Egg incubation temperature as a causal factor for malformations in rainbow trout

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Background and objective

Previous studies on effects of embryonic temperatures in Atlantic salmon and rainbow trout has shown that temperatures outside the optimum of the species can:

- ✓induce skeletal deformities
  - •fused or compressed vertebrae
  - •deformed skull
- ✓induce soft tissue deformities or deviations
  - •aplasia of septum transversum
  - •inverted abdominal organs
  - •reduced number of pyloric cacea

These studies were done with Norwegian eggs. Are the results valid also for other geographic strains?

Aim of the study

The present study aimed to investigate temperature tolerance of rainbow trout eggs of different geographic origins (north-south).

The temperature tolerance of triploids versus diploids was also addressed.

Effect parameters:
- •Survival
- •Growth
- •Skeletal deformities
- •Soft tissue deformities

Experimental setup

Pooled egg groups originating from 3 different genetic strains (1, 2 and 3) were fertilized and transported to Nofima, Norway in March 2007.

After fertilisation, half of the eggs originating from strain 2 were pressure treated to produce 3n individuals

The eggs were incubated in triplicates in small, insulated units equipped with individual inlets and outlets at 6, 10 and 14ºC from fertilization to first feeding

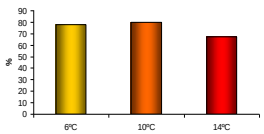
At first feeding two out of the three replicates were transferred to duplicate150 l tanks and reared at 12ºC

The experiment was terminated at approx. 40 g fish size

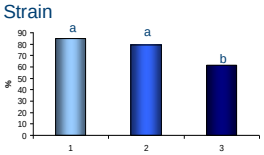
Experimental units for egg incubation

Survival from hatching to first feeding

Temperature

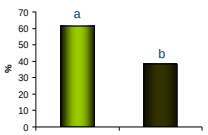


Strain



Ploidity

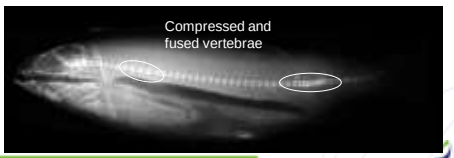
Diploid vs. Triploid, Strain 3



Examples of deformed vertebrae

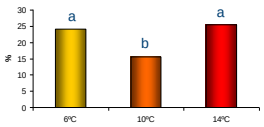
a. Rainbow trout with a normal vertebral column

b. Severely compression of the vertebral column in the caudal area



Fish with vertebral deformities

Temperature



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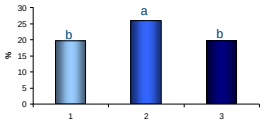

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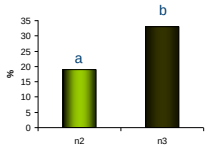
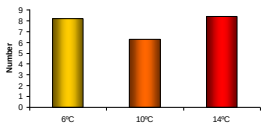
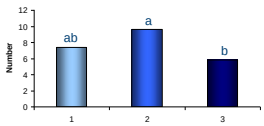


Number of deviant vertebrae per affected fish

Temperature



Strain



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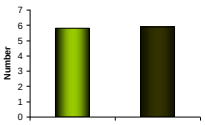
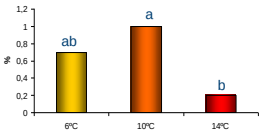
Diploid vs. Triploid, Strain 3



Fish with ”ghost” vertebrae

Temperature



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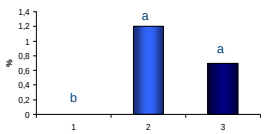

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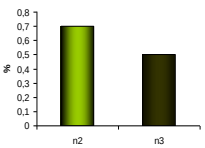


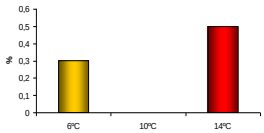
Examples of malformed skull or snoute

Short snote

Missing forehead

Fish with malformed snout/forehead

Temperature



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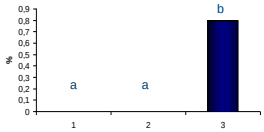

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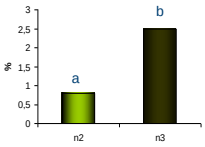
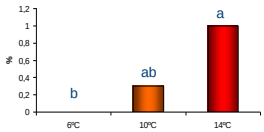


Example of twins

Incidence of fish with twins

Temperature



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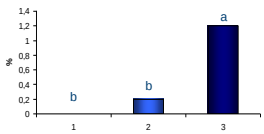

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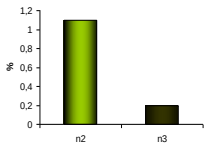
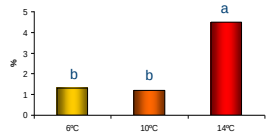


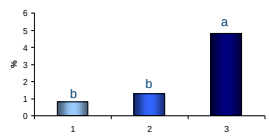
Example of swim bladder torsion

Fish with malformed swimbladder

Temperature



Strain



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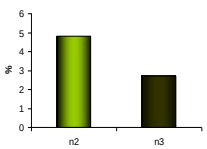
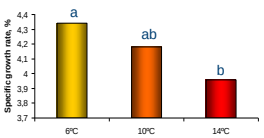
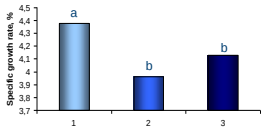


Specific growth rate, SGR (%)

Temperature



Strain



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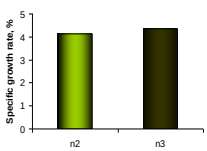
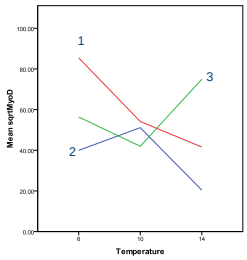


MyoD expression

The RVC (Prof. Neil Stickland) investigated the levels of MyoD gene expression in rainbow trout at first feeding.

It was hypothesised that each incubation temperature would result in a different optimal expression of MyoD from each strain dependant on the latitude of the strain's origin.

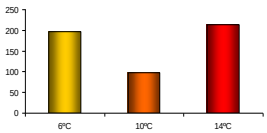
MyoD expression at first feeding



Severity index

(%fish with malformed vertebrae * # affected vertebrae)

Temperature



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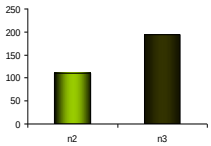
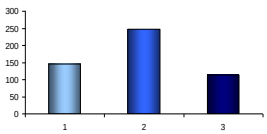


Strain



Conclusions/recommedations

- Main results:
  - 10ºC is the optimal egg incubation temperature
  - 14ºC is too high and
  - 6ºC is too low for rainbow trout eggs
- Relatively moderate effects on malformation rate between 8ºC and 12ºC (results from previous study)
- Results were basically the same for all strains, with some variation between strains for specific malformations
- There were differences between geographic strains in temperature induced malformations (NB: possible effects of egg group/spawning season)
- There were generally more malformations in the triploid groups compared to diploid groups