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Feeding of early larval pike *Esox lucius* L. reared in illuminated cages

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Abstract

The paper presents the results of investigations on the feeding of pike larvae reared in illuminated cages in a mesotrophic lake over a period of 19 days. The same zooplankton species were found both in the lake and illuminated cages. At night, the biomass of all zooplankton groups was higher in illuminated cages than in the lake (with Copepoda prevailing). The first exogenous food of pike larvae (with 13.1 mm average standard length) was cladocerans (*Bosmina*, *Chydorus*) and small copepods (*Cyclops*). Pike larvae were feeding throughout the whole period of 24 h, with the greatest intensity at night when illumination was switched on. The most popular zooplankton groups among pike larvae were Copepoda (up to 94.7%) with less numerous Cladocera (up to 28.8%) and other organisms (up to 0.9%). The indices of alimentary tracts filling (*I*) of larvae feeding on zooplankton reached up to 1220.5‰. With the age of pike larvae, Ivlev's selectivity indices (*E*) with respect to different food components changed—for *Chydorus sphaericus* and *Bosmina* sp. they were decreasing, and for Copepoda increasing. Rotifers usually made an insignificant part of the diet. Pike larvae willingly fed on *Chironomus plumosus* and roach larvae incidentally found in the cages. Cannibalism among pike larvae started when their standard length (SL) was 16.0–22.3 mm (18.7 mm on average). The size of a prey item constituted up to 90.9% of the predator's standard length. After passing over to predatory feeding, gut-filling indices in pike larvae reached up to 2859.6‰. Cannibalism occurred even in case of very low (230 ind. m^{-3}) concentration of pike larvae in cages, which on the 12th day of rearing made 3%; and on the 19th day, 42%. Pike larvae could be reared without additional feeding in illuminated cages up to 2 weeks. Over this period, their mean standard length increased from 13.1 to 20.0 mm. Further rearing of pike larvae does not make any point because their output started to decrease considerably as a result of cannibalism.

Keywords: Pike larvae; Illuminated cages; Diet; Cannibalism; Rearing

1. Introduction

The pike (*Esox lucius* L.) is one of the most widespread and popular fish in Lithuania. It is not only a good bio-meliorator, but also a valuable object of commercial fishing and angling. According to Tyurin (1957), balanced ichthyocenosis with the prevalence of valuable fish species has to hold 20–25% of predators. Scientific investigations show that the most of water bodies in Lithuania do not have a sufficient amount of ichthyophages, including pikes (Bukelskis et al., 1998; Bukelskis and Kesminas, 2002; Žiliukienė and Žiliukas, 2002; Balkuvienė et al., 2003). One of the methods to increase their resources is to stock water bodies with artificially reared valuable fish species.

Szczerbowski et al. (1993) indicate that if early-stage larvae are released into water bodies, merely 0.5% of pikes grow up to a marketable size (0.5 kg), and if larvae

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are reared up to a 0+ age, a marketable size is reached by 30% of pikes. Different methods are applied in aquaculture to produce high quality stocking material. One of such methods is the rearing of fish larvae without supplementary feeding in net cages placed in lakes by using submerged illumination at night to attract zooplankton. References are available on the use of illuminated net cages for the rearing of coregonid larvae (Bryliński et al., 1975; Mamcarz and Szczerbowski, 1984; Mamcarz and Nowak, 1987; Szczerbowski et al., 1993; Mamcarz, 1995; Dostatni et al., 1999), sea bass larvae (Fermin et al., 1996), tench larvae (Pyka, 1981), grass-carp larvae (Schiljukene et al., 1983), pike-perch larvae (Schlumpberger and Zieborth, 1981; Hilge and Steffens, 1996), perch larvae (Skrzypczak et al., 1998), bream larvae (Žiliukienė, 2005) and asp larvae (Mamcarz et al., 2001).

