Growth and condition index – two important factors in mussel farming

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Scientific paper

Summary

Production of mussels is present in most of the Mediterranean countries, with Spain and Greece as the largest producers. Compared to the total production, Croatian mussel production is continuously small – only around 3.000 tones of mussels a year are placed on the market. Farming technology is relatively simple, while the whole sector is characterized with unorganized market and unconsolidated small producers. Growth and condition index are important factors for mussel farming in terms of reaching the market sized length and good meat yield. By knowing the hydrodynamics and trophic features of the production area and the biological characteristics of mussels, along with the right zoo technical procedures, we can partially influence growth and condition index of cultured mussels. The aim of this paper is to describe main ecological impacts on these two factors under aquaculture. The purpose is to summarize important farming procedures, which can reflect with utilization of the natural potentials on the production site and with increased profitability for the producer.

Key words*: bivalve farming, mussel, Adriatic Sea, aquaculture*

Introduction

Bivalves from the genus of *Mytilus* are present throughout the world oceans and seas. Among them, family of *Mytilidae* is represented with 5 species, from which two are commercially important in Europe: *Mytilus edulis* (Blue mussel) and *Mytilus* galloprovincialis (Mediterranean mussel). Mediterranean mussel is distributed throughout the Mediterranean coast, but is also found on the coast of the Atlantic and even in Central and Southern California, endangering the native *Mytilus trossulus* (Dardignac-Corbel, 1990; Braby and Somero, 2006). In the Adriatic Sea, this species is widely distributed and commercially produced in aquaculture. In contrast to other species of *Mytlidae*, M. galloprovincialis can be considered invasive and highly successful in inhabiting new areas, with potential to jeopardize seed collection of already present species (Wonham 2004). For example, recent studies in area of Bay of Mali Ston (Croatia) indicate that mussel feeding on bivalve larvae is one of the main causes of reduced collection of oyster spat (Peharda et al. 2012).

Wild populations of mussels inhabit coastal intertidal zone with rocky sea bed but dense colonies are also found on various substrates such as plastic buoys, anchored ships, anchors and ropes, aquaculture facilities, etc. Largest populations in the Adriatic Sea are found in Bay of Mali Ston, Krka estuary, Novigrad Sea and Lim Channel (Figure 1.).

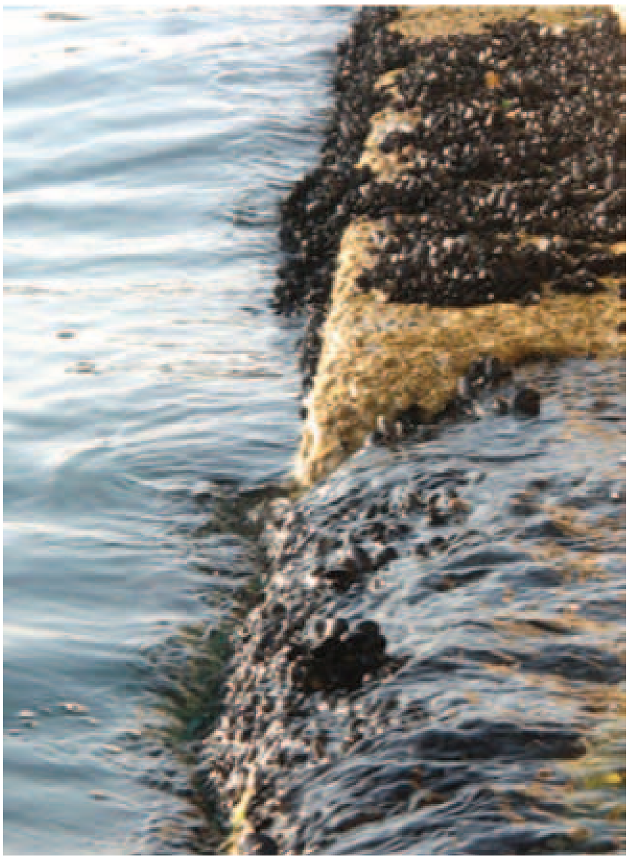

Figure 1. Distribution of mussel – intertidal zone

Such limited distribution is induced mainly by biological factors of predation and competition and not by the unavailability to survive in deeper infralitoral zone. For example, stable populations of mussels are found

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regularly below 20 m depths, with normal growth rates (Goslin, 1992).

