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THE POTENTIAL OF COMMERCIAL FARMING OF THE EUROPEAN FLAT OYSTER, *OSTREA EDULIS*, IN THE KOTOR BAY (ORAHOVAC)

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MOGUĆNOST KOMERCIJALNOG UZGOJA ŠKOLJKE KAMENICE, *OSTREA EDULIS* U USLOVIMA KOTORSKOG ZALIVA (ORAHOVAC)

Abstrakt

Kamenica, ostriga, *Ostrea edulis*, je jadranska školjka, koja se već nekoliko decenija vještački gaji u Jadranu, najviše na hrvatskom primorju. Izuzetno je cijenjena, te stoga dostiže i visoku cijenu na tržištu. Nakon ranijih eksperimentalnih istraživanja Instituta sedamdesetih godina prošlog vijeka, ova vrsta je po prvi put, 2010. godine komercijalno uzgajana u uslovima Bokotorskog zaliva, u mjestu Orahovac kod Kotora. Institut i kompanija „D.O.O. Školjke Boke" su u julu mesecu uvezli 9000 jedinki mlađi iz poznatog uzgajališta u Stonu (HR). Školjke su nasađene na lokaciji Orahovac u neposrednoj blizini reke Ljute u severnom delu Kotorskog zaliva. Primjenjen je prirodno-veštački način uzgoja, gde se kamenice vešaju na brodske konope povezane sa polietilenskim bovama, na dubinu 4–7 metara. Mereni su osnovni hidrografski parametri, temperatura i salinitet, kao i dužinski rast na 100 slučajno odabranih jedinki iz uzgajališta. Maksimalne temperature 27.6 T°C izmerene su u julu a najniže 11.2 T°C. Vrednost saliniteta je bila najveća u avgustu i iznoslila je 27.8 ‰ a minimum je bio u decembru 6.3 ‰. Temperaturni opseg je uobičajen za područje Kotorskog zaliva, dok su vrednosti saliniteta bile neuobičajeno niske u jesenjem periodu, čak i na dubinama 4–5 metara, što je bilo uslovljeno izuzetno velikim količinama padavina. Istraživanja pokzuju da je rast od jula do oktobra bio ujednačen i ukupno je iznosio 1cm, odnosno u proseku 0.25 cm po mesecu. Od oktobra do januara nastupa nešto usporeniji rast i ukupno iznosi 0.3 cm. Od januara ponovo nastupa nešto pojačani intezitet rasta koji ukupno iznosi 0.5 cm. Dakle u periodu od 8 meseci (jul–mart) ukupni rast iznosi 1.9 cm.

Rast kamenica zavisi od mnogo faktora, a najviše od količine hrane (planktona) i temperature. Kako i naša istraživanja pokazuju, rast je najintezivniji bio u letnjim mesecima, kada su i povoljne temperature koje uslovljavaju u povećanu količinu planktonskih zajed-

nica. Salinitet takođe igra značajnu ulogu u rastu kamenica, ali su one otpornije na kolebanja saliniteta od dagnje, koja se takođe veštački gaji. Do skoro identičnih istraživanja došao je Glamuzina u Malostonskom zlivu 2006, kada je konstatovao ukupni rast 1.7 cm za period jun–april. Merenja smrtnosti pokazala su nešto povećane vrednosti (15%) u julu neposredno posle postavljanja jedinki u more, što je verovatno uslovljeno transportnim šokom i prilagođavanju uslovima u vodi Kotorskog zaliva. U kasnijim mesecima on opada i od septembra do marta iznosi 0%. Onda se u martu 2011. pojavljuje uobičajeni problem predatora, kada ribe orade *Sparus aurata*, napadaju uzgajalište i čine veliku štetu, naročito na cementiranim nizovima kamenice, jer su više otvorene nego one u kašetama. Svi dosadašnji podaci pokazuju, da uslovi vode u Kotorskom zalivu, naročito na ušću rijeke Ljute, izuzetno pogoduju dobrom rastu i kondiciji ove vrste, što ide u prilog njenom komercijalnom uzgoju, ćime će se pored dagnje, *Mytilus galloprovincialis*, upotpuniti ponuda školjkaša, naročito u vrijeme turističke sezone na crnogorskom primorju.

Ključne reči: *Kamenica, marikultura, Kotorski zaliv, dužinski rast*

INTRODUCTION

European flat oyster, *Ostrea edulis,* Linnaeus, 1758 (ordo: Bivalvia) is a sea shell from the Ostreidae family, elongated and heart–shaped, whose natural habitat is in the Mediterranean, but is also found in the eastern Atlantic Ocean and the Black Sea. It lives in areas of brackish water up to 10 m in depth, attached to the sediment in sparsely populated colonies. Its body is located between two asymmetrically shaped shells connected by a strong muscle. The shells are stone–grey in colour, which helps the animal to stay hidden on the sediment. It feeds on plankton retained by filtering seawater. It can reach lengths of up to 13 cm and weights of up to 100 g. It is predated on by starfish, snails, crustaceans, and fish.

