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EFFECTS OF DIFFERENT REARING ENVIRONMENTS ON THE MORTALITY OF ATLANTIC SALMON BROODSTOCK AND EGGS.

Yngve Ulgenes, Ole J. Torrissen and Tom Hansen.

Matre Aquaculture Station
Institute of Marine Research
Directorate of Fisheries
N-5198 Matredal
Norway

ABSTRACT.

Atlantic salmon (Salmo salar) reared for three years in seawater were moved to brackish- and freshwater before they matured. A control group matured in seawater. The groups were given different feeding regimes the last months before maturation. Mortality of maturing and stripped broodfish was lower in both the brackish and freshwater than that in seawater.

Eggs stripped from fresh- or brackish water showed significant lower mortalities to the eyed stage than eggs stripped from seawater. There was no significant differences in mortality to the eyed stage between groups of eggs stripped from brackish and fresh water.

Starvation of Atlantic salmon broodstock four months prior to spawning did not seem to adversely affect egg quality.

INTRODUCTION.

Following a heavy increase in the demand for eggs in the salmon farming industry the use of reared broodstock to produce eggs has become a necessity.

Eggs from reared Atlantic salmon brood most often show much higher mortality during incubation than eggs from wild broods.

The hereditability of mortality of eggs from fertilization to the eyed stage is reported to be rather low (Kanis et al. 1976) and therefore genetic factors are supposed to be of minor importance causing this situation.
Most of the interest is concentrated on environmental factors and husbandry. Springate and Bromage (1984) claimed that fish husbandry and factors altering the composition and size of eggs are most likely to determine the egg quality. It has been shown that survival of eggs to hatch is dependent upon nutritional factors as shown for the content of micronutrients in the eggs (Hirao et al. 1955, Takeuchi et al. 1981, Sandnes et al. 1984).

Since the Atlantic salmon is an anadromous species it has been suggested that the usual practice of holding salmon broodstock in seawater until maturity might be detrimental to egg quality. At present in the commercial salmon farming it has become more common to transfer the salmon broodstock to lower salinities (brackish or fresh water) before maturation (Ulgenes and Naevdal, 1984).

The aim of this experiment was to investigate the effcts of keeping Atlantic salmon broodstock under different salinities and feeding regimes on the mortality of broodfish and eggs during incubation.

MATERIAL AND METHODS.

Atlantic salmon (Salmo salar) were held in seawater netpens, 10 metres in diameter , at Austevoll Aquaculture Station from the smolt stage until maturation, a period of three years. At this time the weight of the fish ranged from 6 to 20 kilos. During their growth period the last two years the fish were given a moist pellet feed mainly made of sprat, capelin, herring meal and prawn shells (offal from the prawn processing industry), and fortified with vitamins and minerals. The seawater salinity at this localization is quite stable at approximately 30 ppt.

In May of the year of maturation, the broodstock was separated from harvested fish. The broodstock population was later in the summer divided into four groups by separate transports to three other locations (see Figure 1). The control group was not moved from the seawater netpens.

In the middle of July the first group of 90 fish were transported about 100 kilometers by boat from Austevoll to the Matre Aquaculture Station. In Matre 38 fish were put in netpens 8 metres in diameter in typically brackish water with surface salinities below 15 ppt most of the year. The fish held in these netpens were fed the moist pellet feed described above from the middle of July to the beginning of September when the eating ceased. The remaining 52 fish were put in two concrete dams 10 meter in diameter supplied with brackish water (15 ppt) at a flow rate of approximately 1 litre per kg fish per minute. These broodfish stopped eating after they were put in these dams.

In the middle of October two weeks afer all broodfish had stopped eating, a second group of 125 fish were shipped from Austevoll to Matre. 54 of these fish were placed in the netpens and 71 were placed in the concrete dams. After this last transport the water supplied to the dams was gradually changed from brackish to fresh water during a period of a week.

