BIOLOGY AND CONTROL OF THE EURASIAN PERCH PERCA FLUVIATILIS REPRODUCTIVE CYCLE

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Introduction. The Eurasian perch, Perca fluviatilis, has been identified as a species destined for diversification of inland aquaculture. In Western Europe, the aquaculture development is mainly linked with its intensive rearing in recirculating aquaculture system (R.A.S.). In order to satisfy the market requirements, reproductive cycle must be controlled to obtain out-of-season spawning and produce fingerlings throughout the year. For 8 years, in order to meet this overall objective, different studies (in indoor and outdoor conditions) have been successively conducted.

Reproductive cycle in natural habitat. From April 1995 to April 1996, the annual reproductive cycle of male and female Eurasian perch Perca fluviatilis (morpho-anatomical and sex steroids changes) was studied at the Departmental Fishfarming Lindre Center (Moselle – France) (Sulistyco et al., 1998, 2000). More recently the testosterone (T), estradiol-17β (E₂) and 17, 20β-dihydroxy-4-pregnen-3-one (17,20β-P) variations have been measured during the pre-ovulatory period in female Eurasian perch, and the ovarian synthesis of 17,20β-P and 17, 20β, 21-trihydroxy-4-pregnen-3-one (20β-S) has been examined (Migaud et al., 2003a). Results suggest a role for 17,20β-P in the final stages of oocyte development and spawning release. Spawning occurs in early spring over 6-7 weeks (March – April). During this period, the eggs and larvae quality highly fluctuates (Kestemont et al. 1999, Migaud et al., 2001a).

Environmental control of the reproductive cycle. The environmental cues of the reproductive cycle were studied to determine the respective effects of the seasonal variations of temperature and photoperiod. Previous work performed in several percids species suggest that temperature would play the major role in the timing of the reproductive cycle, especially final maturation and spawning (Craig, 2000).

Recently, Migaud et al. (2002) have shown in indoor conditions that a long cooling period (6 weeks vs 3 weeks, from 21 to 6°C) allowed a more advanced gonadal development in females, correlated with a higher increase of oocyte diameter and higher plasma levels of testosterone. In the same way, a longer chilling period (5 months vs 3 months, at 6°C) resulted in higher gonadosomatic indexes (GSI), plasma testosterone and protein phosphorus levels. The fish exposed to a cooling period of 6 weeks and a chilling period of 5 months also showed the largest GSI, and highest plasma estradiol and testosterone levels. Finally, at the end of the chilling period, a short water warming period up to 14°C (one month vs two months) resulted in higher rates of mature females (33-38% vs 7-8%) and spawning (31-33% vs 0%) (P < 0.05). Spontaneous out-of-season spawning (17 ribbons) and larvae were obtained for the first time in this species (Migaud et al., 2003b). Relative fecundity was about 100 eggs.g⁻¹ of female body weight. Five ribbons were fertilized at rates ranging from 5 to 90%. Delayed spawning in Eurasian perch can be induced by temperature manipulations, but treatments tested are not efficient enough because of low female maturational and spawning rates and high variability of fertilization rate (Migaud et al., 2001b).

The effects of photoperiod have been also investigated in further experiments to improve the protocol for inducing out-of-season spawning (Migaud et al., 2001b). Firstly, three photoperiodic regimes were tested in triplicate: continuous photophase, constant daylength set at 16L:8D and natural photoperiod, to determine the effects of photoperiodic regimes on the onset of gonadogenesis in males and females under ambient thermal conditions. This study showed that a continuous photophase, applied to fish from mid-July to October, inhibits the initiation of the perch male and female reproductive cycle (GSI below 2 % and 1% in females and males, respectively). Under a constant daylength regime, a very heterogeneous gonadal development was observed. These results are in accordance with previous studies in which photoperiod was fixed at 12L:12D (Migaud et al., 2002). Under a natural photoperiod regime, gonadal development (GSI above 3 %) was in accordance to that of fish harvested from natural habitat at the same period of the year. Thus, the initiation of gonadogenesis and gametogenesis would need seasonal daylength variations. A 10-month experiment was also carried out to investigate the effects of photoperiodic regimes under ambient temperature on a complete reproductive cycle and spawning quality. Fish were reared in 12 tanks (3000 L, 88 fish/tank, initial weight of 300g, age²) in an outdoor recirculating system and subjected to 4 photoperiodic regimes in triplicate: continuous photophase, constant daylength (16L:8D) as observed in indoor conditions and natural and simulated natural photoperiod. The results confirmed those obtained in the first experiment and showed effects on egg quality with lower fecundity, fertilization rate and egg size under constant daylength compared to the natural and simulated natural photoperiods. Hatching rate in the natural photoperiod treated averaged 54 %, whereas it was nil in the simulated natural photoperiod and constant daylength treatments. Light characteristics (spectrum, intensity, daily changes...) appeared to have an effect
on spawning release and egg quality (Migaud et al., 2003c).

More recently, it was demonstrated that variations of the photoperiod conditions during the period preceding the application of inducing photothermal programs can completely inhibit the initiation of gonadogenesis and gametogenesis in males and females.

**Broodstock management.** First results have demonstrated the effects of the broodstock intrinsic characteristics and/or management on their fitness to reproduction under controlled conditions. Fish age, spawning time and food composition have an effect on spawning quality. Generally, gamete quality increases with the age of the fish. However the selection of broodstock from a batch of fish reared from the larval stage in R.A.S. should target smaller fish (200-250 g vs 350-400 g) as a significant effect of body weight was observed, with a better gonadal development recorded for smaller broodstock (P < 0.05, Migaud et al., 2003b). Likewise, broodstock with a higher relative growth rate during the reproductive cycle may have better reproductive performance. This could be related to feeding behavior. Regarding the effect of the quality of broodstock diet, high levels of eicosapentaenoic (EPA) and docosahexaenoic acids (DHA) improve the eggs and larvae quality of Eurasian perch (Abi-Ayad et al., 1997).

**Broodstock mortality.** During the spawning season, Eurasian perch broodstock showed high mortality rates (50-100%). In relation to reproduction and environmental conditions, the physiological (high cortisol levels : 50-110 ng.ml⁻¹) and immunological (weakness of the non-specific immune response) status of the broodstock could explain these high mortality rates (Wang et al., 2003).

**Conclusions.** The environmental control of the reproductive cycle is now relatively well understood. The application of artificial conditions allows production of out-of-season spawning. However, further studies are necessary to improve the quality of the reproduction concerning gametes and larvae viability, and broodstock welfare.

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