On the M74 Syndrome in Baltic Salmon (*Salmo salar* L.) and the Pollution Situation in the Baltic Sea

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Introduction

The four-year Swedish research project "Reproductive Disturbances in Baltic Fish" (the FiRe project) finished in July this year. The main focus of the project has been the M74 syndrome in Baltic Sea salmon *(Salmo salar)*, which kills salmon fry 2-3 weeks after hatching. The reason for this emphasis was the very high mortalities (around 90 %) that were recorded in salmon fry in the early 1990s.

Material and Methods

In late 1993 a scientific steering group was formed for the FiRe project and consisted of 7 Swedish senior scientists who represented disciplines that were relevant to the topic. The group produced a research plan in 1994 (1) and during the project period 1994 to 1998 the FiRe project invited scientists to submit proposals for subprojects. A total budget of 16.1 million Swedish crowns was made available for research support through joint financing by the Swedish Environmental Protection Agency, the National Board of Fisheries, the Swedish Council for Forestry and Agricultural Research, the World Wide Fund for Nature (WWF) and the Power Board. An international workshop was also arranged by the project in November 1995 (2) to facilitate international cooperation and exchange of information.

Results and Discussion

The project is at present being reported and the results will be published in a special volume of Ambio (No. 1/1999). At this stage we can conclude that the reason(-s) for the occurrence of M74 are yet not known. However, research has lead to a much improved characterisation of the M74 syndrome (3) and an effective method for treating salmon fry in the hatcheries. Several former hypotheses have been tested and new ones have evolved. Furthermore, an international network of scientists working on related problems has been established.

Several possible explanations for the M74 syndrome still remain to be tested and not all of them relate to pollution. We would, however, like to take the opportunity at this conference to discuss possible connections to pollutants and in particular the possible role of dioxin-like compounds.

The brackish Baltic Sea is heavily polluted by anthropogenic inputs of nutrients, together with a number of identified and unidentified toxic compounds (4, 5). Major polluting industries include pulp and paper mills, mining operations and steel and metal foundries, while nutrients come from agricultural runoff, atmospheric deposition and sewage plants. Persistent organic contaminants and heavy metals have occurred at very high levels in top predators such as fish, fish-eating birds and seals (5). Reproductive failure and a disease complex in grey and ringed seals were probably caused by organochlorines such as PCB (6). Since the 1970s, levels of organochlorines (DDT and PCB) have decreased in fish, seabirds and seals, and shell thickness has increased in eggs of guillemot. The fertility of Baltic seals has now increased, but uterine lesions and the disease complex still occur (5).

Early Swedish studies showed that levels of heavy metals, polychlorinated dibenzodioxins and dibenzofurans in eggs, fry and females were not significantly different in salmon affected by M74 and healthy salmon (7). Levels of persistent organic pollutants in salmon vary between individuals (e.g. with fat content), possibly due to different migratory and feeding patterns (8). However, there are no differences in concentrations of organohalogen substances in muscle and eggs of healthy salmon, compared to salmon whose offspring develop M74 (L. Asplund pers. comm.).

Finnish studies on the role of chlorinated organic compounds are not conclusive. No connection was found between polychlorinated diphenyl ethers (PCDE) and the occurrence of M74 (9). Recent research suggests a correlation between levels of planar PCBs, dioxin-like contaminants and polychlorinated dibenzofurans in female salmon and the occurrence of M74 in their offspring (10).

It should be emphasised that levels of known contaminants in the Baltic have declined since the 1970s (5) and do not covary with the occurrence of M74. However, the activity of some detoxification systems in the fish liver, e.g. the Cytochrome P450-system and the activity of 7-ethoxyresorufin-O-deethylase (EROD), which are frequently used as biomarkers for the presence of chlorinated organic compounds, indicate that female salmon and fry suffering from M74 have higher loads of toxicants compared to normal salmon (7).

In the early 1970s, reproduction disorders in salmonids from the North American Great Lakes were correlated to chlorinated organic compounds, i.e. planar PCBs and chlorinated dioxins (11). Today, reproductive disorders are still prevalent in these salmonids (e.g. mortality is about 80 % in lake trout, *Salvelinus namaycush*, from Lake Ontario) but there is no longer a clear correlation with pollutants (12). Today, the reproductive disorders in North American salmonids are thought to have a dietary origin and the symptoms (called EMS, the Early Mortality Syndrome) are similar to those of the M74 syndrome (11). M74 should be considered to be a variety of EMS (2) and both EMS and M74 are characterised by a deficiency of thiamine (vitamin B1) (13-16).

Observations and laboratory experiments have also resulted in successful thiamine therapy for fry affected by EMS and M74 (single or repeated bathing of eggs or fry in thiamine) in North American, Swedish and Finnish hatcheries (14, 17-19).

Thiamine may have functions other than as an essential co-factor for thiamine containing enzymes. For example, thiamine may participate in the metabolism of xenobiotics. With the exception of the Cayuga Syndrome in Atlantic salmon from the New York Finger Lakes the EMS/M74 is more prevalent in contaminated systems. This implies possible contaminant/thiamine interactions, e.g. contaminants may increase the thiamine requirement of early life stages of salmonids (11).

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