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Effect of food amount on growth of tench larvae, *Tinca tinca**

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Abstract: Tench larvae in four stages were recognized to survive all in higher rates (95-100%) in laboratory after four weeks of rearing when they were fed on appropriate amounts of live *Artemia* nauplii. The more the food was supplied, the better the growth of larvae was within respective five levels of food supply. The most profitable increment of body weight was obtained with a series of minimum food supply: 1 mg/ind./day in the first week from the 4th day after hatching, 2 mg/ind./day in the 2nd week from the 12th day, 3 mg/ind./day in the 3rd week from the 19th day and 4 mg/ind./day in the 4th week from the 25th day.

1. Introduction

Tench, *Tinca tinca*, is native in European freshwaters, and has been introduced outside its original habitat widely to such areas as Israel, Tunisia, India, Indonesia and Japan, as well as Australia (BARDACH *et al.*, 1972). This cyprinid species is known to grow relatively slow as compared with the carp, *Cyprinus carpio*, a well-known species for aquaculture. However, because of its potentiality of resistance to disease and stress (HEUT, 1957; VON LUKOWICZ *et al.*, 1986), tench seems to be very useful for the same purpose, and effective technologies are eagerly expected in seed production for the fish.

One of the urgent problems for intensive seed production of this species in larval stages may be in relation to the feeding. Although the larval rearing of the fish is known as effective by feeding on living organisms (VON LUKOWICZ *et al.*, 1986), represented by *Artemia* nauplii (BRYANT and MATTY, 1980), no attempt seems to have been precisely made to quantify the optimum feeding. The present study aims, therefore, to determine the optimum quantity of *Artemia* nauplii as food for larvae of the fish.

2. Materials and Methods

The larvae were obtained for the present study by induced ovulation of a brood stock kept in the Laboratory of Fish Culture, Tokyo University of Fisheries. Mature parents were bred under a natural photo-regime in an indoor tank furnished with small amount of running water, the temperature of which was adjusted to around 20°C. They were fed on an artificial food or pellets prepared specifically for carp.

Concerning the treatment for the parents, females of about 800 g were administrated with 10 mg/kg of acetone-dried pituitary gland of the silver carp once by an injection into the abdominal cavity through the base of pelvic fin on 4 September 1986. Males of about 500 g were administrated with 5 mg/kg of the same pituitary gland in the same way as above-mentioned. Immediately after the treatment, both sexes were put together in a pond of 1.5 tons of water. About 14.5 hours after the injection, eggs were artificially ejected by hand-massages and inseminated with milt by the dry method.

Larvae hatched out during a period of 7-9 September 1986. Water temperature for incubation of larvae was 22.0±0.2°C. They began to take food on the 4th day after hatching. All of them were kept in a vessel of 30 *l* before appliance to the experiments. In the vessel, they were fed on excess amount of *Artemia* nauplii, or in a sufficient condition of food supply, always but during the first week of feeding, in order to get a same-sized stock for experiments.

The feeding experiments were carried out in four stages of growth of the fish. The first stage was designated as a week beginning at 4 days after hatching. The others were of the

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following 2nd, 3rd and 4th week. Experiments in each stage were planned as follows.

In each experiment, a lot of 20 larvae each were distributed in beakers of 2 *l* with aeration in accord with 5 feeding levels as mentioned below. Every morning, before the first feeding, sediments in beakers were siphoned out. At the same time, dead fish, if present, were eliminated from there and counted. Water was replaced by half every time, and maintained always at 17.6-24.2°C (22.0±1.6°C on average).

Initial stock for the first stage was of 4-day old larvae, in which the yolk sac was almost absorbed. Succeeding stages began in beakers furnished with new stock of equal size. At the end of every stage, larvae were picked up and preserved in 10% formalin solution. These samples were measured in weight and total length as soon as possible.

As for the food supply to the stock, *Artemia* nauplii were derived from eggs incubated in a glass beaker containing 2 *l* of seawater. They were gathered with plankton net, and supplied twice a day at 9:30 and 15:30 throughout experiments at five levels of feeding A1-A5 (Table 1), which were designated independently by stage of growth.

No symptom of any diseases was recognized throughout the experiments.