Mussels are gonochoristic with similar sex ratio between males and females. Sex differentiation in adults can be done according to coloration of the gonads – males are usually whitish while females have orange coloration (Figure 2.). In the Mediterranean region, release of gametes is recorded throughout the year, with peaks in spring and autumn period (Dardignac-Corbel, 1990). Spawning occurs at early life stages when mussels reach size of over 30 mm in length, when they release smaller quantities of gametes.

Figure 2. Differences in coloration of mussels according to sex: left – female; right – male

Production of *Mytilus galloprovincialis* is present in most of the Mediterranean countries. Total of 119.964 tones with total value exciding 117 million U.S. dollars were produced in 2009 with Spain and Greece as a leading countries (FAO, 2010). Croatian production compared to other countries is minor and at constant of around 3.000 tones a year (Mišura et al. 2008). Technology production is similar and relatively simple throughout the Mediterranean. It is based on collection of seed from the wild by use of various types of collectors (Figure 3), plantation into plastic mesh bags and culture on longlines or rafts until reaching commercial size of over 60 mm, after which they are cleaned (or processed) and placed on the market. Almost 80% of production on the Mediterranean is sold as fresh mussels, while the rest is being processed and afterwards sold as a product with extended shelf life.

Growth of mussels

Mussel growth, like in other bivalves, is influenced by variety of factors, such as size and age of the individual, genotype and numerous ecological factors (Gosling, 1992). Among them, the most important factor is the food availability, both in terms of quantity and composition. While feeding, mussels digest particles of various sources and size, ranging from only 1 µm to even 200 µm (Wong and Levinton 2004; Ezgeta- Balić et al. 2012).

Figure 3. Mussel seed on the rope collector before being planted into mesh bags

Like in other bivalves, the main component of the diet is phytoplankton, but numerous studies indicate that a large proportion of mussel diet is composed of organic detritus, anorganic particles, dissolved organic matter, bacteria and zooplankton (Sidari et al. 1998; Ezgeta - Balić et al. 2012; Peharda et al. 2012). Other factors affecting growth are temperature, salinity and exposure to currents and air. Increased food availability within temperature range from 10 – 20°C usually reflects with fastest growth, while above 20°C and bellow 5°C growth is significantly slower. Increased growth is noticed in area with constant inflow of fresh water from the mainland. This is due to the increased food availability rather than the low salinity itself. Low salinity can actually have negative impact on mussel growth, while in extreme cases it can be lethal (Gosling 1992). Optimum for mussel is the salinity range of 25 – 28 ‰ although they are capable to withstand 18‰ salinity without negative effects. While establishing mussel farm, great importance should be given to understand seasonal variations of salinity, including variation according to different depths.

In aquaculture conditions, seeding densities have large impact on mussel growth rates. High densities can cause reduced food competition for individuals in the middle of mussel mesh bags reflecting with slower growth rates. When mussel seed is planted into mesh bags, it is recommended to fill 2-3 kg of mussels per 1 meter of mesh bags. This will allow enough space for normal food competition and will result with optimal final density. For each producer it is necessary to perform seasonal growth rate measurements at different sites of production area and at different depths. Among several methods for growth rate measurement, growth in length is a preferred option for mussel. This can easily be done by the use of variable caliper with a precision of at least 1 mm, measured as the maximum distance between the anterior and posterior margins of the shell (Figure 4.).

