Recommendations on prevention of malformations in Rainbow trout

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1. Introduction

For rainbow trout, the recommendations given in the following section are based on results obtained from work made within the FineFish project and some closely related activities.

2. Temperature in early life stages

The effect of temperature exposure on malformations in rainbow trout has so far been studied only in fish exposed to different temperatures during egg incubation and up to the stage of first feeding. In summary, the results confirm the hypothesis that rainbow trout can tolerate temperatures that are somewhat higher than salmon at similar life stages and that the early life stages of rainbow trout, unlike salmon, are vulnerable to low temperatures (< 8°C).

Data from salmon indicate that temperature is an issue for the induction of malformations in salmonids also beyond first feeding,. Similar experiments for rainbow trout are strongly demanded by the profession.

The existing recommendations can be summarised as follows:

- The optimal incubation temperature for rainbow trout eggs is 10°C
- The tolerance range is 8°C to 12 °C, i.e. that no effect or minor effects on malformations are expected when applying temperatures within this range
- Temperatures > 12°C and < 8°C are likely to induce skeletal malformations
- Rainbow trout eggs should not be subjected to cooling regimes during incubation in order to delay hatching
- Temperature sensitivity remains also beyond eyed egg stage
- Temperature recommendations are the same for diploids and triploids

These temperature recommendations are valid for the different geographic strains which have been examined until now

More information on temperature effects during egg incubation can be found in Chapter 3 of this book.. It should be noted that, although rainbow trout eggs are sensitive to long term incubation at low temperatures (< 8°C), wide experience substantiates the observation that the common procedures for transport of eyed eggs on ice are tolerated well.

3. Impact of nutritional components

The impact of nutritional components on development of malformations was addressed in Chapter 5 of this publication. Based on these data, some recommendations can be given:

- The importance of dietary mineral supply for adequate skeletal mineralization is confirmed. Special attention should be paid to the level and availability of phosphorus in the formulation of diets for normal vertebral development during the early ontogeny of rainbow trout.
  The dietary available phosphorus requirement is estimated to be approximately 1% diet for adequate bone mineralization of rainbow trout fry

- For rainbow trout, quite high levels of vitamin A are recommended for broodstock nutrition (around 200 IU/g diet). The supplementation of 20 IU/g diet that is usually used in commercial diets for salmonids might not be enough to fulfil the vitamin A requirement of rainbow trout

- High dietary levels of vitamin A are beneficial for reproduction and early growth and no effect on skeletal development was noticed in comparison to other fish species. This difference might be due to the fact that the level of retinoic acid, the active metabolite of vitamin A, appears to be well controlled in eggs of rainbow trout

- Experimental results suggest that compared to late developmental stages, early stages are more susceptible to dietary oxidative stress, possibly due to lower response of endogenous antioxidant defence system

- The importance of the control of lipid peroxidation in fish feeds for normal growth of rainbow trout fry was highlighted. A correct supply of antioxidants (such as vitamin E or C) should be provided in fish feeds to protect polyunsaturated fatty acids from lipid peroxidation

- The importance of dietary phospholipid supply for early growth and adequate skeletal mineralization has to be highlighted

4. Water quality

Presently, little data on effect of water quality on malformations in rainbow trout is available from scientific studies, and more studies in this field are clearly warranted, both in respect of establishing specific tolerance limits for water quality parameters, and examination of the interactions between different aspects of water quality. Some limited and rough advice can be given, based on a field experiment done in a commercial hatchery.

The study tested the effect of dissolved CO_2 at levels between 3 and 30 mg L^{-1}, and a dose-response relation between CO_2 level and skeletal malformations was indicated during early juvenile rearing.

It is recommended to control the levels of dissolved CO_2 in rearing water for juvenile rainbow trout. Until further data are presented, it is suggested to use the corresponding limit in Atlantic salmon as a guideline, which is to maintain dissolved CO_2 <15 mg $L^{-1.}$

Figure 1 : Rainbow trout (approximately 50g wt.) with severe shortening of the body (top) caused by fusions of vertebrae, compared to normal (bottom)

Field trials made with different products and procedures for the disinfection of eggs indicate similarly that disinfection has a potential impact on malformation rate.

It was also noted during the project that the use of chemicals in rainbow trout hatcheries is widespread. Thus, the prophylactic control of microbes and parasites as well as therapeutic agents and procedures should be subject to further studies.

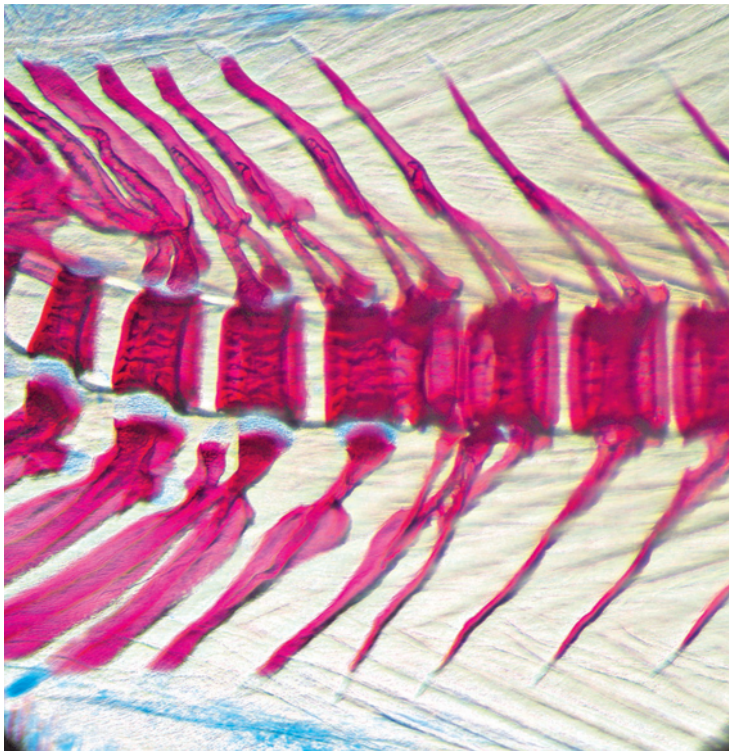

Figure 2 : Vertebrae in rainbow trout juvenile (approximately 1g), showing three vertebrae in the process of fusion. The fish was reared at 17^{o}C from first feeding and onwards.