3. Results and Discussion

Data provided by the present experiments are summarized in Table 1, where is applied DUNCAN's (1958) new multiple-range test for the

Table 1. Growth of tench larvae fed on *Artemia* nauplii at 5 food levels (A1-A5) in laboratory.

Food levels (mg/ind./day)	Mean final body length (mm)	Mean final body weight (mg)	Specific growth rate (%/day)	Food conversion ratio	Survival rate (%)
1st stage (after 1 week)	(Initial body length 5.17 mm, Initial body weight 0.52 mg)				
A1 0.1	6.41±0.36*	1.17±0.24	5.03	1.08	100
A2 0.5	7.29±0.37	1.93±0.43	8.13	2.48	100
A3 1.0	8.11±0.85^{ab}**	3.06±1.17^{a}	10.99	2.76	100
A4 1.5	7.87±0.79^{a}	3.06±1.05^{a}	10.99	4.13	100
A5 2.0	8.43±0.68^{b}	3.84±1.00	12.40	4.21	100
2nd stage (after 2 weeks)	(Initial body length 6.89 mm, Initial body weight 1.69 mg)				
A1 0.5	7.94±0.41	2.99±0.59	3.54	2.67	100
A2 1.0	8.38±0.67	3.90±1.18	5.18	3.16	100
A3 2.0	9.66±0.61^{a}	6.75±1.56^{a}	8.59	2.76	100
A4 3.0	9.81±0.68^{a}	7.26±1.63^{ab}	9.04	3.76	100
A5 4.0	10.03±0.62^{a}	7.67±1.67^{b}	9.38	4.68	100
3rd stage (after 3 weeks)	(Initial body length 9.62 mm, Initial body weight 6.75 mg)				
A1 1.0	10.65±0.95	8.19±2.69	1.19	4.86	100
A2 2.0	11.48±1.15	11.61±4.28	3.36	2.88	100
A3 3.0	12.16±0.77^{a}	14.51±3.77^{a}	4.74	2.74	95
A4 4.0	12.27±0.85^{a}	15.65±4.09^{ab}	5.21	3.15	100
A5 5.0	12.69±1.27^{a}	18.43±6.44^{b}	6.23	3.00	100
4th stage (after 4 weeks)	(Initial body length 12.98 mm, Initial body weight 20.08 mg)				
A1 2.0	14.03±1.09^{a}	24.72±7.11^{a}	1.29	3.02	100
A2 3.0	14.69±1.14^{abc}	29.83±8.16^{abc}	2.45	2.15	100
A3 4.0	14.58±1.41^{abc}	29.90±9.46^{abc}	2.47	2.85	100
A4 5.0	15.09±1.73^{bc}	34.67±12.44^{bc}	3.38	2.40	100
A5 6.0	15.38±1.33^{c}	36.12±11.25^{c}	3.64	2.62	100

* Mean±S.D.

** Means with the same superscript are not significantly different ($p>0.05$).

significance of results on growth, as well as in Fig. 1. As for the other values treated with here, they were calculated after the following equations (BROWN, 1957; CHIBA, 1961):

$$\text{Specific growth rate} = \frac{\log_e WT - \log_e Wt}{T-t} \times 100$$

$$\text{Food conversion ratio} = \frac{\text{wet weight of a given food}}{\text{wet weight gained by larvae}}$$

$$\text{Feeding rate} = \frac{F}{(WT+Wt)/2}, \text{ and}$$

$$\text{Growth rate} = \left(\frac{WT}{Wt} - 1\right)\left(\frac{1}{T-t}\right),$$

where WT is final body weight; Wt, initial body weight; $T-t$, period of feeding in days; F, total weight of given food.

Growth

The increment of total bady length in groups A3, A4 and A5 was much larger than that in groups A1 and A2 after 1 week. After 2 as well as 3 weeks, there were significant differences in total length between groups A1 and A2 and groups A3, A4 and A5.

A similar tendency of differences among the groups was obtained in body weight. Namely, the body weight in groups A1 and A2 was less than that in groups A3, A4 and A5. At the end of the 2nd and 3rd week, the body weight of groups A1 and A2 was apparently less than that of groups A3, A4 and A5. After the 4th week, there was a significant difference in body weight between groups A4 and A5 and groups A1, A2 and A3.