Concurrent with the last transport to Matre, 136 broodfish were put into two ashore 7 meter diameter plastic tanks at the Austevoll Aquaculture Station. These tanks were supplied only with fresh water, the fish having been acclimatized to lower salinities by brackish water seven days prior to moving.

After this last transport 73 broodfish remained at the Austevoll Aquaculture Station.

The fish matured in the beginning of November and mature males and females, anesthetized with benzocaine, were stripspawned once a week. Eggs from fish stripped in Austevoll were fertilized and swelled for 2 hrs before transport to the hatchery in Matre, a 4 hour ride by car.
Eggs stripped in Matre were fertilized and immediately put into the hatching units without swelling.

Egg groups from individual fish were incubated in 40 x 40 cm hatching units (Ewos no 2003). During incubation the eggs were treated three times a week with malachite green. No dead eggs were removed from fertilization to the eyed egg stage. At the eyed egg stage dead and living eggs were counted in an egg sorting machine.

RESULTS.

Table 1 shows the percentage mortality of broodfish at the different locations. The fish transported to Matre were lifted out of the boat by a hydraulic lifted dipnet. An accident caused a breakage fo this dipnet with the result that the fish fell on the deck. This was probably the reason for the death of 8 broodfish in Matre the day after the transport as included in the mortality figures in Table 1 at the brackish water locality. No other fish died immediately after transport. Apart from this accident the total mortality of broodfish during the experiment

was relatively low at the two localities in Matre, with 10.5 % and 17.4 % in the concrete dams and netpens respectively. It appears that most of the mortality in Matre came before stripping and that only a minor part died after stripping.

In Austevoll the mortality after stripping was higher than in Matre at both the freshwater and the seawater locations, being 34 and 33 % respectively. Mortality before stripping was highest in seawater with 30.1 % while that in fresh-water was relatively low at only 3.7 % (Table 1).

Stripping of broodfish was conducted from October 26. to December 15. and the maturing process seemed to be normal. There was some indication that fish stripped from fresh water matured earlier than fish stripped from seawater but the time difference was not clear.

Eggs stripped from fish maturing in fresh- or brackish water did not show any great mortalities (Fig. 2) and the two groups were not significantly different (Table 2). The average mortalities from green to the eyed stage of eggs stripped from the freshwater locations were 10.4 % and 11.5 %, while the average mortality of eggs stripped from brackish water was slightly higher at 21.1 % (Fig. 2). There was no significant difference in mortality between these three groups (Table 2). Conversely the average mortality to the eyed stage of the eggs stripped from seawater was 47.5 % (Fig. 2) and had a significant higher mortality than all other groups (Table 2).

The fish from the first transport to Matre that were placed in concrete dams were not given any feed from the middle of July until stripping in November, a period of four months. The fish from the second transport placed in these dams were fed at Austevoll until transport in the middle of October and were starved for only one month before stripping. Comparing the eggs originating from these two categories of broodfish there was no significant difference in mortalities to the eyed stage(P=0,05).

The fish from the first transport which was placed in netpens at the brackish water locality in Matre were fed the moist feed until three weeks before the second transport from Austevoll. Comparing eggs from this group of fish with eggs from the fish placed in the netpens in October there was no significant difference in mortality to the eyed stage (P=0,05).

DISCUSSION.

This study seems to have revealed some interesting features concerning salmon broodstock maturation. The transport from Austevoll to Matre was considered to be hazardous and cause severe handling stress on the heavy broodfish. However apart from the accident mentioned (dipnet breakage) there was no mortality which clearly could be caused by rough handling of the groups brought to Matre.

In Austevoll the mortalities at both locations were higher than in Matre. It is possible that the fish placed in the fresh water tanks were moved back to seawater too early after stripping and therefore showed higher mortalities (Table 1).

The total mortality of broodstock from fresh- and brackish water in Matre was 10.5 % and 17.4 % respectively. This is low compared to that reported from several commercial fish farms where an average mortality exceeding 30 % is to be expected (Ulgenes and Naevdal, 1984).

