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Fish biology

FOOD PASSAGE AND FOOD SELECTIVITY OF TENCH *TINCA TINCA* (L.) LARVAE FED ZOOPLANKTON

PRĘDKOŚĆ PRZECHODZENIA POKARMU PRZEZ JELITO I WYBIÓRCZOŚĆ POKARMOWA LARW LINA, *TINCA TINCA* (L.) ŻYWIONYCH ZOOPLANKTONEM

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The time of zooplankton passage through the gut of tench larvae and their food selectivity was studied on days 17 and 22 of tench larvae life. The gut passage was assessed with a marker method. The marker were *Artemia* nauplii. In the larvae aged 17 days food passage took 5 h and in larvae aged 22 days—7 h. In the initial period of life the larvae were fed small species of Cladocera and Rotatoria. Later in the zooplankton sample spined rotifers were abundant. For this reason they were not willingly consumed by the larvae. In both zooplankton samples copepod nauplii were less abundant and they were not eaten by the larvae. The low gut fullness was found for both groups. It indicated the low consumption, larvae transferred from tanks with *Artemia* to tanks with zooplankton. Presumably the larvae were stressed during the manipulation. In this case the gut passage was assessed under conditions of low content of food organisms in the gut of larvae.

INTRODUCTION

Feeding conditions are crucial in early rearing of fish larvae and influence the productivity indices during subsequent life of fish. Food ration and food selectivity make the basis for intensive rearing technology for zooplankton-fed fish.

Daily food ration is a methodological bottleneck in research on feeding of fish larvae (Kamler 1992). Daily food ration is affected by gut filling and the time of food passage through the gut of larvae (Szlamińska et al. 1995).

Under the conditions of permanent abundance of food the relationship between abundance of prey in the digestive tract and time (food passage) can be presented by a linear function (Szlamińska et al. 1995) or exponential function (Elliott and Persson 1978). After the cessation of feeding the gut evacuation can be characterised by sigmoid function (Szlamińska 1987).

The natural food of tench larvae in Czech ponds and their zooplankton selectivity were described by Šestakova et al. (1988, 1989). During the first 2 weeks of rearing tench larvae preferred Cladocera, followed by Rotatoria, and Copepoda.

This paper presents the time of zooplankton passage through the gut of tench larvae and their food selectivity.

MATERIAL AND METHODS

Experiment was carried out at Research Institute of Fish Culture and Hydrobiology at Vodňany in 1993. The methods of larvae rearing were described in details by Kamler et al. (1995) (we used the same fish material). The biometrical characteristics of larvae were presented in Tab. 1. The temperature at which larval gut passage occurred was 22°C.

Table 1

Biometrical characteristics of tench larvae

Day of life	N	Lc	Lt	Ww
17	23	7.67 (0.61)	8.10 (0.66)	3.24 (1.08)
22	22	8.51 (0.55)	9.12 (0.64)	5.10 (1.30)

N—number of individuals; means and SD (in parentheses): Lc—body length (mm), Lt—total length (mm), Ww–wet weight (mg)

The gut passage time was assessed with a marker method. *Artemia* nauplii were used as a marker. On days17 and 22 of larval life, the larvae were fed *Artemia* in high concentration for 2 hours. Next the larvae were catched with a high-mesh dip-net which retained larvae and allowed to pass the nauplii. The larvae were put into tanks with high concentration of pond zooplankton. Every 1 hour 10-indiv. samples of larvae were taken for observation of *Artemia* presence in the gut. This presence was manifested by a rose colouration of the gut content. The remaining food organisms were grey-green. The time of *Artemia* passage was assessed as complete when 50% of larvae in the sample had no visible *Artemia* in their alimentary tract. At this time the concluding, 30-indiv. samples of the larvae, were taken.

The larval selectivity for zooplankton food was assessed by coefficients of food selection or "selectivity indices":

a) Šorygin's:

$Ks = r/p$

r – relative abundance of food species in the gut,

p – its relative abundance in the environment.

This coefficient vary from 0 to infinity. The higher is the value, the greater the preference.

b) Ivlev's:

$Ki = (r–p)/(r+p)$

This coefficient vary from –1 to +1. Positive values of the coefficient suggest some preferences for this species as a food and the nearer the value is to 1, the greater the preference. The 0 value is when the relative abundance of a food species in the gut and the environment is the same. Negative values of the coefficient suggest avoidance of the species as a food.