Prepared in the best way and applied most widely are the methods of using pike larvae culture tanks where larvae are intensively fed with plankton organisms (Timmermans, 1979; Steffens, 1985; Kokh et al., 1980; Szczerbowski et al., 1993), and ponds (Zalachowski, 1973; Timmermans, 1979; Sherman and Chizhik, 1989; Hubenova et al., 2001; Grozev et al., 2002). The initial research on the rearing of pike larvae in illuminated net cages (Jäger et al., 1980; Gensch, 1983; Mamcarz et al., 1998) demonstrated that this method can be an effective alternative to the above-mentioned methods. One of the problems encountered with in rearing predatory fish is cannibalism (Giles et al., 1986; Wright and Giles, 1987; Górny, 1992; Baras, 1999; Baras et al., 1999; Hatziathanasiou et al., 2002; Baras et al., 2003; Molnár et al., 2004; Skov and Koed, 2004). The aim of this research is to analyze the feeding characteristics of pike larvae reared in illuminated net cages in early development stages and to determine their rearing duration up to the manifestation of cannibalism. The data obtained is a contribution to the fishery practice, and especially to the production of pike stocking material and biology of the species.

2. Material and methods

Pike larvae rearing in illuminated net cages was carried out in Lake Rubikiai (northeast Lithuania), a mesotrophic lake with 944 ha area, 16.1 m maximum depth, and 5.7 m average depth. The method described by Bryliński et al. (1975) was applied. The 1.5 m^3 cages were attached to a floating deck anchored in a bay of the lake at a 100 m distance from the coast and at a depth of 1 m. The cages were covered with 1.2×1.2 mm mesh size netting. To attract zooplankton, each cage was illuminated with two 12 V/60 W bulbs put into cages at a depth of 0.5 m. The light was switched on at 21.00 h and switched off at 07.00 h. The exterior of the cages was cleaned at least twice a week to prevent silt and algae accumulation. Pike larvae rearing in illuminated net cages lasted 19 days—from 11 to 29 of May. Two experiments were carried out.

2.1. First experiment

The first experiment lasted from 11 to 24 of May (14 days). The objective of the first experiment was to tell differences between the zooplankton of the lake and that in cages, define the feeding peculiarities of different-size pike larvae, onset of cannibalism. For this purpose, two cages were stocked with 8-day-old already floating pike larvae with a density of 3000 ind. m^{-3}. At the beginning of the experiment, fish samples were taken on the 1st and 5th day of rearing. Later for the purpose of more precise determination of the beginning of manifestation of cannibalism, samples were taken every 2–3 days (on the 7th; 9th; 12th and 14th day of the experiment). Fish samples (10 ind. from each cage) were taken twice per 24-h period—at 01.00 and 13.00 h, and on the 12th day of the experiment at 20.00 h additionally. Simultaneously, at 13.00 and 01.00 h, the samples of zooplankton were taken using a plankton net (Kiselev, 1969) inside the cages. Pike larvae samples and zooplankton samples taken from each cage were combined to make one joint sample. Also, the lake zooplankton at a distance of 10 m from cages was examined. According to the literature (Szczerbowski and Mamcarz, 1984), the attractive effect of light caused a 1.4-fold increase in the numbers of the three major zooplankton groups around the cages at night. Therefore for more precise determination of species composition and structure of the lake zooplankton, samples were taken at 13.00 h on the same days as in cages. The water temperature of the lake varied from 14.4 to 17.8 °C (15.7 °C on average) during the experimental period. Water transparency measured by Secchi disc was 2.6 m.

2.2. Second experiment

The second experiment lasted from 22 to 29 of May (9 days). The beginning of the experiment coincided with the 12th day of the first experiment, when cannibalism was already noticed among pike larvae. The objective of the second experiment was to find out whether it was possible to avoid cannibalism in illuminated cages after a marked decrease of pike larvae density compared with the first experiment. For this purpose, a small part (7.6%) of the larvae reared during the first experiment (by equal number of larvae from each cage) was moved to two new cages. During the second experiment, fish concentration in cages was 230 ind. m^{-3}. Fish samples were only taken on the last rearing day so that their yield could be precisely