CURRENT STATUS AND PROSPECTS IN BURBOT, *LOTA LOTA* L., AQUACULTURE

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TRENUTNO STANJE I PERSPEKTIVE RAZVOJA AKVAKULTURE MANIĆA *LOTA LOTA* L.

Apstrakt

Manić, *Lota lota* L., je jedini slatkovodni predstavnik familije Gadide koji živi u Holarktiku. Ova vrsta je nedavno postala važan kandidat u procesu diverzifikacije slatkovodne akvakulture zbog potrebe za niskom temperaturom vode, brzog rasta i velike komercijalne vrednosti.

Effikasnost produkcije riba u akvakulturi u RAS-u je zavisna od mnogo parametara i svaki korak u proizvodnji se karakteriše određenim teškoćama. Najvažnije je obezbediti optimalne uslove za gajenje (npr. fototermalni režim, količina i kvalitet hrane, kvalitet vode) koje mogu do dovedu do najvećeg prirasta. Međutim, još uvek se ne zna dovoljno o idelanim uslovima za gajenje manića. Shodno tome, cilj ovog rada je da razmotri trenutni status akvakulture manića i da se ukaže na moguće načine razvoja intenzivnog sistema gajenja ove vrste.

Poznato je da je najbolja temperatura za gajenje larvi manića 12 ^{o}C. Na ovoj temperature tri dana nakon izvaljivanja kod larvi (DPH – day post hatch) počinje punjenje mehura, a 5 dana nakon izvaljivanja, larve kod kojih ne dođe do punjenja mehura ne moga da preplivaju rastojanje od 10 cm do površine vode.

Kao i većina larvi riba i larve manića moraju da se hrane živom hranom na početku svoje egzogene ishrane. Utvrđeno je da nema potrebe larvama manića davati zooplankton jer se uspešno mogu hraniti sa naupliusima artemije od samog početka. Na 12 ^{o}C naupliuse treba davati od 9 do 10 dana nakon izvaljivanja.

Prelazak larvi sa žive hrane na veštačku hranu je jedna od najproblematičnijih, ali i najvažnijih faza u gajenju riba i direktno je vezana za povećan mortalitet jedinki. Jedna od glavnih teškoća u gajenju larvi manića je njihov prelazak na kompletna hraniva. Istraživanja pokazuju da je potrebno gajiti larve manića do oko 50 dana na temperaturi od 17 ^{o}C dok ne dostignu preko 25 mm dužine i 0.20g težine, što se smatra za "početnom tačkom" za prelazak na kompletna hraniva.

U gajenju juvenila i adulta manića nema većih problema s obzirom da imaju brz prirast, dobro iskorišćenje hrane i 100% preživljavanje kod riba koje se hrane kompletnim hranivima. Podaci jasno pokazuju da je najefikacije hraniti juvenile manića na 17 °C sa učešćem hrane od oko 2% u odnosu na ihtiomase dnevno. Uticaj osvetljenja na juvenile nije utvrđen. Takođe je utvrđeno da je najveća efikasnost u unosu hrane za adulte manića temperatura od 11 °C.

S obzirom da je manić postao jedan od značajnijih kandidata u proizvodnju riba u akvakulturi, postoji još uvek potreba za unapređivanjem postojećih metoda gajenja kao i razvijanje novih. Najvažnije je da se nastavi sa istraživanjem biologije i ponašanja manića koja mogu pomoći u osmišljavanju novih eksperimenata i rešavanju postojećih problema. Osim toga, razvoj tehnologije komercijalne proizvodnje riba zahteva utvrđivanje brojnih faktora, kao što su sastav hrane, temperatura, optimalno osvetljenje, koji imaju uticaja na efikasnost gajenja u intenzivnim uslovima, a još uvek su nedovoljno objašnjeni i razumljivi kod ove vrste.

Ključne reči: Lota lota, gajenje larvi, zalučivanje, gajenje riba
Keywords: Lota lota, larviculture, weaning, fish farming

INTRODUCTION

In recent years, increased attempts in the diversification of freshwater aquaculture have been observed. This has led to thorough research on the possibilities of intensive production (in recirculating aquaculture systems [RAS]) of few important candidates among the commercially valuable fish species. It regards, among others, perch, *Perca fluviatilis* L., pikeperch, *Sander lucioperca* (L.) and burbot, *Lota lota* L. (Teletchea *et al.* 2008, Fontaine *et al.* 2009). In the case of the latter, the lowest progress has been observed to date.

Burbot, *Lota lota* L., is the only freshwater representative of the Gadidae family, found almost in the entire Holarctic (e.g. Teletchea*et al.* 2006). Recently, burbot became an important candidate for diversification of freshwater aquaculture due to low temperature requirements, fast growth rate and high commercial value Edsall*et al.* 1993; Trabelsi*et al.* 2011; Wocher*et al.* 2011).