Specific growth rate

The specific growth rates of tench larvae were higher in the early time and decreased as they grew. Similar reduction of the specific growth rate with growth was also observed in carp larvae (BRYANT and MATTY, 1980). At the end of the 1st and 2nd week, the specific growth rates of groups A3, A4 and A5 were larger than those of groups A1 and A2.

Food conversion ratio

The food conversion ratio ranged from 1.08 to

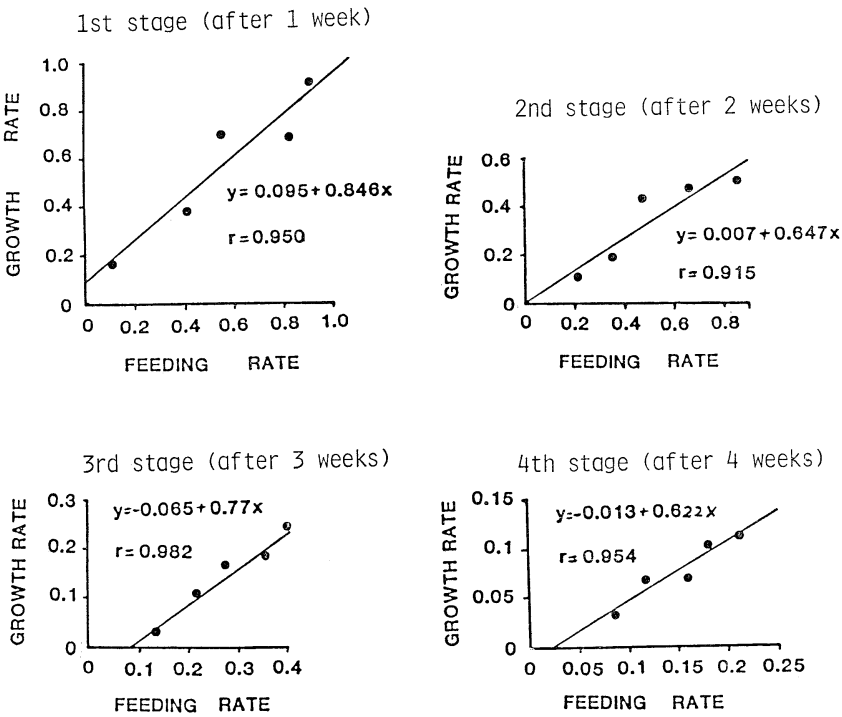

Fig. 1. Relationships between the feeding rate and the growth rate in 4 stages of tench larvae fed on *Artemia* nauplii.

4.86. The relationship between food levels and food conversion ratios was not so clear.

Relationships between the feeding rate and the growth rate are shown in Fig. 1. A positive relationship was recognized in every stage.

Survival

Survival rates of the larvae used in the experiments were high and almost 100 %.

From the results of this experiment it is concluded that tench larvae fed with *Artemia* showed high survival rate under laboratory conditions. It was much higher than the survival rate of larvae fed with artificial food for carp larvae (18 %, unpublished data).

The total body length, body weight and specific growth rate in groups A3, A4 and A5 were higher than those in groups A1 and A2. These results indicate that the amount of *Artemia* nauplii for tench larvae should be maintained at least at the level of group A3, *i.e.* 1, 2, 3 and 4 mg/ind./day in the 1st, 2nd, 3rd and 4th week, respectively.

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テンチ仔魚の成長におよぼす給餌量の影響

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要旨: テンチ *Tinca tinca* の仔魚の適性給餌量を明らかにする目的で，ふ化後 4，12，19 および 25 日目の発育段階の平均体重 0.52，1.69，6.75 および 20.08 mg の仔魚に，それぞれ，1日1尾当り 0.1～6.0 mg の生きているアルテミア・ノープリウスを7日間給餌して成長率を調べた。その結果，給餌量の多いものほど高い成長率を示したが，1日1尾当りの給餌量は，ふ化後4日目から1週間は 1 mg 以上，12日目から1週間は 2 mg 以上，19日目および25日目から1週間はそれぞれ3および 4 mg 以上であることが望ましいことがわかった。