RESULTS

Table 2

Number of zooplankton in the sample: n—number of taxa, N—number

Groups of zooplankton	17-day-old larvae			22-day-old larvae		
	n	N		n	N	
		indiv.·dm^{-3}	%		indiv.·dm^{-3}	%
Copepoda	2	2 350	23.35	2	285	12.38
Cladocera	5	7 220	71.73	4	1 663	72.24
Rotatoria	9	495	4.92	4	354	15.38
Total	16	10 065	100	10	2 302	100

The analysis of environmental zooplankton samples (Tab. 2) showed that on day 17 of larval life the density of the organisms was 10 065 indiv. · dm^{-3}. The sample was consisted of 16 taxa, mainly *Bosmina longirostris* (57.4% of individuals). Copepod nauplii consisted to 55% of Copepoda. On day 22 of larval life the density of the organisms was 2 302 indiv. · dm^{-3}. The sample was consisted of 10 taxa, mainly *Bosmina longirostris* (42.5% of individuals). Only the small number of copepod nauplii was found in the sample (less than 0.5%) Moreover, the number of spined Rotatoria increased.

In 17-day-old larvae, after 2 h of feeding with *Artemia* and 5 h of feeding with pond zooplankton (i.e. when 50% of larvae had no *Artemia* in the gut), only single *Artemia* were observed in the gut of the larvae (1–5 indiv., Tab. 3). Small quantity of *Bosmina longirostris* (1–6 indiv.), and sporadically (1 specimen in the two individuals) of *Keratella coch-*

Table 3

Number (N, indiv.) of zooplankton in the larval gut. For each experimental group : mean and SD (in parentheses). Number of fish investigated in each sample: 30 indiv.

Groups of zooplankton	17-day-old larvae N	22-day-old larvae N
Artemia	1.33 (1.30)	4.33 (3.22)
Others	2.97 (1.58)	1.33 (1.62)
Total	4.30 (2.00)	5.67 (3.45)

learis and *Lecane elsa* were found. In an average gut, 1.33 indiv. of *Artemia* and 2.97 indiv. of the remaining zooplankton species were present in the gut of larvae.

In 22-day-old larvae, after 2 h of feeding with *Artemia* and 7 h of feeding with zooplankton (i.e. when 50% of larvae had no *Artemia* in the gut), 1–7 specimens of *Artemia*, 0–5 specimens of *Bosmina longirostris*, 0–2 specimens of *Ceriodaphnia quadrangula*, and single specimens of *Brachionus calyciflorus* and *Daphnia* were observed.

Therefore, food passage time was 5 h for the larvae aged 17 day and 7 h for the larvae aged 22 day.

Table 4

Selectivity indices of larvae: *Ks*–Šorygin's index, *Ki*—Ivlev's index

Zooplankton species	Group of larvae			
	17-day-old larvae		22-day-old larvae	
	Ks	*Ki*	*Ks*	*Ki*
Bosmina longirostris	1.08	0.04	0.39	-0.44
Ceriodaphnia quadrangula			8.33	0.79
Daphnia longispina			0.05	0.91
Brachionus calyciflorus			0.38	-0.45
Keratella cochlearis	2.60	0.44		
Lecane elsa	15.5	0.88		

The coefficient of food selectivity, calculated on the basis of zooplankton samples and content of larval gut were presented in Tab. 4. For *Bosmina longirostris* these values were: *Ks* = 1.08 and *Ki* = 0.04 (on day 17 of larval life) and 0.39 and –0.44 (on day 22 of larval life, respectively).Younger larvae willingly consumed *Keratella cochlearis* (*Ks* = 2.60 and *Ki* = 0.44) and *Lecane elsa* (*Ks* = 15.5, *Ki* = 0.88). Older larvae willingly ate Cladocera and avoided *Brachionus calyciflorus* (*Ks* = 0.38, *Ki* = –0.45)

DISCUSSION

The zooplankton samples collected during the present experiment had a similar composition as the samples collected by Šestakova et al. (1988, 1989) at Vodňany.