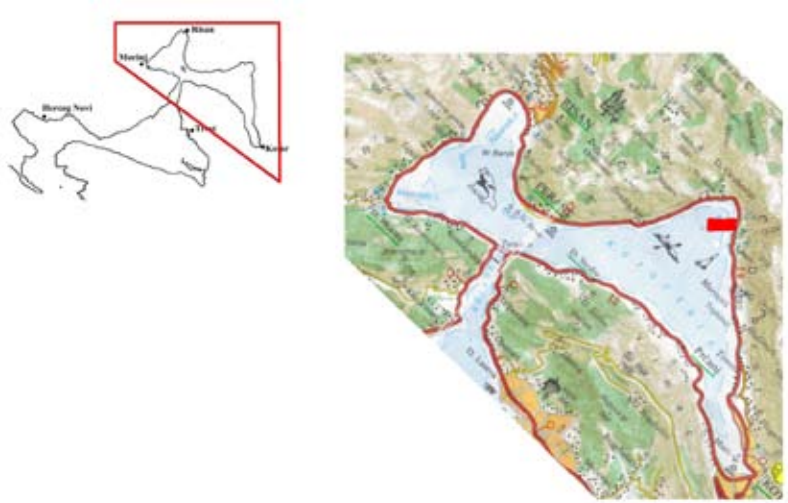

Figure 1. Map of Kotor Bay, locality of Orahovac (red)

European flat oyster has been considered a delicacy since the Roman times, due to the salty taste of its flesh, and is usually consumed raw. High levels of protein, carbohydrates and vitamins give the flesh its nutritional value (Tomšić & Lovrić, 2004). Due to this, it is artificially farmed in the Mediterranean, especially in Croatia in the Lim Bay and Bays of Pula and Mali Ston. The annual production in Croatia is about 4000 t (Statistical Yearbook Repablic of Croatia, 2009). Due to the negative influences it has been virtually wiped out from it natural habitat. It was once abundant in the Boka Kotorska Bay, especially in the Kotor Bay, an area with a high influx of freshwater from the Ljuta River. Unfortunately, specimens naturally found in the Kotor Bay are now few and far between. In the 1970s, the Institute of Marine Biology did some research on the European flat oyster (Stjepčević, 1974). Since then, 20 mussel (*Mytilus galloprovincialis*) farms were established in the Bay, but so far there have been no oyster farms. Due to this, the "ŠKOLJKE BOKE" company desires to re–establish oyster farming in the Kotor Bay area, under the expert guidance of the Institute of Marine Biology.

METERIALS AND METHODS

The individual oysters were imported from the oyster farm in Mali Ston in July 2010. All necessary permits for import of biological specimens were previously obtained under the surveillance of the Institute of Marine Biology in Kotor. A total of 9000 specimens were seeded at the newly founded private oyster farm of the "ŠKOLJKE BOKE" company in Orahovac, near the Ljuta river.

Figure 2. Oyster, *Ostrea edulis* and the oyster farm in Orahovac

Figure 3. Oysters attached to the ropey with cement

The basic hydrographical parameters were taken at the oyster farm, temperature and salinity, along with mortality and growth. A longline farming system was used, in which oysters are attached to ropes reaching 4–7 m in depth, which are then connected to polyethylene buoys. 80% of the total number were cemented to the surface, while the remaining 20% were grown in boxes. Length, height and width (thickness) were measured on a

monthly basis on 100 randomly selected individuals. Visual control of the algae growth on the oysters was also done at the same time.

RESULTS AND DISCUSSION

The results of the hydrographical and meristic measurements from the July 2010–March 2001 period are given in Table 1.

Tabela 1. Results of the hydrographical and meristic parameters from the Orahovac locality

DATE	DEPTH (m)	T (°C)	SALINITY (‰)	LENGTH (cm)	WIDTH (cm)	HEIGHT (cm)	MORTALITY
06.07.2010	5	27.6	21.1	6.5	5	0.85	0%
04.08.2010.	5	21.3	12.51	6.9	5	0.87	7.5 %
01.09.2010	5	25.2	27.8	7.2	5.2	0.90	5%
02.10.2010.	5	17.7	25.4	7.5	5.3	0.92	0%
15.11.2010.	5	13.5	8.8	7.6	5.5	0.92	0%
10.12.2010.	5	11.3	6.3	7.6	5.5	1	0%
10.01.2011.	5	11.2	6.4	7.7	5.5	1.1	0%
24.02.2011.	5	14.1	8.2	8.0	5.7	1.2	0%
15.03.2011.	5	14.5	8.6	8.2	5.8	1.3	15%
19.03.2011.	5	12.1	6.4	8.4	6	1.4	0%

