Effects of oil pollution on Aquatic Organism (Review Article)

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Abstract: Oil pollution has become a global environmental issue in that oceanic ecosystems and inland aquatic ecosystems are threatened greatly. The evaluation and prediction of the effects of oil pollution on water environment have become a very urgent and important issue. It has been estimated that approximately 5 million tons of crude oil enters the marine environment each year from a variety of sources mostly known are the spills from shipwreck, but there are several less conspicuous sources, like intentional flushing of ship compartments, spills from oil rigs, oil from industries, oil refineries, run-off from urban areas.

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Introduction:

Sources and concentrations of PAHs

Polycyclic aromatic hydrocarbons (PAHs) are widespread and mainly originate from fossil fuel combustion and the release of petroleum and petroleum products **(El Nemr *et al*., 2004; Andres *et al*., 2010 and Chao *et al*., 2010**). Chemically, PAHs are compounds contain two or more fused aromatic rings in linear, angular or clustered arrangements. They generally possess high chemical stability, which results in high levels in the environment and enhanced bio-accumulation **(Di-Toro *et al*., 2000; Arey & Atkinson, 2003 and El Nemr *et al*., 2007).**

PAHs are aromatic compounds made from two or more fused benzene rings. Two main categories of PAH contamination of the aquatic environment has been described: pyrogenic and petrogenic. Pyrogenic sources are those including combustion of hydrocarbons or indeed any organic material (engine exhaust, fires and aluminium smelting resulting in atmospheric deposition and wastewater effluents) whereas petrogenic sources include discharges from petroleum related activities as well as natural sources (oil seeps, erosion of coal/peat/oil shale deposits, oil spills, discharges of oil tanker ballast water and produced water, coal-fired power plants and sewage treatment plants). **(Neff, 1990 and Kennedy & Farrell, 2008)**.

Pyrogenic and petrogenic discharges will to a large extent comprise different PAHs, which make it possible to estimate the main sources in a particular area by comparing their relative contribution. Petrogenic discharges are dominated by low-molecular weight PAHs, similar to the parent crude oil pattern, often with high abundance of alkyl substituents (Neff, 4 2002). Pyrogenic PAHs are produced at high temperatures through incomplete combustion, and will be dominated by four-, five-, and six-ringed PAHs (Neff, 2002). PAHs from pyrogenic and petrogenic sources may behave very differently in the environment, as pyrogenic PAHs will commonly be more or less tightly bound to particles (soot etc.), whereas petrogenic are dissolved or loosely bound to particles and therefore comparatively more available to marine organisms (Farrington, 1986). The heavier and more hydrophobic PAHs tend to adsorb to particulate organic matter and may therefore be concentrated in sediments. The main source of PAHs to the North Sea is activities related to petroleum exploitation, producing a petrogenic PAH profile. However, in other parts of the world, sources such as natural oil seeps (Allen et al., 1970) or coal in sediments (Achten and Hofmann, 2009) may be significant contributors producing a similar petrogenic profile.

Many PAHs have toxic, mutagenic and/or carcinogenic properties. Although the large number of individual PAHs that occurred in the environment, most regulations, analyses, and data reporting focus on only a limited number of PAHs, typically between14 and 20 individual PAH compounds. Such compounds are given the priority because they are the most PAHs effective as toxic or carcinogenic pollutants (**Ruiz *et al*., 2011; Liu *et al*., 2012a; Salem *et al*., 2014 and Abdel-Shafy & Mansour, 2016**).

Biological uptake of PAHs is generally considered to be correlated to the PAH lipophilicity (Kow), but may also depend on the extent of alkylation (Jonsson et al., 2004) and the bioavailability of each component (Utvik and Johnsen, 1999; Baussant et al., 2001). In fish, PAHs may be taken up directly from water (bioconcentration) or via the diet (Grung et al., 2009). Some organisms, such as molluscs, may accumulate PAHs in tissue due to a relatively inefficient metabolism. PAHs may therefore be quantified in their tissues to estimate recent exposure. Fish, on the other hand, have an efficient metabolism (see Van Der Oost et al., (2003)) and readily excrete most PAHs. Therefore, PAH metabolite concentrations in bile (rather than tissue levels) are used to indicate exposure (Aas et al., 2000b).

Effects of PAH

Petroleum concentrations as low as 0.1 ppm have been shown to be acutely toxic to marine larvae (USEPA, 1986), and small quantities of crude oil mixed with sea-water have been shown to affect the feeding behavior of fish and shellfish (Connell & Miller, 1980). These and other toxic effects are dependent on many factors, including the chemical composition, partitioning properties, bioavailability, bio accumulation and the toxicity of the chemical mixture and its constituents (Connell and Miller, 1980 and 1981).

Many effects of PAH exposure have been observed in marine fish. Specifically, studies have been conducted on the embryonic and larval fish, the development of fish exposed to PAHs, and uptake of PAHs by fish via various routes of exposure. One study on found that Pacific herring eggs exposed to conditions mimicking the ‘’Exxon Valdez’’ oil spill resulted in premature hatching of eggs, reduced size as fish matured and significant teratogenic effects, including skeletal, cardiovascular, fin and yolk sac malformations (Carls et al., 1999). Yolk sac edema was responsible for the majority of herring larval mortality (Carls et al., 1999). The teratogenic malformations in the dorsal fin and spine, and in the jaw were observed to effectively decrease the survival of developing fish, through the impairing of swimming and feeding ability respectively. Feeding and prey avoidance via swimming are crucial for the survival of larval and juvenile fish (Carls et al., 1999). All effects observed in herring eggs in the study were consistent with effects observed in exposed fish eggs following the *Exxon Valdez* oil spill (Carls et al., 1999). Zebrafish embryos exposed to oil were observed to have severe teratogenic defects similar to those seen in herring embryos, including edema, cardiac dysfunction, and intracranial hemorrhages (Incardona et al., 2005). In a study focused on the uptake of PAHs by fish, salmon embryos were exposed to crude oil in three various situations, including via effluent from oil coated gravel (Heintz et al., 1999). PAH concentrations in embryos directly exposed to oil and those exposed to PAH effluent were not significantly different. PAH exposure was observed to lead to death, even when the PAHs were exposed to fish via effluent. From the results, it was determined that fish embryos near the *Exxon Valdez* spill in Prince William Sound that were not directly in contact with oil still may have accumulated lethal levels of PAHs (Heintz et al., 1999). While many laboratory and natural studies have observed significant adverse effects of PAH exposure to fish, a lack of effects has also been observed for certain PAH compounds, which could be due to a lack of uptake during exposure to the compound (Incardona et al., 2005).

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