



MEAGRE (*Argyrosomus regius* Asso, 1801) AQUACULTURE IN CROATIA

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ABSTRACT

The objective of this review is to present current status of meagre aquaculture in Croatia. Meagre *Argyrosomus regius* (Asso, 1801) is a fast growing migratory fish species which used to be widespread along the coast of the Adriatic Sea. Today, it is very rare in fisheries catches and is considered highly endangered. Recently, meagre has become an increasingly important species in the Mediterranean aquaculture. In Croatia, meagre is a relatively new cultured species whose farming started after the year 2000. Since the European Commission identified species diversification as a top priority in the framework of the 2020 strategies for Aquaculture, and with recent studies revealing that meagre adapt easily to captivity and maintain a rapid growth rate, this species became an interesting candidate for Croatian as well as Mediterranean aquaculture.

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INTRODUCTION

Meagre *Argyrosomus regius* (Asso, 1801) is a migratory fish species which belongs to the Sciaenidae family. It is distributed in the Eastern Atlantic, from Norway to Gibraltar and Congo, including the Mediterranean and the Black Sea (Griffiths and Heemstra, 1995).

In the Adriatic Sea, meagre was widespread along the eastern coast, especially at the mouths of certain rivers (Cetina, Neretva, Bojana). However, it became very rare in fisheries catches and today is highly endangered (Šoljan, 1975; Jardas et al., 2008). The mouth of the River Bojana in Montenegro (Ulcinj region) is probably one of the last locations in the Adriatic Sea where this species occurs naturally (Joksimović, 2007).

Global fisheries production of meagre ranges from 5000 to 10000 tonnes per year (Monfort, 2010). The production from capture fisheries in Europe is low, ranging from a few hundred tonnes to 1500 tonnes in different countries. The main markets for wild meagre are southern Spain, Portugal and western France, where it is landed as a large size fish (commonly above 5 kg) that is much appreciated by local

buyers, with additional supplies originating from Morocco and other countries (Monfort, 2010).

In the last decade, meagre has become an increasingly important fish species to Mediterranean aquaculture. Several biological characteristics make meagre an interesting candidate for aquaculture. Some of these characteristics are: capability to withstand diverse environmental conditions, fast growth even in captivity and a good feed conversion when fed on dry formulated feeds. Furthermore, this species possesses a high flesh quality as well as suitability for industrial processing (Calderon et al., 1997; Poli et al., 2003; Hernández et al., 2009; Martínez-Llorens et al., 2011).

Regarding health issues, bacterial diseases, *Vibrio anguillarum* (García et al., 2013), *Nocardia* sp. (Elkesh et al., 2013), *Photobacterium damsela* subsp. *damsela* (Labella et al., 2011) have caused problems in meagre rearing in Spain and Greece. Limited data exist on parasitic diseases of meagre, with most records related to those reared in cages or ponds in the Mediterranean area, which include infections with *Amyloodinium ocellatum* (Soares et al., 2012a), *Sciaenocotyle* sp. (Monogenea) (Merela et al., 2009), *Microcotyle panzerii* (Monogenea) (Quilichini et al., 2009). Non-infectious

diseases, as systemic granulomatosis (Ghittino et al., 2004) in meagre from Italian fish farms and sarcoma in the thymus (Soares et al., 2012b) in Portuguese farms, have been noticed. In general, this species is very disease-resistant and easy to handle (FAO, 2014a). Even though breeding is not excessively demanding, it is necessary to follow all zoohygienic protocols to ensure a better quality of the final fish product. In Croatia, this species is a relatively new cultured fish whose farming started on a pilot scale after the year 2000. Therefore, the aim of this study is to examine the status of meagre aquaculture in Croatia.

BIOLOGICAL CHARACTERISTICS

With a total length of over 180 cm and live body weight of more than 50 kg, meagre is one of the largest sciaenids (Costa et al., 2008). It is a coastal fish, abundantly present in European estuaries with rocky and sandy bottoms and at depths of usually less than 80 m (Prista et al., 2008). It is an anadromous species which usually enters estuaries at the end of May to spawn. It stays in inshore waters (estuaries and along the coast) until the end of summer and then migrates offshore for the winter period (FAO, 2014a). However, Griffiths and Heemstra (1995) reported the meagre spawning period from January to May in Mauritania.

Juveniles feed mostly on small demersal fish and crustacean (Martínez-Llorens et al., 2011), while specimens with a total length greater than 40 cm prefer pelagic fish and cephalopods (Calderon et al., 1997). Water temperature seems to be the most important factor determining its trophic migration and reproduction (Monfort, 2010).

Recent research on age determination based on otolith annuli readings has shown that the maximum age for meagre was 36 years (LT=182 cm), as demonstrated in Portuguese waters (Prista, 2013). However, Costa et al. (2008), in their study on meagre biology and fishery, reported 43 years as the maximum age, also using samples from Portuguese waters. González-Quirós et al. (2011) studied meagre from the Gulf of Cádiz and reported that the two aged specimens (186 and 189 cm LT) belonged to the 41- and 42-year classes. They also estimated length-at-first maturity of 61.6 cm for males, and for females in the range of 70–110 cm. Biological parameters for meagre from the Adriatic Sea are sporadic or non-existent (Dulčić et al., 2009).