The data demonstrates that the temperatures ranged from the maximum of 27.6°C measured in July to the minimum of 11.2°C in January. The highest salinity levels were measured in August at 27.8‰, with the minimum recorded in December at 6.3‰. The temperature range is quite common for the Kotor Bay (Stjepčević, 1974), but the salinity levels are significantly different, especially during the autumn period. This can be explained by high rainfall during the previous autumn, reducing salinity in the process, even at greater depths.

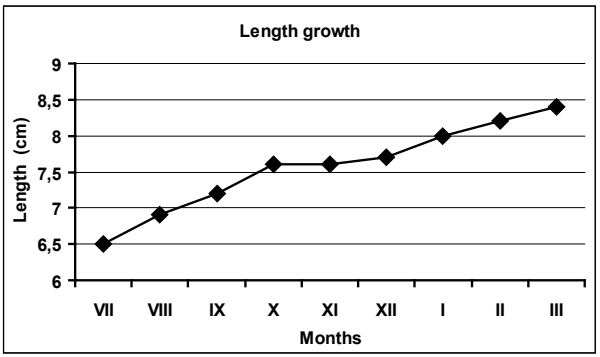

Figure 4. Graphic representation of the growth of oysters

As seen in Figure 4, growth in the July–October period was uniform. The research shows a uniform growth pattern in the July–October period. The total growth was about 1 cm, or approximately 0.25 cm per month. From October to January the growth slowed to a total of 0.3 cm. The growth intensity increased again in January, with a total of 0.5 cm. Therefore, the total growth for the entire eight–month (July–March) period was 1.9 cm. Oyster growth depends on a number of factors, but primarily on abundance of food (plankton) and temperature. As this research shows, the highest growth rate occurs during the summer months, when the temperatures suitable for plankton communities are the highest. Salinity also plays a significant role in the growth of oysters, but they are much more resistant to the salinity fluctuations than mussels, which are also farmed in the area (Stjepčević, 1974, Glamuzina, 2006, Marušić *et.al.,* 2010). The reduced growth during autumn months was mostly due to the high amounts of rainfall and increased freshwater influx. The autumn of 2010 had a high amount of rainfall, and the oysters had to be lowered deeper underwater to a depth of 7 m because of the low salinity levels (6.1‰) at the surface. The extremely low salinity values and low temperatures can cause negative growth, when the shell is forced to use its reserves for vital physiological processes. Glamuzina (2006) reported similar results from the Mali Ston Bay, where the total growth reported was 1.1 cm for the June–October period. He also reported a drop in growth rate, which was just 0.6 cm for the November–April period. This indicated similar hydrographical parameter changes in the Bays of Kotor and Mali Ston.

The mortality values were somewhat higher in July (15%), right before the seeding of the spat, probably caused by transport shock and subsequent acclimatisation to the conditions in the Kotor bay. The mortality later decreased, and was estimated at 7.5% in August and 0% in the September–March period. Higher mortality rate was avoided by lowering the oysters to greater depths during the rainy season and the reduced salinity caused by freshwater influx. In spring, oysters were exposed to gilthead seabream (*Sparus aurata*) predation, which can crush oyster's shell in order to get to the meat inside. This problem can be reduced by setting a protective net around the oyster beds, although nothing can guarantee a 100% protection.

The visual check–ups for the growth on shells determined that various organisms from the classes *Ascidiacea* and *Bryozoa*, *Polychaeta, Bivalvia* and various algae (*Phaeophyta* and *Rhodophyta*) can cause fouling of the oyster shells. This presents a problem as the presence of these organisms causes reduction in the available food for the oysters, and can reflect negatively on the growth of the shells.

CONCLUSIONS

Based on this preliminary research and comparisons with the earlier research done in the Kotor Bay, as well as the data from the Bay of Mali Ston, it can be said that hydrographical and biological conditions of the Kotor Bay offer extraordinary opportunities for oyster farming. The European flat oyster is highly priced, and along with the Mediterranean mussel could be considered a gastronomical part of the eco– and ethno–tourism, and could, in our humble opinion, play a significant role in the economy of Montenegro, as well as become a true Montenegrin brand in time. Of course, along with the great enthusiasm of the founders of this project, it is necessary to have the help of the Ministry of agriculture and rural development and the local authorities, who would have to recognise the importance and sustainability of the project.

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