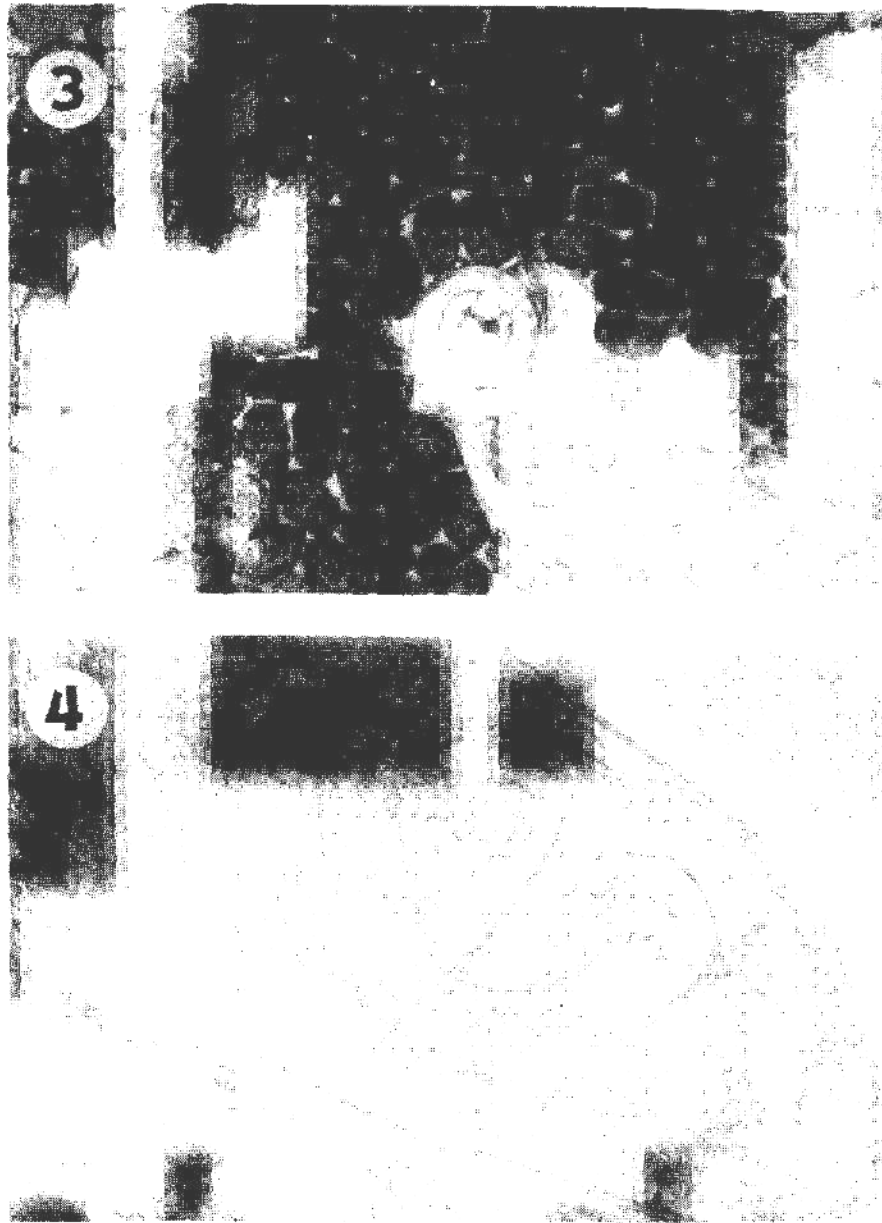


Fig. 3. Infective larva of *Cystidicoloides tenuissima* in compressed body (abdomen) of adult *Ephemera danica* ($\times 280$).
Fig. 4. Infective larva of *Cystidicoloides tenuissima* located in leg (femur) of the mayfly nymph *Habroleptoides modesta* ($\times 750$).