MEDITERRANEAN PRODUCTION STATUS

Meagre aquaculture started in the mid-1990s in Southern France and Italy, followed by Spain in 2004 and later by Greece, Turkey and Egypt (Monfort, 2010). Although it is presently farmed in several countries in the Mediterranean basin, its production has not yet reached its full potential and rearing trials are still very limited (Martínez-Llorens et al., 2011). However, as a result of achievement of reproduc-

tion in captivity, the production has significantly increased over recent years. For example, the FAO (2014a) reported an increase from 845 tonnes produced in 2006 to a maximum of over 14.383 tonnes in 2011. Currently, the main producer is Egypt with over 2000 tonnes per year (mostly capture based aquaculture), followed by Spain (1.374 tonnes) and Turkey (512 tonnes). Despite being the most important suppliers of meagre fingerlings, France and Italy produced around 300 tonnes in 2008 (Monfort, 2010). In Croatia, 24 tonnes were produced in 2012 (Croatian Ministry of Agriculture, 2014). The main markets for farmed meagre are Italy, Spain, Portugal and Israel where it is sold mostly as fresh product at a size of around 2.5 kg (Monfort, 2010).

PRODUCTION CHARACTERISTICS OF MEAGRE

Compared to the most important cultured Mediterranean fish, i.e. Gilthead sea bream (*Sparus aurata*) and European sea bass (*Dicentrarchus labrax*), a major biological advantage in favour of meagre is the fast growth rate which enables it to reach the size of 1 kg in a ten-month period and a commercial weight ranging from 1.5 to 3 kg in two years (Jiménez et al., 2005; Martínez-Llorens et al., 2011). A low feed conversion ratio of 0.9-1.2 was reported for these species (Monfort, 2010; Duncan et al., 2013). According to FAO (2014 a), survival rate for juvenile fishes (3-20 g) in cages was around 80%. Recently, several studies that were focused on the feeding of meagre under aquaculture conditions, indicated that basic dietary nutrient requirements of meagre juveniles and sub-adult stages are close to those of other carnivorous marine fish species. For example, Chatzifotis et al. (2012) reported that a dietary crude protein level of 50% resulted in nearly optimal growth performance in juvenile meagre, while Martínez-Llorens et al. (2011) found that meagre fed a commercial diet with 47% crude protein and 20% crude lipid showed the best growth performance. These latter figures are similar to those being currently adopted in commercial diets for sea bream and sea bass, which are in a range of 45–55% of crude proteins and 17 – 21% of crude lipids on a dry weight basis (Chatzifotis et al., 2012). A comparison among these Mediterranean fish species in terms of overall production volumes and growth rate records under farming conditions is shown in Table 1.

Meagre is a fish species that, along with some other emerging species such as common dentex *Dentex dentex* (Linnaeus, 1758), contributes to the species diversification process in the Mediterranean aquaculture. Still, as a relatively new species on the European market, it needs to find its niche. According to Monfort (2010) the main direction in future market development for meagre should be oriented to the production of ready-to-cook portions (fillets, cuts, smoked fillets, etc.). The market for the whole fish is reducing, while the demand for a portion-sized product is growing. Studies on meagre feeding and aquaculture conditions in Italy have

Table 1. Production characteristics of Sea bass, Sea bream and Meagre in the Mediterranean region

Species	Sea bass	Sea bream	Meagre	Reference
Total production in the Mediterranean in 2012 (in tonnes)	153.182*	159.730**	10.221***	*FAO 2014B **FAO 2014C ***FAO 2014A
Growth in 12 months (g)	150 – 300*	150 – 300**	>700***	*FAO 2014B **FAO 2014C ***FAO 2014A
Growth in 24 months (g)	300 – 500*	300 – 500**	2.000-2.500***	*FAO 2014B **FAO 2014C ***FAO 2014A
Feed conversion rate (FCR)	1.4-1.6*	1.3-1.75*	0.9-1.2**	*Andrew et al. (2005) **Martínez-Llorens et al.(2011)
Market price (Euro)	5*	5*	6-8**	*Murias (2014) **Monfort (2010)

shown that meagre is indeed a fish that provides low-fat flesh, even under intensive farming conditions. They found low presence of fat (mesenteric and intramuscular), even using a diet with the highest fat content (Polí et al., 2003; Piccolo et al., 2008). Hence, based on the flesh quality, meagre has to be considered as a fish species of high nutritional and dietetic value (Qučmčner, 2002; Polí et al., 2003).

PRODUCTION IN CROATIA

The first meagre production in Croatia was carried out by the Plankton Trade Company from Pelješac, followed by companies Riba Mljet from the island of Mljet, Dalmar and Cromaris from the Zadar region and recently Hama from the island of Hvar. However, most of the above mentioned companies have stopped meagre production due to the fact that this species was unknown to Croatian consumers since meagre marketing was still insufficient (Bavčević, L., pers. comm.). Nowadays, import of meagre fingerlings is only being recorded on fish farms on Hvar and by the Cromaris



Fig 1. Floating meagre cages (16 m) near the island of Košara in the waters around the island of Pašman (Photo: Čolak, 2015)

Company. Floating meagre cages are located in Duboka Bay (Hvar), near the island of Košara in the waters around the island of Pašman, in Velo žalo off the northern side of the island of Dugi otok and in Lamjana near the island of Ugljan (Fig. 1).