In the seawater location prespawning mortality was relatively high compared to the other localities. High prespawning mortality is also reported for Pacific salmon species (Kerns, 1980). From the data on fresh- and brackish water in this experiment it seems probable that Atlantic salmon is not bound to die after spawning like the Pacific species (Childerhose and Trim, 1979). This might also imply that the prespawning

mortalities experienced were a result of stress caused by the environment.

During maturation a number of physiological changes, including hormonal, most probably affect osmoregulation in the salmon. As suggested by Gall (1980) the salinity regime at maturity is critical for hydration and normal development of the eggs and sperm. Allee (1980) reported a relationship between high osmolality of blood serum and high mortality of broodfish held in seawater to maturity. We do not know if high blood osmolality might explain some of our mortality figures from the seawater location but further experiments are in progress to investigate this.

Higher mortality of eggs stripped from seawater compared to that from fresh- or brackish water was also found in a similar study by Kittelsen (1983). The reason for higher mortality from seawater is somewhat diffcult to explain. Allee (1980) found no relationship between freshwater and seawater egg fertility but the survival of eggs to the eyed stage was lower from seawater than from freshwater, parallel to our findings.

In our study the eggs stripped from fresh and seawater in Austevoll were transported by car for 4 hours. It is possible that eggs stripped from a high salinity regime are less tolerant than eggs from freshwater to disturbance during transport. This will be further studied this season.

Ridelman et al.(1984) reported that starvation of rainbow trout for 40 days before spawning did not adversely affect egg viability. In our study there seemed to be no effect of starving the salmon four months from July to November on the survival of eggs. It is therefore probable that the nutritional status of the fish was adequate for egg formation already from midsummer. This might imply that feeding of salmon broodstock the few months ahead of spawning is of no use for the fish for making viable eggs and that this practice merely is an economic waste

for the farmer. However starvation might cause negative effect on the fecundity as reported for rainbow trout (Scott,1962) and this must be further investigated for Atlantic salmon.

As a conclusion egg quality concerning survival to the eyed stage seem to be influenced by water salinity to the broodstock with higher survival of eggs stripped from brackish or fresh water.
Starvation of salmon brood for 4 months prior to spawning does not seem to adversely affect egg viability.

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Table 1. Mortality of brodfish at the different locations.

	Dead before stripping.	Dead after stripping.	Total.
Matre, concrete dams.	9 (7.3 %)	4 (3.3 %)	13 (10.5 %)
Matre, netpens.	12 (13.0 %)	4 (4.3 %)	16 (17.4 %)
Austevoll, plastic tanks	5 (3.7 %)	34 (25.0 %)	39 (28.7 %)
Austevoll, netpens.	22 (30.1 %)	33 (45.2 %)	55 (75.3 %)

Table 2. t-Test for significance of difference in mortality to the eyed stage of eggs stripped from the concrete dams in Matre (MD), the netpens in Matre (MN), the plastic tanks in Austevoll (AP) and the netpens in Austevoll (AN).
NS = not significant, | = significant.
p = 0.05

