Available online at www.sciencedirect.com

SCIENCE DIRECT®

Aquaculture 252 (2006) 385–393

Aquaculture

www.elsevier.com/locate/aqua-online

Influence of photoperiod on reproductive performances in Eurasian perch *Perca fluviatilis*

Hervé Migaud [a,b], Neil Wang [a], Jean-Noel Gardeur [a], Pascal Fontaine [a,*]

[a] *Laboratoire de Sciences Animales, INRA-INPL-UHP, Nancy 1, MAN, 34 rue Sainte Catherine, 54000 Nancy, France*
[b] *Reproduction and Genetics Group, Institute of Aquaculture, University of Stirling, Stirling FK9, Scotland*

Received 8 June 2005; received in revised form 22 July 2005; accepted 29 July 2005

Abstract

The aim of the study was to determine the effects of photoperiod regimes under natural temperature conditions on reproductive performances (gametogenesis, spawning quality) in Eurasian perch *Perca fluviatilis*. During a 10-month experiment, fish were reared in 12 tanks (3000 L, 88 fish/tank, initial mean weight of 300 g, age of 2^+) in an outdoor water-recirculating system and subjected to 4 photoperiod regimes in triplicate: continuous lighting (24L:0D), constant photoperiod (16L:8D), simulated natural (SNP) and natural (NP) photoperiods. Gametogenesis, spawning time and egg quality were studied. No gonadal development was observed in males and females under 24L:0D treatment. The 16L:8D treatment resulted in heterogeneous gametogenesis with only 54% of gravid females and less than 30% of maturing males. A normal gametogenesis was observed under NP and SNP conditions with 100% of gravid females and spermiating males during the spawning period. Under SNP and 16L:8D regimes, spawning period was delayed in comparison to NP regime and 45% and 65% of the maturing females did not spawn, respectively. All spawning were released and harvested between dawn and 4 p.m., independently of the photoperiodic regime applied. These results show that daily lighting variations are important in the control of Eurasian perch spawning. Significantly higher fecundities were observed under SNP and NP regimes compared to 16L:8D. The photoperiod regimes and artificial lighting significantly affected egg quality, as fertilization rates in 16L:8D and SNP groups were very low (7.7% and 3.3% respectively) compared to the NP treatment (57.2%). Hatching rates were null in SNP and 16L:8D regimes, whereas a 54% hatching rate was estimated in NP treatment. Finally, high mortality rates were recorded during the spawning period. These mortality rates were significantly higher in 16L:8D and SNP treatments (63–72%) than in NP and 24L:0D treatments (36–40%). Photoperiod regimes thus strongly influenced Eurasian perch gametogenesis, spawning time, spawning rate, eggs quality and broodstock mortality.

Keywords: Eurasian perch; Reproduction; Photoperiod; Egg quality; Larval quality; Breeders mortality

* Corresponding author. Tel.: +33 3 83 30 28 41; fax: +33 3 83 32 30 16.
E-mail addresses: herve.migaud@stir.ac.uk (H. Migaud), gardeur@ensaia.inpl-nancy.fr (J.-N. Gardeur), pascal.fontaine@lsa-man.uhp-nancy.fr (P. Fontaine).

0044-8486/$ - see front matter © 2005 Elsevier B.V. All rights reserved.
doi:10.1016/j.aquaculture.2005.07.029

1. Introduction

In most temperate species, it is widely accepted that the pattern of seasonally changing day length is primarily responsible for synchronising the timing of reproduction, especially in winter spawners (Bromage et al., 2001). In Eurasian perch *Perca fluviatilis*, a spring spawner, the reproductive cycle is related to both annual water temperature and photoperiodic variations (Sulistyo et al., 1998, 2000). Although temperature has been considered as the main environmental cue controlling reproduction in perch (Craig, 2000; Migaud et al., 2002), it has been recently demonstrated that photoperiod variations also play a major role. Seasonal variations in day length are involved in the initiation of gametogenesis in Eurasian perch (Migaud et al., 2004a). A continuous photophase inhibits reproduction in males and females with very low sex steroid levels throughout the reproductive cycle (Migaud et al., 2003a) as shown in marine species such as cod, *Gadus morhua* (Davie et al., 2003). Under natural or simulated natural temperature variations, constant (12L:12D or 16L:8D), simulated natural or natural photoperiodic variations allow gametogenesis and spawning in perch (Migaud et al., 2003a, 2004b). However, a constant photoperiod results in variable gonadal development, especially in females that partly respond to the environmental stimulation (temperature decrease only) and ultimately spawn. For example, under a constant 12L:12D photoperiod, 33–38% of females complete gonadogenesis and 31–33% spawn (Migaud et al., 2004b). In this study, relative fecundity reached 100 eggs g^{-1} and fertilization rate ranges from 5% to 90%. Eurasian perch broodstock can also develop their gonad, mature and spawn under various photoperiods. However the effects of photoperiod regimes on the reproductive performances and quality (i.e., spawning time, spawning rate, fecundity, fertilization and hatching rates, broodstock mortality) have never been accurately evaluated.

In female sea bass, *Dicentrarchus labrax*, held under natural temperature variations and constant long photophase (15L:9D) a reduction of fecundity (124,000 eggs kg^{-1}) was observed in comparison to both simulated natural photoperiod (230,000 eggs kg^{-1}) or constant but shorter photophase (9L:15D), (256,873 eggs kg^{-1}) (Zanuy et al., 1995). These authors hypothesized that the photoperiodic signal may generate important modifications of the neuroendocrine mechanisms involved in the control of the gonadal growth. In Atlantic cod, switch from an ambient light regime experienced during 5 months (from June 23rd to December 22nd) to a continuous light advanced spawning time by 28 days and reduced fecundity (1,400,000 vs. 1,670,000 eggs kg^{-1}) and egg size (1.24 vs. 1.33 mm) compared to ambient control (Hansen et al., 2001). A reduction in daylength is a vital environmental signal regulating the maturation and the spawning of cod, and maturation may be arrested or delayed in its absence. In trout *Oncorhynchus mykiss*, periods of constant day length can alter spawning times by advancing or delaying spawning period depending on the timing of exposure to constant conditions (Bromage et al., 2001). Importantly, varying the timing of the continuous light period (in relation to photoperiodic history) not only affects the time of spawning but also produces marked differences in the proportion of fish that spawn out of season (Randall and Bromage, 1998). In Percids, most researches examining photoperiod and reproduction have focused on shifting the spawning period by compressing the duration of the reproductive cycle, thus advancing the spawning season. By increasing photoperiod (from 8L:16D to 14L:10D) and temperature (from 7 to 12 °C) over a 1 month period, Zakes and Wszczepkowski (2004) were able to advance the spawning period in pikeperch, *Sander lucioperca* by 3 months while retaining good embryo quality (71.5–77.5% of eyed eggs). This treatment was applied at the beginning of the winter period (January 1st). In yellow perch, *Perca flavescens*, females submitted to a condensed photo-thermal regime (4 months) by the end of August spawned 1 month earlier than control (simulated natural temperature and photoperiod), however egg quality was reduced with a fertilization rate of only 36.5% compared to 81.7% in controls (Ciereszko et al., 1997).

In a prospect of a future application of photothermal manipulations to induce out-of-season spawning, a study was conducted to determine the effects of photoperiod regimes on the reproductive performances and quality in Eurasian perch.