Since the beginning of meagre aquaculture in Croatia, fingerlings were obtained and transferred mostly from French and Italian hatcheries. Currently, a broodstock is being cultured in cages in a Cromaris farm in Lamjana (Island of Ugljan), with intention to start fingerling production in their own hatchery in the future. Fish is held in net cages with a diameter of 16-24 m on semi-off shore location near the southern part of Ugljan. Breeding technology is similar to that of seabass and seabream. At this moment, in the three mentioned Cromaris farms, imported fingerlings are of average weight of 8 g and are transferred to floating cages of 16 m in diameter during August and September. The authors have observed some losses (approximately 15%) of meagre fingerlings during transport. For feeding, Cromaris uses extruded dry pellets containing 51% crude protein and 17% crude lipid for fingerlings up to 20 g and 45-48% crude protein and 16 – 20% crude lipids for larger fish. Feeding of fish includes two methods: hand feeding and automatic feed dispensers which are usually filled once per day. Fingerlings are fed five to six times per day, in agreement with feed manufacture feeding tables. Maximum feeding rate is 3.5% of body weight per day in 8 g fingerlings during summer time and minimum is 0.30% of body weight in 1 kg fish during winter time. In Lamjana farm average water temperature varied from 10.8°C in February to 25.0°C in July and August. In this farm, feeding of juvenile and adult fish is usually performed twice a day in summer months, while in winter fish are fed once in two days. The authors have noticed that in the above mentioned Croatian fish farms monitoring of feeding behaviour of meagre in cages is difficult due to the fact that fish are mostly occupying the bottom of the cage area. This could result in underfeeding and weakening of fish, which in turn could become more prone to diseases.

Also it could result in overfeeding.

In general, survival rate in all mentioned farms is 60-80%. The major losses were recorded during the cold winter months, from February to April. In some farms on the Eastern Adriatic Sea, mortality during winter 2012 reached 100% when water temperature was below 10°C (Bavčević, L., pers. comm.). The authors have observed presence of the parasites *Ceratomyxa oestroides* in meagre (Fig. 2). However, significant losses were not recorded.



Fig 2. Parasite *Ceratomyxa oestroides* in meagre farmed in Croatia (Photo: Čolak, 2014)

Under the above mentioned environmental and culture conditions, meagre reaches over 1 kg in about two years with a final feed conversion ratio (FCR) of around 2.5 and 10 kg/m³ stocking density. Meagre harvests are done in accordance with market demand.

CONCLUSION

When compared to the aquaculture of seabass and seabream, meagre farming in Croatia is still under development. The losses of meagre fingerlings during transport could be related to the changes in the quality of sea water during long-lasting transportation. Therefore, there is a need to improve transport protocols. Also, regarding special environmental requirements for meagre breeding in Croatia, the authors have noticed that low temperatures in the Eastern Adriatic Sea during the winter period were related to increased losses. However, the aetiology of mortality remains undefined. Even though meagre has fast growth rate in other Mediterranean countries (Table 1), values of its growth rate are lower in Croatia. This could be related to lower annual sea temperature in the mentioned meagre farm locations and also to feed and feeding technology. Possibilities for further development of meagre aquaculture in Croatia could include change in hatchery production starting with spawning two

months earlier. This way, the fingerlings would have longer growing period in the first year. Presently, cage locations are in the Middle Eastern Adriatic Sea. This area has lower sea temperature than the southern Adriatic and therefore change of farm locations could also promote better meagre growth. Although the Croatian fish market is starting to recognize this "new" species, there is a need to improve its marketing. Further research is needed also to improve meagre feeding and its production technology as it is a very interesting species for the diversification of aquaculture in Croatia and in other European countries.

Sažetak

UZGOJ HAME (*Argyrosomus Regius* ASSO, 1801) U HRVATSKOJ

Svrha ovog pregleda je prikazati uzgoj hame, *Argyrosomus regius* (Asso, 1801), u Republici Hrvatskoj. Hama je migratorna vrsta ribe koja je u prošlosti obitavala duž cijele jadranske obale. Danas je iznimno rijetka u ribarskim lovinama te se smatra ugroženom vrstom. Odnedavno, hama je postala sve važnija riblja vrsta u mediteranskoj akvakulturi. U Hrvatskoj se počela uzgajati iza 2000. godine. S obzirom da je Europska Komisija u smjernicama strategija za akvakulturu istaknula, kao jedan od ciljeva, diversifikaciju vrsta, a novija su istraživanja pokazala da se ova vrsta lako prilagođava kaveznim uvjetima te da ima brzi prirast, hama postaje sve interesantnija vrsta u hrvatskoj i mediteranskoj akvakulturi.

Ključne riječi: hama, akvakultura, Hrvatska, Mediteran

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