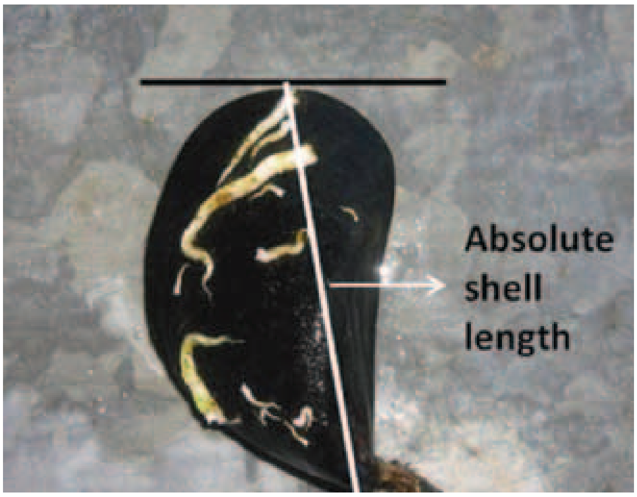

Figure 4. Maximum shell length

The key to successful track of the growth rates is to take representative sample which reflects the size structure of the target population. Even more precise results can be obtained by measuring individual growth rates. For this, representative sample (minimum of 30 shells) should be marked, after which successive measurements can be performed over a fixed period of time. Various methods for marking shells are available. Among them, tagging with plastic markations (for example Hall Print, Australia) which are glued directly on the shell is proven to be practical and reliable (Peharda et al. 2007; Župan et al. 2014) (Figure 5.). By measuring growth rates at different sites and depths producer is able to better perceive influence of ecological factors on mussel growth and to utilize production area with achieving maximum growth rates. This will result in higher biomass produced. Growth measurements can be done on a three months basis, separate for each year class.

Figure 5. Shell markation and a sample of marked individuals for tracking individual growth rates

Condition index of mussels

Measurements of condition indices, which relate the amount of bivalve meat to the quantity of shell, are used for various scientific or commercial purposes. This is especially important in quality assessment and marketing of bivalves – the higher proportion of meat, the better. In mussels, condition index can vary relative to size of the shell, period of the year, environmental factors, but above all by the food availability and reproductive stage (Gosling 1992). Seasonal changes of environmental factors lead to complex interactions between temperature, food and salinity which influence somatic growth and reproduction and indirectly, the condition index.

In the Adriatic Sea, lowest values are recorded during winter and highest during spring periods, before spawning peak. Differences in condition index are noticed for mussels cultured on the sea bottom and those suspended in the water column, which have significantly higher values due to the better food quality and less concentrations of the sediment in the water. Due to the great variability influenced by the ecological factors, it is preferred to measure individual condition indices of representative sample of the same size and age.

According to Davenport and Chen (1987), there are 7 methods for measuring condition index. Among them, following three are recommended as most reliable and practical:

1) C. I.= weight of cooked meat / weight of cooked meat + weight of the shell x 100

2) C. I. = weight of cooked meat / total volume – volume of the shell x 100

3) C. I. = weight of dried meat / weight of the shell x 100

Method 1 enables calculation with frozen samples, it takes account the most easily measured parameters, and is proven as most practical method for the farmers. The methodology is simple: mussels are placed into boiling water for three minutes. Afterwards, meat is removed from each shell and placed on the paper to remove excess of water. In the meantime, shells must be cleaned from all biofouling to avoid its influence on the weight of the shell and the final index. Meat and shell weights are measured (0.01 g precision) and condition indices are calculated individually as mentioned above in the formula (Figure 6.).

Unlike growth measurements, condition indices must be at least performed on a monthly basis, considering the great variability during the single season. Preferably, samples for measuring condition of mussels should be placed on several locations within the same production site, in order to determine the most suitable micro locations for aquaculture.

Figure 6. Measurement of condition index of mussels

Conclusion

Along with the basic conditions for bivalve aquaculture, such as sufficient seed collection and good survival, for successful production it is necessary to achieve fast growth rates and high condition indices. Unlike fed aquaculture species (fish, crabs, etc.), where producer can directly influence these factors through the feeding regime, in bivalve aquaculture they are depended solely on the environmental conditions. However, knowing the hydrodynamics and trophic features of the production area and the biological characteristics of mussels, along with the right zoo technical procedures (for example, choosing the adequate depth, location, density, etc.), we can partially influence growth and condition index of cultured mussels. This way the natural potentials of the production site is maximally utilized, which can reflect with increased profitability for the producer.

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