How does different photoperiods from fertilization to start feeding effect smoltification in Atlantic salmon?

Background

Atlantic salmon has an anadromous lifestyle with migration between fresh- and saltwater environments at different stages in the lifecycle. This requires changes in physiology, morphology and behavior. The preparatory changes of these traits prior to entering the marine environment is known as **smoltification.**

Atlantic salmon smoltify during spring in accordance with a natural increase in the photoperiod. Manipulation of the photoperiod is commonly used in cultivation of salmon which enable a season-independent production of smolt.

The aim of this study was to examine if light exposure during early development would affect the consecutive smoltification. The focus in the present work were development seawater tolerance measured as an increase in Na-K-ATPase [NKA] enzyme activity. The development of seawater tolerance is controlled by hormones, which are under control of light.

Experimental design

From fertilization until start feeding the eggs were distributed and exposed to three different light regimes; constant white light (LL), light/dark white light (LDw) or absolute dark (DD) (figure 1). From start feeding and until the winter signal were given (12.12.18) the light regime were LDw = 20:4 for all groups. After winter signal the photoperiod was switched to continuous light (LL = 24:0). Gill tissue and blood sample were retrieved from 54 randomly selected salmons, at four different stages in the development to keep track on the smoltification process. Blood were obtained from the caudal vessel posterior to the anal fin. Weight and length were also measured for calculation of Fulton's condition factor. The NKA-enzyme activity were measured according to the microassay method by McCormick.

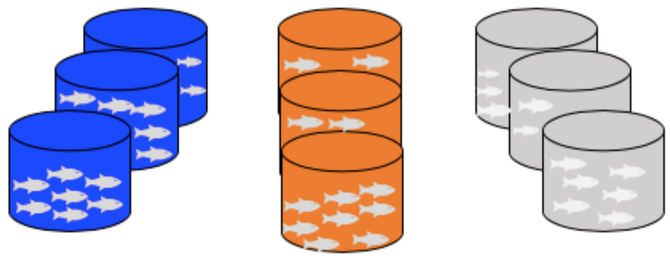

Figure 1: Illustration of the nine different tanks, accordring to light treatment.
Blue indicates absolute dark, orange constant white light and grey is the light/dark regime.

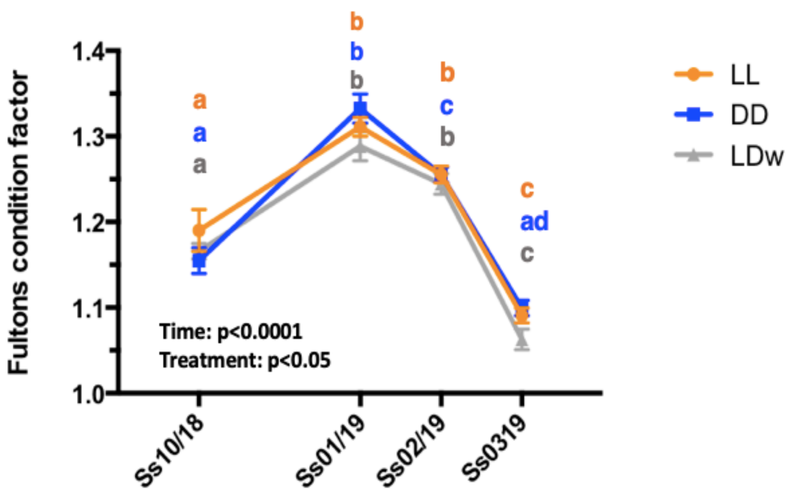

Figure 2: Shows mean condition factor and standard error of means (sem) in freshwater juvenile Atlantic salmon (*Salmo salar*) parr and smolts sampled on October 10 (Ss10/18), January 20 (Ss01/19), February 12 (Ss02/19) and March 12 (Ss03/19). N = 18 for each group. Total N=216. The different light regimes from fertilization to start feed are as follows; total darkness (DD), constant white light (LL) (Medium Intensity 0.1W/m^2), light/dark white light (LDw) (Medium Intensity 0.1W/m^2). All groups were kept at LDw =20:4 from startfeeding (February 2018), until December 12. Then it changed to 12 hours light and 12 hours darkness for 6 weeks, followed by 6 weeks 24 hours light. Different letters indicate differences between timepoints within each treatment (two-way ANOVA, Bonferroni's adjusted post-hoc test).

