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Effect of Different Rearing Systems on Survival Rate of Hatchery Reared Black Sea Turbot, *Scophthalmus maximus*

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Abstract

Rearing experiments were carried out to examine the effect of different rearing systems on survival of hatchery reared Black Sea turbot, Scophthalmus maximus. The larvae were reared under natural light regime from hatching until 20 days old. Three groups were set as follows: Group I: continuously exchanged sea water (open-system), group II: stagnant seawater treated with 10 ppm EDTA, group III: stagnant seawater. The feeding regime consisted of Nannochloropsis, Brachionus and Artemia. From initial total length of 3.44±0.07 mm on day 0, larvae grew to 8.30±0.39 (group I), 8.45±0.56 (group II) and 8.51±0.50 mm (group III) on day 20. Survival rates were 21.1, 15.3 and 9.1% in group I, II, III, respectively.

Key Words: Turbot, *Scophthalmus maximus*, growth, survival rate, larval rearing.

Introduction

Turbot, *Scophthalmus maximus*, is a marine flatfish distributed along the seashore in Europe, Black Sea and Azov Sea, whose significance for farming has greatly increased during last decade. In 1986, commercial farms in Europe produced less than 1,000 tonnes of Atlantic turbot (Paulsen, 1989), but total production reached to 5,500 tonnes in 2000 (Person-Le Ruyet, 2002).

In Turkey, Black Sea turbot is a popular species for commercial fishing. As in many species, the population of this fish has declined to the point that severe restrictions on the allowed catch have been put in place. These restrictions may make both commercial aquaculture and stock enhancement economically attractive. Either of these ventures would benefit from increased efficiency in production of juvenile fish.

Black Sea turbot was selected in the 1990's as the most suitable marine fish species for farming in the Black Sea region of Turkey, based on its high value, good market demand and perceived rapid growth characteristics in suitable water conditions (Çelikkale *et al*.,1998), and thus experimental studies on intensive culture of Black Sea turbot began in 1998. However, high mortality have been encountered during early stages of Black Sea turbot, and difficulties in rearing early stage larvae have delayed the development of mass production (Şahin, 2001).

Larval growth and survival in fish culture are two fundamental variables. However, their predictability and variability are still not solved due to scarce of research on the topics for the Black Sea turbot.

In the present study, in order to find the cause of heavy mortality and to establish a stable rearing technique for Black Sea turbot, the effects of different seawater treatments on early stage growth and mortality in hatchery-reared Black Sea turbot were examined.

Materials and Methods

Eggs from one female turbot were fertilized with the pooled sperm from two males on April 30, 1999. After hatching, the larvae were transferred to 0.5 m^3 circular polyethylene indoor tanks at a density of around 5 larvae/l at Trabzon Central Fisheries Research Institute. The larvae were reared under natural light regime of Trabzon (40°57'30" N, 39°51'42" E) from hatching until 20 days old. Three groups were set as follows: Group I: continuously exchanged sea water (open-system), group II: stagnant seawater treated with 10 ppm EDTA, group III: stagnant seawater. The group I and group III were set in triplicate, but the group II was set in four replicates. The seawater used in the hatchery is pre-treated by using sand filter and UV sterilization system. Each tank was moderately aerated. During the experimental period from day 0 to day 4, the water in the group I was exchanged at a rate of 50%/day and the water exchange rate was increased to 100%/day on day 5. The larvae in the other two groups were maintained in stagnant water until day 3, and then the rearing water was partially changed daily by using 300 µm mesh drainers at a rate of 0.1-0.3 turnovers/day at 5 day intervals, increasing to a final rate of 1 turnover/day and then slowly replaced with

preserved sea water. In group II, EDTA was added to the preserved water. Debris, faeces and dead fish were siphoned off every day. The water temperature in each experimental tank was kept at 16°C using a 2 kW heater.

The microalga *Nannochloropsis* sp. was introduced in the larval rearing tanks on day 1. The algal cell density was maintained at 5-10x10^5 cells/ml from day 1 to day 20. The L-type rotifers were introduced on day 4 when the larvae partly absorbed their yolk in the group I, and on day 2 in the group II and group III. The rotifer density in the larval rearing tanks was maintained at 3-5 rotifers/ml (group I), and 10 rotifers/ml (group II and III). From day 13 onwards, newly hatched *Artemia* nauplii were introduced in the tanks at a rate of 0.5 ind/ml.

The water quality in the larval rearing tanks, particularly the dissolved oxygen, pH, and seawater temperature were monitored regularly twice a day to maintain the larval tanks in good condition and to determine the water exchange required during the experimental period.

Total lengths of 0, 5, 10 and 20 days old larvae were recorded to compare growth among the different treatments (30 larvae were measured per tanks). The number of survival larvae was monitored on day 0, 5, 10, 15 and on day 20 by counting the larvae in five water samples taken from different sections of the tank using 500 ml beaker.

The statistical analysis was conducted using one-way ANOVA and Tukey test for multiple comparison of means (Sokal and Rohlf, 1981). Data from replicate groups were pooled for each treatment prior to analysis.