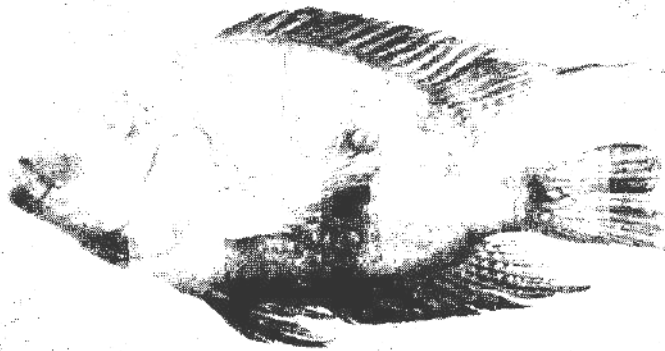
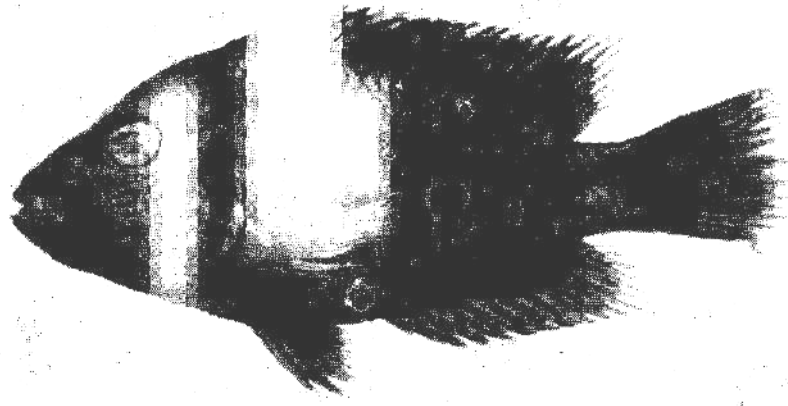


Fig. 1. F, hybrid between *Cichlasoma nigrofasciatum* and *Cichlasoma meeki*, body length 69 mm, sex unknown.

Fig. 2. Male of *Cichlasoma meeki*, body length 77 mm.

Závěta J.: Note on the variability of *Mesogonistius chaetodon*.