	MD	MN	AP	AN
MD	-	NS	NS	|
MN		-	NS	|
AP			-	|

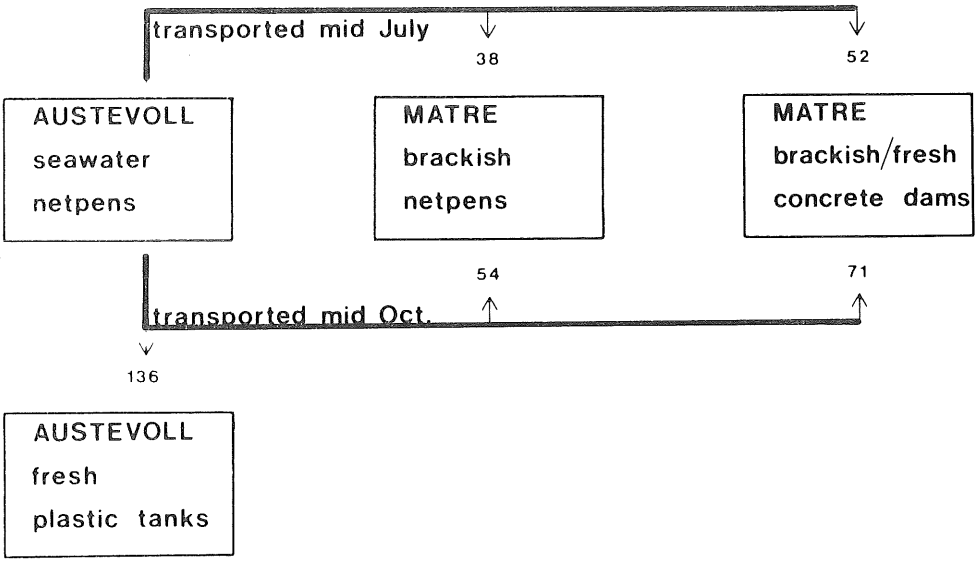

Figure 1. The distribution of broodfish in the experiment. Time of transport and number of fish transported are indicated by arrows.

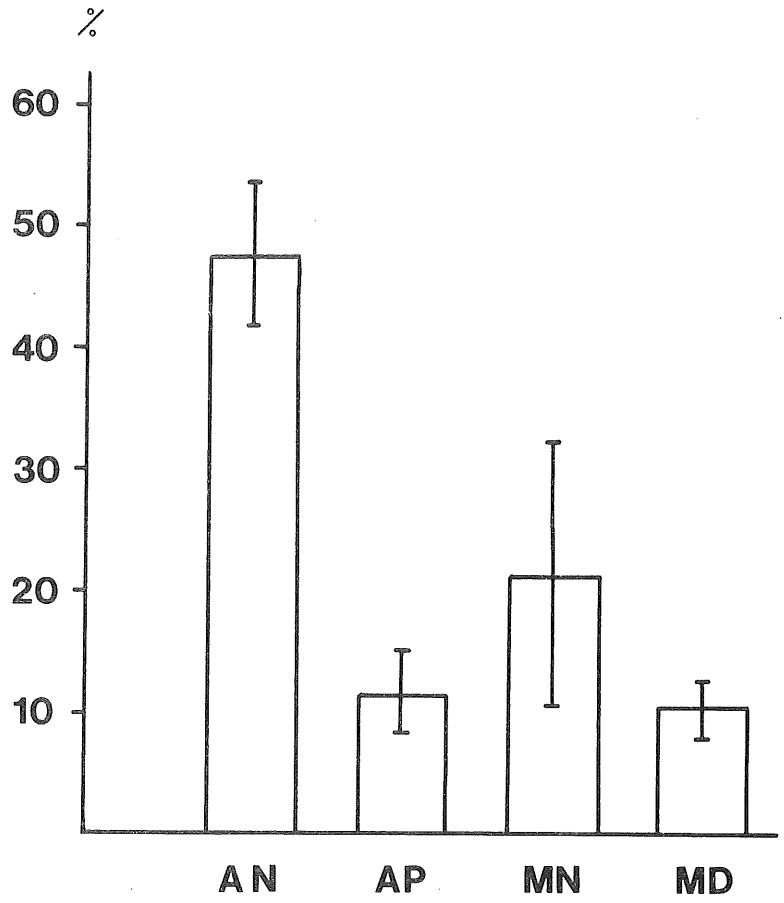

Figure 2. The mortality of eggs from fertilization to the eyed stage.
AN = seawater netpens in Austevoll,
AP = freshwater plastic tanks in Austevoll,
MN = brackish water netpens in Matre,
MD = brackish- / freshwater concrete dams in Matre.
Averages +/- 95% confidence interval.