The effectiveness of aquaculture production of finfish in RAS is dependent on many variables and different obstacles characterize each of the production steps. Shortly after hatching, the most important thing is to provide suitable conditions for swim bladder inflation and the right amount and kind of food securing high growth and survival rates (Dąbrowski 1984; Czesny *et al*. 2005). Usually, the next step is to wean the larvae onto commercial (dry) diet in the most efficient way (Jensen *et al.* 2011; Palińska-Żarska *et al*. 2013). Further on, it is necessary to secure optimal culturing conditions (e.g., photothermal regime, amount and quality of feed, water condition) that will provide the highest growth (Trabelsi *et al.* 2011). However, there is not enough data on the most suitable culturing conditions for burbot production. On the other hand, the published data are sometimes ambiguous or incomplete. Therefore, the aim of this paper is to review the current status of burbot aquaculture and to indicate the possible ways of development considering intensive production of this species.

INITIAL REARING OF LARVAE

The best temperature for burbot larvae rearing is 12 °C (Wolnicki *et al*. 2002). It is very important, from the burbot production point of view, that the larvae do not have major problems with inflation of their swim bladders, like some larvae of Perciformes (Rieger *et al*. 1998; Czesny *et al*. 2011). It was observed that (at 12 °C) larvae begin to inflate their swim bladder on the 3 day post hatch (DPH), while on 5 DPH none of the larvae without an inflated bladder are able to swim up the distance (10 cm) to the water surface (Palińska-Żarska *et al*. 2012).

Another important matter during the initial rearing of fish larvae is the question what kind of food should be given and when is the best moment to feed the larvae? Like most of the fish larvae, burbot larvae also need to be fed with live food from the beginning of the exogenous feeding. Since burbot larvae are one of the smallest among freshwater species (at the moment of hatching they have around 4 mm), trials to feed them with zooplankton organisms were performed (Harzevili *et al*. 2003; Lahnsteiner *et al*. 2012). However, it was found that there is no need to feed them with zooplankton since they could be successfully fed with *Artemia* nauplii from the very beginning (at 12 °C the nauplii should be given from 9-10 DPH) (Żarski *et al*. 2009; Palińska-Żarska *et al*.2012).

WEANING

The transition of larvae from live food to artificial diet is one of the most problematic, yet most important stages in fish culture and is strictly associated with increased mortality (Jensen *et al*. 2011; Wocher *et al*. 2011). However, from an economic point of view, it is very important to wean larvae at the earliest possible stage of culturing since the cost of feeding with live food is very high (Baskerville-Bridges & Kling 2000). However, considering larviculture of burbot, the biggest bottleneck is weaning the fish onto compound diet. The obtained results indicate that it is necessary to ensure intensive rearing of burbot larvae for about 50 days (at 17 °C) until they reach over 25 mm and over 0.20 g, what may be considered as a "starting point" for the weaning procedure. The described results clearly indicate that the appropriate length and weight of larvae, not the age, are the parameters that are considered the for effective transition to artificial feed (Palińska-Żarska *et al*. 2013).

JUVENILES REARING

There are not a lot of papers dealing with rearing burbot juveniles, since there are no big problems at this stage. High growth rate, good feed utilization and 100% survival rate of fish fed with dry compound diet are recorded. The latest findings concern the optimal food ratio for juvenile burbot or the light intensity and temperatures during rearing of juveniles (Wolnicki*et al*. 2001; Trejchel*et al*. 2012).

The obtained data clearly demonstrate that the most effective feeding level for burbot juveniles reared at 17 °C is about 2% of fish biomass per day (Trejchel *et al*. 2012). Finally, the data demonstrate that there is no effect of light conditions (1800 lx or 4 lx) on the rearing of burbot juveniles (Trejchel *et al*. 2012). These data supplement already published data, where light conditions for burbot juveniles remained unclear (e.g. Jensen et al. 2011; Trabelsi et al. 2011). However, for culturing purposes of juveniles burbot, constant light conditions may be recommended.

LIVING IN RAS

There are almost no data about adult burbot growth in RAS. One of the main reasons is that there are not many difficulties related to this, therefore not many experiments are conducted on adult burbots. There are some data dealing with the optimal temperature, both for feeding burbot (Pääkkönen&Marjomäki 2000) and for its reproduction (Żarski *et al*. 2010). It was confirmed that the highest efficacy of food intake for the adult burbot is around 11 ^{o}C (Pääkkönen&Marjomäki 2000). It was described that the synchronization of the spawning could be reached only under controlled thermal regimes, when spawners are kept at 6^{o}C before spawning while after spawning the temperature is decreased to 1^{o}C. This restrictively controlled thermal regime during reproduction of burbot in RAS provided the most synchronous spawning of females (Żarski *et al*. 2010).

FUTURE PROSPECTS IN BURBOT AQUACULTURE

Since burbot become a very promising candidates for aquaculture production there is still a need to improve the existing methods of rearing, as well as to develop new ones. The most important is to carry on with the observation of burbot biology and behavior, which helps to design new experiments and solve existing problems. Besides, the development of comprehensive commercial fish production technology requires determining numerous factors that may have an impact on the efficacy of rearing burbot in intensive culture conditions. Feed composition (exclusively for burbot) and the optimal light intensity still seem to be poorly explained and understood in this species. Furthermore, the main bottleneck in burbot aquaculture is still weaning. That is why the biggest challenge is the economic optimization of costs connected with such long feeding of larvae with live food. Data attained till this day are a very good basis for further research on the optimization of all factors (e.g., temperature, type of feed, other methods of feed change such as co-feeding) affecting burbot production effectiveness.

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