FAMILY AND PLOIDY EFFECTS ON LARVAE SURVIVAL, DEFORMITIES AND PERFORMANCE IN ATLANTIC SALMON

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The Atlantic salmon (*Salmo salar*) farming industry is under increasing pressure to negate the impact that escapees have, particularly potential inbreeding between wild and farmed stocks. Furthermore, greater public awareness and the need to protect natural resources require the development and implementation of new or alternative environmental regulations and operating standards. One option is the production of sterile stocks by triploid induction. Triploidy is not a new concept, originally tested in the early 1990's as a means to avoid maturation. Unfortunately, poor performance, higher mortalities and deformities led to the industry abandoning triploidy in favour of photoperiod control of maturation prior to harvest. However, although photoperiod does reduce maturation in culture, farmed stocks remain reproductively competent and the threat of genetic pollution following escapes persists. Triploid induction is the only present method that can produce sterile fish. Furthermore, significant advances in selective breeding, husbandry, diet formulation, operating procedures, and an overall greater knowledge of salmon physiology in recent times suggest that some of the problems previously associated with triploidy may no longer be an issue and hence the industry is now keen to explore this option again.

Given theses advances we established a series of experiments as part of the EC FP7 "Salmotrip" project to examine the interaction of family and ploidy on survival, deformity prevalence and growth performance from egg to smolt in Atlantic salmon. In two year classes (2007, 2008) 10 full-sib experimental families were created. Family egg batches were divided in two at fertilisation with one group subjected to a hydrostatic pressure shock of 9500PSI for 5min 300degree minutes post-fertilisation to induce triploidy. A third trial produced 90 full-sib families for commercial field trialling using the same protocol. In the 2007 year class on stock-out in 2008, parr were subjected to one of two photoperiod regimes to produce S1+ or S0+ smolts respectively. The 2008 year class were monitored from egg to pre-smolt regimes of the summer 2009. A series of trials were also conducted in Norway to examine triploid performance under sub-optimal conditions. In all trials, during egg incubation, hatchery and smolt grow-out, mortality, growth, gill ATPase activity, deformity prevalence

and triploid yield were recorded and the interaction between ploidy and family examined.

In most year classes survival to hatch did not differ between ploidy but was significantly affected by family. However, reduced family survival was found to strongly correlate with gamete quality. At hatch, measurement of nuclear RBC length confirmed 100% triploid induction success rate in all fish examined.

During the hatchery phase ploidy significantly affected size at hatch (530°DD), with diploids generally larger than triploids. A significant effect between family on weight was also evident. Weight advantage of diploids over triploids was only maintained for 6 weeks post-first feeding. Deformity prevalence in first feeding stages was generally low (mean <2%), with no overall effect of ploidy, but there was a significant family effect on occurrence of deformity (0.5% to 4% range).

During freshwater grow out to smolting, significant family effects on size were maintained irrespective of ploidy. Unlike the hatchery phase the growth advantage diploids had over triploids was reversed. Within 2 months triploids were significantly heavier than diploids and this was maintained from the onset of smolt regimes throughout grow-out in both S0+ and S1+ populations. Importantly, production of S0+ triploid smolts is reported for the first time. ATPase activity and completion of smoltification was affected by time and ploidy in S0+ populations, but not in S1+. This correlated strongly with fish size at onset of smolt regimes and subsequent growth performance. Deformity prevalence in freshwater was generally low <2%.

Our findings show that with correct broodstock selection triploid salmon can perform as well if not better than their diploid siblings. The low incidence of deformity during the hatchery and freshwater phases is a significant improvement over previous reports in triploid salmon stocks. However, long-term sea monitoring will be required to determine whether previously reported deformities are a function of the change in environment or are genetically borne. It will also be important to determine if families that perform well in freshwater stages perform as well during saltwater grow out. Such knowledge will aid in improving selective breeding programs. Furthermore, out-of-season triploid smolts can be successfully produced without any of the poor performance reported in previous trials. Our results show important criteria to consider when manipulating smoltification time in triploid salmon. Overall, our results provide promising knowledge for the salmon industry as they indicate year round production of salmon can be maintained and genetic/ecological threats reduced through the potential adoption of triploid salmon.