The low gut fullness was typical for all the groups. Its indicated the low consumption of larvae transferred from tank with *Artemia* to tank with zooplankton. We presume that the larvae were stressed by the manipulation with the dip-net. In this case the gut passage was assessed under the conditions of low content of food organisms in the gut. It prevented

the "pusher effect", described by Szlamińska (1987) and Szlaminska et al. (1995). It consists in accelerated pushing of partly digested gut content by the intestine thus the time of passage is also accelerated. In a case of a non-stressing method of collecting the larvae from the suspension of zooplankton, the effect of pusher, evident in the conditions of excess food, should be present. In the case of the present experiment the passage time can consistent typical for poorly fed larvae. Thus, the passage times determined in the present experiment were not typical for the surveyed population.

The data on the larval gut passage reviewed by Kamler (1992) (*Morone saxatilis* fed *Artemia* nauplii for 2.3–4.5 h; *Cyprinus carpio* fed *Artemia* nauplii for 7 h; 13 species of fish—8.6 h), indeed, were close to results of the present experiment but they were assessed with other methods. The larvae were fed with one organism and the above-mentioned data concerned a gut evacuation, not a gut passage. In the presently studied conditions the "pusher effect" did not manifest itself.

Van der Meeren (1995) assessed, indeed, the evacuation of *Artemia* nauplii from the gut of halibut larvae but he used the correction anticipated by the exponential model of gut evacuation published by Elliott and Persson (1978). This van der Meeren's curve presenting the dependence of passage time on the concentration of food organisms was more realistic than the data reviewed by Kamler et al. (1992). In the latter the passage time is overestimated.

The marker method of description of the passage time through the gut of fish larvae should be used, especially in the case of separation of larvae from the zooplankton. Otherwise, the effect of stress could disturb the regularity of physiological processes and comparability of obtained data.

Our data partially confirm the data of different authors discussed by Šestakova at al. (1989). These data concerned the food selectivity of tench larvae. The authors stressed that from beginning of active feeding tench larvae fed small Cladocera, the food of greatest size the larvae were able to swallow. In the present experiment, in the initial period of exogenous feeding, the larvae fed rotifers and small species of Cladocera (*Bosmina* sp). Rotifers were more willingly eaten than above-mentioned species, in spite of numerous presence of Cladocera in the zooplankton sample. In our later sample (larvae aged 22 day) in the pond zooplankton the spined species were abundant. For this reason they were not willingly consumed by the larvae. It seems that for experiments on gut passage of larvae the non-spined zooplankton species should be choosen, especially for tench larvae characterised by a small mouth opening. Sutela and Huusko (1988) observed also the avoidance of hard-spined rotifers by vendace larvae.

CONCLUSIONS

1. Time of food passage through the gut of tench larvae is shorter (5 h) in younger fish (17-day-old) than in older ones (7 h) (22-day-old). It is a common phenomenon in early stages of fishes in which the length of intestine is longer in older than in younger ones.
2. In fish larvae food selectivity depends mainly on possibility of swallowing of living preys. Spined rotifers are avoided.
3. The method of food passage assessment in fish larvae needs improvements. Under stress conditions larval food intake is limited. A stress-free separation of larvae from uneaten food, remains unresolved.

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PRĘDKOŚĆ PRZECHODZENIA POKARMU PRZEZ JELITO I WYBIÓRCZOŚĆ POKARMOWA LARW LINA (*TINCA TINCA* (L.)) ŻYWIONYCH ZOOPLANKTONEM

STRESZCZENIE

Czas przechodzenia zooplanktonu przez przewód pokarmowy larw lina w wieku 17 i 22 dni był oznaczany metodą z markerem. Naupliusy *Artemia* służyły jako marker. Larwy żywiono artemią przez 2 godziny, następnie odcedzano je od zawiesiny artemii siatką o dużych oczkach. Po odcedzeniu larwom zadawano dużą koncentrację zooplanktonu. Co 1 godzinę pobierano próbki larw o liczebności 10 osobników, by stwierdzić jak wiele artemii znajduje się w ich jelitach. Za czas pasażu przyjęto okres, w którym opróżniało się 50% larw. Wtedy pobierano próbki larw o liczebności 30 osobników, które poddawano szczegółowej analizie.

Larwy młodsze opróżniały się w ciągu 5 godzin, natomiast starsze w ciągu 7 godzin.

W początkowym okresie życia (17 dzień) larwy wybierały z pokarmu małe gatunki wioślarek i wrotki, w późniejszym okresie (22 dzień) larwy omijały kolczaste wrotki i odżywiały się głównie większymi wioślarkami.

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