EFFECTS OF CHEMICAL POLLUTION ON FISH IN THE DRAINAGE AREA OF THE RIVER NARVA, ESTONIA

Arvo Tuvikene
Department of Hydrobiology, Institute of Zoology and Botany,
Estonian Agricultural University, 51014 Tartu, Estonia
Tel.: +372 7 454518, Fax: +372 7 454546, E-mail: arvot@zbi.ee

EXTENDED ABSTRACT ONLY – DO NOT CITE

There is great concern over the effects of toxic chemicals in the River Narva drainage area. Contaminated sediments and water in many parts of this water system may be impairing biota. Many fish populations have been found to be seriously depleted and many local fish often have elevated levels of contaminants in their tissues (Tuvikene et al., 1999). The main pollutants having impact to the River Narva ecosystem are nutrients. The River Narva passes the oil shale mining and processing area and thus receives elevated amounts of polycyclic aromatic hydrocarbons (PAHs), heavy metals (HMs), phenols and sulfates (Tuvikene et al., 1999; 2000). While there have been many laboratory studies of behavioural effects of individual toxicants, there is relatively little knowledge of the effects of the complex mixtures of toxicants that occur in the environment. General objectives of the study were to determine the ecotoxicological factors limiting the living conditions of fish populations in different sites of drainage area of River Narva. Specific objectives were to study the bioaccumulation, bioavailability and physiological effects of toxic substances, especially PAHs and HMs from selected sites influenced by oil-shale industry. Olfactory sensitivity of crucian carp (*Carassius carassius*), measured as electro-olfactogram (EOG), was used as an indicator of physiological status of fish. The olfactory organ is an important sensory pathway for fishes in finding food, in homing to spawning areas and in mediating responses to alarm substances from conspecifics. The olfactory organ is continuously exposed to the environment, it is very sensitive, and it mediates essential life functions. These facts motivated our studies on the function of the olfactory organ to find how the water from different study sites modify the olfactory sensitivity to food signals, alarm and sex pheromones.

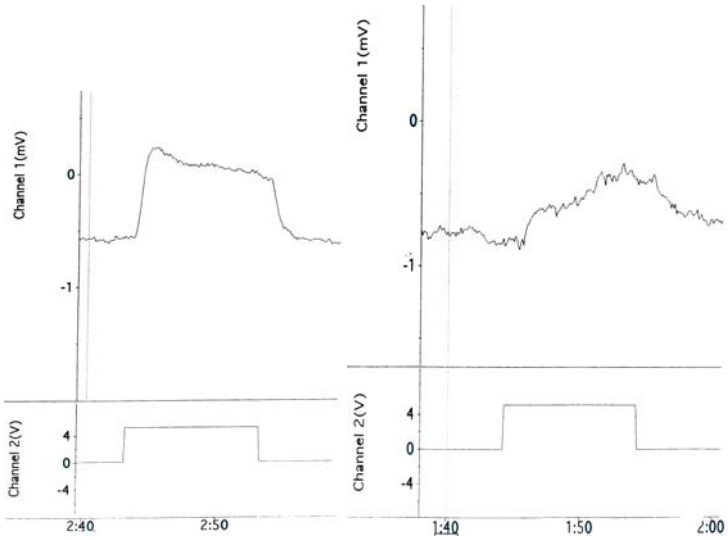

Figure 1. Cross-adaptation: The effect of alkaline leachate from oil shale industry to the olfactory sensitivity to 10^{-8}M hypoxanthine – 3(N) – oxide as alarm stimulus of crucian carp. Left: control, right: exposed. Bottom graph shows duration of stimulus (10 seconds).

EOG recordings are widely used to determine olfactory sensitivity of fish to a variety of compounds which are or have been hypothesised to function as feeding attractants, migratory cues, and sex pheromones. Recent studies have been shown that EOG recordings can be used to evaluate the sublethal effects of pollutants, e.g. acidification and pesticides (Moore & Warning, 1996), and HMs (Wang & Huang, 1999). Polluted water, especially with HMs, has effects on predator avoidance and pray capture ability (Weis et al., 1999).

One of the important effects of the nutrient overenrichment in aquatic systems is the influence to the bioavailability of xenobiotics. The fate of PAHs and HMs is largely determined by sorption to the suspended particulates and sediments. Sorption depends on the characteristics of both
the sediments and the chemicals involved. The content of organic matter and size of the sediment and seston particles, and various abiotic and biotic factors

affect bioavailability and bioaccumulation of pollutants in fish. The studied fish had differences in bioaccumulation of PAHs and HMs between study sites, and this could be explained with the differences in bioavailability.

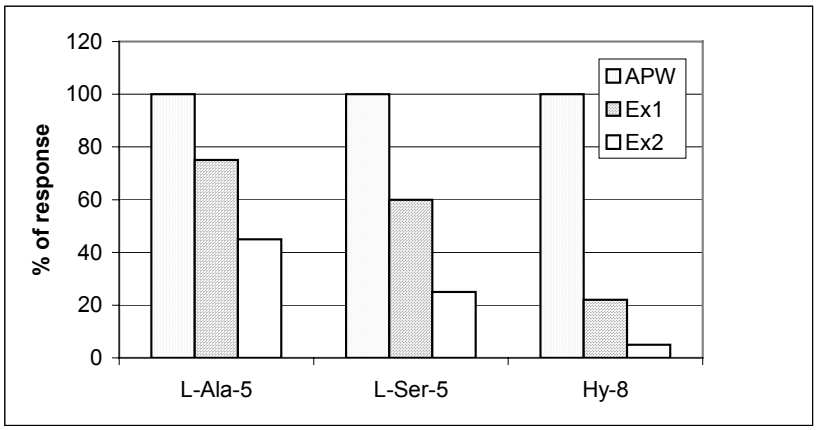

Figure 2. EOG responses in Crucian carp to different stimulus after perfusion of the olfactory epithelium with toxic extracts. APW – artificial pond water (control), Ex1 – water with elevated pH (~9) and elevated contents of HMs and PAHs, Ex2 – water with elevated phenols and PAHs contents, L-Ala-5 - 10^{-5}M L-Alanine and L-Ser-5 - 10^{-5}M L-Serine as food stimulus, Hy-8 - 10^{-8}M hypoxanthine – 3(N) – oxide as alarm stimulus.

Laboratory studies showed that the different leachates of oil shale ash dumps are acutely toxic for fish. The dose-response relationships were analyzed in artificial pond water and in pond water with extract of oil shale ash. The results showed that the olfactory epithelium of crucian carp is highly sensitive to food and alarm stimulus (Fig. 1 and 2). During exposure of the olfactory epithelium with the water extract of the oil shale ash the size of responses (EOG), and the thresholds decreased significantly.

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