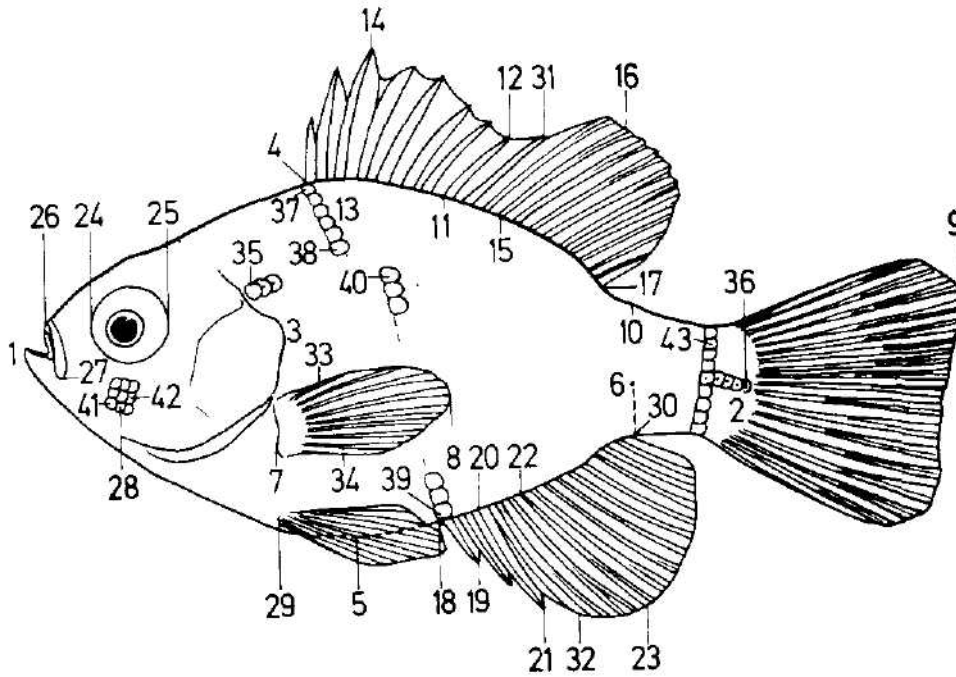


Fig. 1 1-2 body length; 1-3 length of head; 4-5 depth of body, 6-2 length of caudal peduncle; 7-8 length of pectoral fin; 2-9 length of caudal fin; 30-10 depth of caudal peduncle; 11-12 lowest dorsal spine; 13-14 highest dorsal spine; 15-16 highest dorsal soft ray, 18-19 lowest anal spine; 20-21 highest anal spine; 22-23 highest anal soft ray; 24-25 length of orbit; 26-24 length of snout; 26-27 length of upper jaw; 1-28 length of lower jaw; 18-30 length of anal fin; 29-18 distance V-A; 4-17 length of dorsal fin; 26-4 distance from tip of snout to origin of dorsal fin; 4-12 number of dorsal spines; 31-17 number of dorsal soft rays; 32-30 number of anal soft rays; 33-34 number of pectoral rays; 35-36 number of lateral line scales; 37-38 number of scales above lateral line; 39-40 number of scales below lateral line; 41-42 number of rows of scales on cheek; 43 number of scales around caudal peduncle.

Závěta J.: Note on the variability of *Mesogonistius chaetodon*.

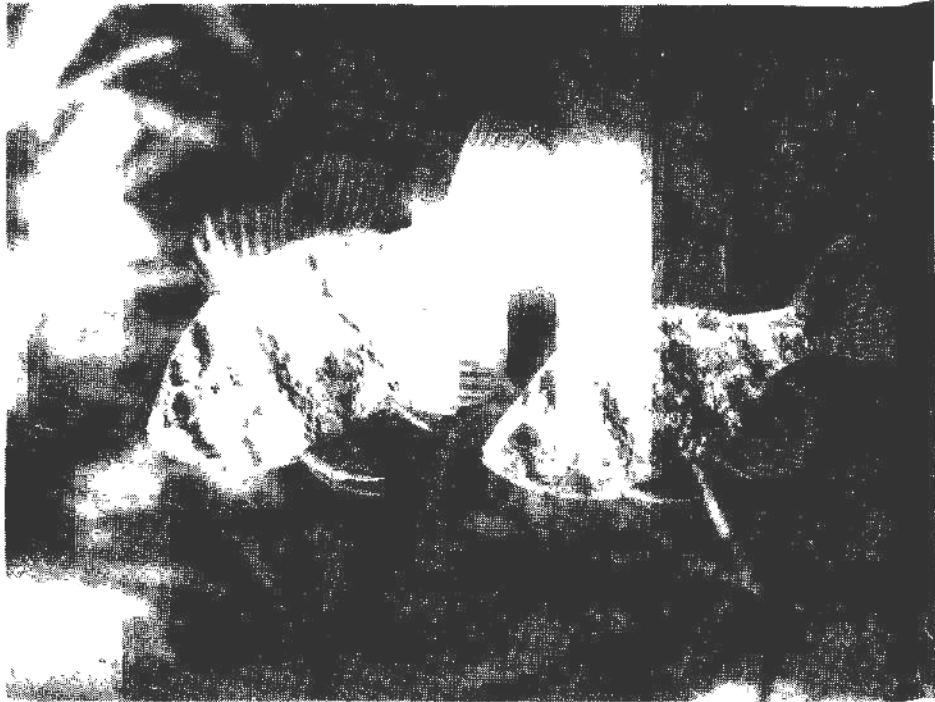


Plate 1. Two aquarium specimens of *Mesogonistius chaetodon*. Photo Rudolf Zúkal.

POKYNY PRO AUTORY

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

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

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

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

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

Přepis cyrilice proveďte podle mezinárodních pravidel vědecké transliterace (nikoliv fonetické transkripce) — viz ISO Recommendation R 9. International System for the transliteration of cyrillic characters 1. Ed. October 1955 nebo Zekalle R., 1965: *Pedobiologia*, 4: 88—91, Jena.

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

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

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