Results

Water quality parameters such as seawater temperature, pH and dissolved oxygen are given in Table 1.

As seen in Table 1, water quality parameters were fairly constant during the experimental period and mean sea water temperature, pH and dissolved oxygen were observed around 16°C, 8.2 and 7.0 mg/l, respectively.

Survival rates varied from 19.8 to 22.4% with a mean of 21.2±1.32% in group I, from 14.3 to 16.2% with a mean of 15.3±0.84% in group II and from 8.6 to 9.6% with a mean of 9.1±0.50% in group III. The mean survival rate at day 20 was higher in group I than group II and group III (Fig. 1). Differences were statistically significant ($p<0.05$).

The mean total length (± SD) at the start of the experiment was 3.44±0.07 mm. Larvae grew to 8.30±0.39 mm in group I, to 8.45±0.56 and 8.51±0.50 mm in group II and group III on day 20 (Fig. 2). At the end of the experiment, larvae reared at the group I were smaller than those reared at group II and group III, but differences were not statistically significant.

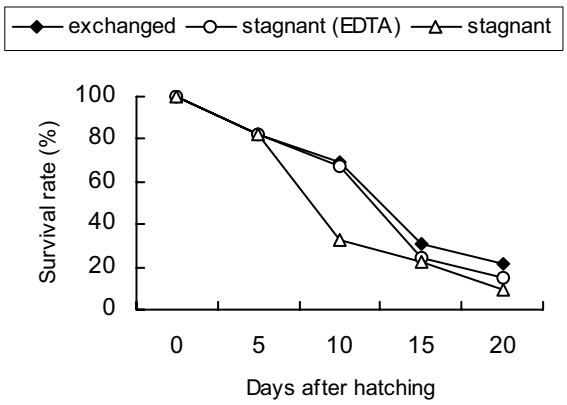

Figure 1. Survival rate of *Scophthalmus maximus* during experimental period.

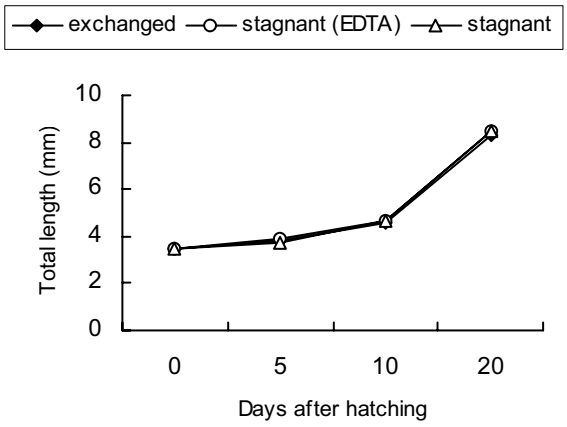

Figure 2. Growth in length *Scophthalmus maximus* larvae during experimental period.

Table 1. Water quality parameters during experimental period (SD, standard deviation).

Group	Temperature (°C)			pH			Dissolved oxygen(mg/l)		
	min	max	mean±SD	min	max	mean±SD	min	max	mean±SD
I	14.1	18.5	16.1±1.117	8.14	8.64	8.32±0.149	6.4	8.6	7.6±0.528
II	13.8	18.8	16.3±1.029	7.88	8.62	8.20±0.194	5.6	8.6	7.2±0.717
III	13.7	18.6	16.2±1.257	7.93	8.63	8.29±0.314	5.6	8.4	7.0±0.647

Discussion

Fish larvae can be reared under stagnant or open-system conditions. Generally, partial water exchange method is adopted, and microalgae are supplied to the rearing tanks during the initial stages of culture. In this study, both of the two types of larval rearing systems were applied.

From an economical point of view, the main variables in larval rearing are survival and growth. Growth rates were not significantly affected by different rearing systems, although the rate tended to be small in the open-system, group I. This results would be caused by the larvae in group I expending more energy to keep position under the open-system.

The stagnant water affected the survival negatively. Significant differences on survival between larvae in the three treatments were noted after only 5 days. Survival was the highest in larvae of group I, followed by those of group II. The lowest survival rate was recorded in the larvae of group III. The growth and survival of fish larvae can be affected by the type of microalgae used. However, according to Støttrup *et al*. (1995), interactions between algae and bacteria in the larval rearing tanks might be more important than the nutritional value of the algae. Dead or dying algae would increase the bacterial substrate. During the first three days in the group II and group III, seawater was kept stagnant, then partially changed at low rates. Low exchange rates of water may affect the retention time of prey in the larval tanks, and changes of biochemical composition of the prey may occur before being consumed by the larvae (Reitan *et al*., 1993); therefore, the larvae would ingest nutritionally deficient food. It has been reported that the microflora associated the food chain are detrimental to the larvae (Muroga *et al*., 1987; Pérez-Benavente and Gatesoupe, 1988; Nicolás *et al*., 1989; Gatesoupe, 1991). Both microalgae and live food have a high bacterial load which may cause some infections and heavy mortality.

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