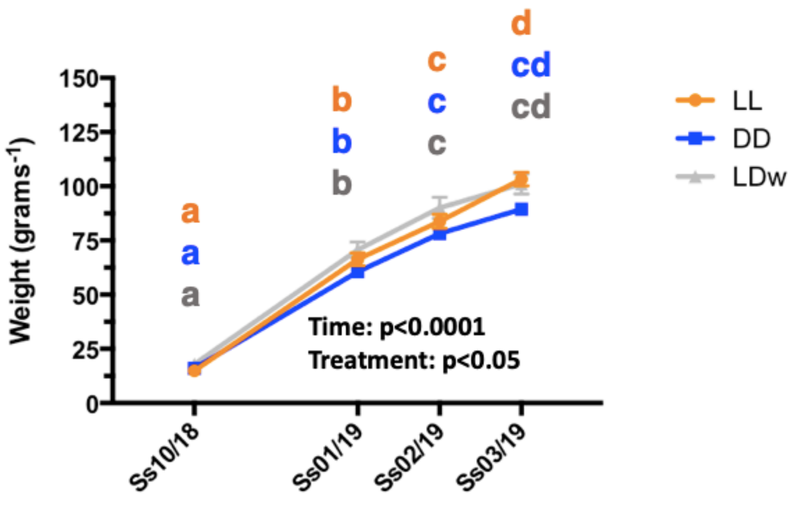

Figure 3: Shows mean weight (grams^{-1}) and standard error of means (sem) in freshwater juvenile Atlantic salmon (Salmo salar) parr and smolts sampled on October 10 (Ss10/18), January 20 (Ss01/19), February 12 (Ss02/19) and March 12 (Ss03/19). N = 18 for each group. Total N=216. The different light regimes from fertilization to start feed are as follows; total darkness (DD), constant white light (LL) (Medium Intensity 0.1W/m^2), light/dark white light (LDw) (Medium Intensity 0.1W/m^2). All groups were kept at LDw =20:4 from startfeeding (February 2018), until December 12. Then it changed to 12 hours light and 12 hours darkness for 6 weeks, followed by 6 weeks 24 hours light. Different letters indicate differences between timepoints within each treatment (two-way ANOVA, Bonferroni's adjusted post-hoc test).

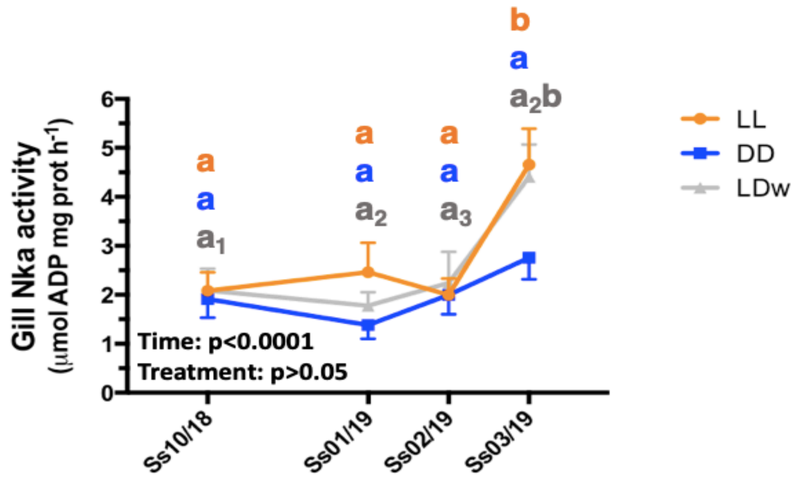

Figure 4: Shows mean gill NKA activity and standard error of means (sem) in freshwater juvenile Atlantic salmon (*Salmo salar*) parr and smolts sampled on October 10 (Ss10/18), January 20 (Ss01/19), February 12 (Ss02/19) and March 12 (Ss03/19). N =14-18 for each group. Total N=204. The different light regimes from fertilization to start feed are as follows; total darkness (DD), constant white light (LL) (Medium Intensity 0.1W/m^2), light/dark white light (LDw) (Medium Intensity 0.1W/m^2). All groups were kept at LDw =20:4 from startfeeding (February 2018), until December 12. Then it changed to 12 hours light and 12 hours darkness for 6 weeks, followed by 6 weeks 24 hours light. Different letters indicate differences between timepoints within each treatment (two-way ANOVA, Bonferroni's adjusted post-hoc test).

Results and conclusion

Condition factor has increase from first to second sampling, followed by a steep decrease (figure 2). There is a significant weight gain throughout of the study. There are a substantial weigh difference between the absolute dark group and those exposed to light (figure 3). The gill NKA activity were highest in the groups exposed to light (LL/LDw) (figure 4).

The parr-smolt transformation is a highly complex process. The results in this study, regarding weight, condition factor and NKA activity indicate that light treatment during early development could effect the downstream processes, such as smoltification. There is also a slight evidence that LL or LDw could be beneficial for salmon rearing. However, it should be taken into account that this study is only based on one genetic family and the fact that there is a vast deviation.

BIO299

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