

**THE EFFECT OF AROCLOR 1254 ON SMOLT DEVELOPMENT
AND SUBSEQUENT SEAWATER PERFORMANCE
AND MATURATION IN ANADROMOUS ARCTIC CHARR**

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Introduction

The winter residence in freshwater of the anadromous Arctic charr (*Salvelinus alpinus*) is associated with low food intake and lipid mobilization, and the charr are emaciated at the time of seaward migration in the spring (Jørgensen et al., 1997). Previous experiments with anadromous charr have shown that lipophilic pollutants such as polychlorinated biphenyls (PCBs) are redistributed from "insensitive" fat stores to sensitive tissues like the brain and liver in late winter/early spring. This redistribution corresponds with much stronger biomarker responses (CYP1A induction) in spring (lean fish) than in autumn (fat fish) in these fish (Jørgensen et al., 2002). Hence, the fish appear to be extra sensitive to these pollutants, especially during the period of smoltification, which pre-adapts the fish for the summer seawater residence. Our study investigated the sensitivity of the smoltification process toward lipophilic, persistent pollutants such as PCB, which are found in alarming concentrations in Arctic wildlife.

Material and methods

In the present experiment wild, anadromous Arctic charr were captured on ascendance. They were individually tagged and transferred to indoor tanks in which they were held at natural freshwater temperatures and light conditions, without being fed, until the following spring. In November, the fish were randomly divided into three groups. The fish in 2 groups were given either 1 or 100 mg PCB (Aroclor 1254)/kg fish. These groups are hereafter termed the high dose (HD) and low dose (LD) groups, whereas the fish in the third group were uncontaminated controls (C). The PCB (dissolved in fish oil) was given as one single dose, administrated orally by force feeding, whereas the controls were given fish oil only.

At four time points from February until the fish had smolted in the beginning of June, 15 fish from each group were sampled for blood for analyses of plasma osmolality and chloride concentrations, and levels of growth hormone (GH), insulin-like growth factor (IGF), thyroid hormones (T3/T4) and cortisol. At the same time point, fish were subjected to a 72-h seawater (33 ppt) challenge test for determining their hypoosmoregulatory capacity.

At the time when the charr had smoltified, the remaining 92 fish (n = 30, 31 and 31 fish from the C, LD and HD groups, respectively) were transferred to one tank with full-strength seawater (natural temperature, 5-10° C), where they were held for 2 months. During this period they were fed in excess. In the beginning of August, they were again transferred to freshwater where they were held, without being fed, until the fish were fully mature in October. Growth and survival during the seawater period, and the proportion of the fish that matured, were recorded in each treatment.

Results

A strongly improved hypoosmoregulatory capacity was seen in the uncontaminated controls in June as compared to February. In June, plasma osmolality (353.8 ± 8.3 mOsm) and chloride concentrations (164.1 ± 3.9 mmol/L) after 72 h in seawater of control fish were comparable to the levels that has been seen in wild anadromous charr when exposed to seawater at the time of their seawater entry in the beginning of June (Aas-Hansen, unpublished results). This indicates that the control fish used in the present experiment were fully pre-adapted for seawater residence at the time when their wild conspecifics descend to the sea. In contaminated fish there were a dose-related reduction in their

hypoosmoregulatory capacity, with plasma osmolality levels being 366.6 ± 7.1 and 394.3 ± 11.3 mOsm in LD and HD fish, respectively, after the 72 h seawater challenge test in June.

Consistent with the abolishment of their hypoosmoregulatory capacity there was an increase in mortality with increasing PCB level during the 2 month seawater residence, with total mortalities being 13, 36 and 47 % in the control, LD and HD groups, respectively. Furthermore, the high dose PCB seemed to cause a reduction in the specific growth rate of the surviving fish during the seawater residence, being 0.60 ± 0.02 , 0.61 ± 0.05 and 0.42 ± 0.04 %/day for the C, LD and HD fish, respectively. There was no effect of PCB on the proportion of fish in each group that matured.

Discussion

The present experiment is ecologically realistic by the following reasons: 1) We used wild, anadromous charr with a natural body composition; 2) The fish were contaminated in the autumn and held without food throughout winter, consistent with the “natural” contaminant exposure during the summer feeding excursion to the sea, and subsequent fasting throughout the winter residence in freshwater of free-living anadromous charr; 3) The fish were given Aroclor 1254, which has been shown to have a congener composition similar to that found in wild fish in the Arctic (Gundersen et al., 2000) and 4) we measured both the development of seawater tolerance, and subsequent seawater performance in an experimental set-up that mimicked the anadromous life strategy of the Arctic charr.

The results showed that an ecologically realistic contaminant (Aroclor 1254) effected the smolt development and subsequent seawater performance of the Arctic charr. Taken together, the results indicate that a body burden of PCB comparable to the highest levels that has been detected in Arctic charr in the arctic (i.e. 5 mg PCB/kg body wet weight; Skotvold et al., 1998) have consequences for the seawater performance of anadromous charr. Preliminary data on plasma levels of hormones involved in the smoltification process indicate that the PCB related effects on smolt development and quality, were accompanied by PCB-related differences in plasma hormone levels. Effects on smolt development and seawater performance will be discussed in relation to differences in plasma levels of relevant hormones.

References

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