Seals & Endocrine Disruptors

briefing

Effects of Endocrine Disrupting Chemicals on Seals

Introduction

Alarming outbreaks of mass mortality in marine mammal populations started in 1988 when the Phocine Distemper Virus epidemic (PVD) ravaged the harbour seal populations along north-western European coasts and killed about 20 000 seals. The seal population was reduced by 60% in places like the Wadden Sea.

At the same time harbour porpoises, that had died of a similar virus, appeared stranded on the beaches. Two years later another mass die-off occurred in the Mediterranean striped dolphin populations. The severe and lethal outcomes of the epidemics led many in the scientific community to believe that a contaminant-induced immune deficiency was responsible for the high mortality during the epidemic outbreaks. A pattern emerged in which seal populations in grossly polluted waters, like the Kattegat, Skagerrak, German Bight and southern parts of the North Sea suffered the worst.

The disease-ridden bodies of harbour seals were washed ashore along the north-western European coasts in large numbers, all with high organo-chlorine concentrations. By comparison, no virus related deaths were reported from seals along the less contaminated west Scottish, Icelandic and Norwegian coasts. It has since been demonstrated with experimental evidence, that seals with chronic exposure to organochlorines, PCBs and DDT in particular, are more prone to disease.

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Endocrine Disrupting Chemicals (EDCs)

Year after year an incredible amount of toxic pollutants enter the North-East Atlantic from a myriad of terrestrial sources, some via diffuse paths through the atmosphere, others via direct routes, through rivers or waste dumping at sea. Many of the pollutants have the potential to interfere with the hormonal balance of marine organisms. These pollutants act as endocrine disrupting chemicals (EDCs) by mimicking hormones and blocking or stimulating production and breakdown of hormones. Subsequently, the hormone levels are altered and the hormonal messenger system controlling physiological processes such as immunoresponse, reproduction and development is disrupted. The effects of EDCs are manifold and causal relationships are hard to reconstruct. However, in adult seals chronic exposure to PCBs and DDT certainly causes immunosupression.

EDCs Found in Seals and/or their Marine Habitats

• PCBs: the production of polychlorinated biphenyls (PCBs) was banned in most western countries years ago. They used to be produced as non-inflammable liquids in hydraulic systems and transformers, as well as for inks and paints and softeners in synthetic materials. Since PCBs are almost chemically inert and non-degradable, they remain in the environment as stable compounds for decades.

• Phthalates: phthalates have replaced PCBs in a number of applications. They are, for example used as softeners in PVC products and emitted into the environment by diffusion from household goods, building materials and land fill sites.

• Dioxins and furans: PCDDs (polydibenzo-p-dioxins) and PCDFs (polydibenzofurans) are amongst the most toxic of all chemicals. Usually, they are a by-product of thermal reactions and are emitted during industrial production, from incinerators and car exhausts.

• Brominated flame retardants: the production of brominated flame retardants is increasing and so is their presence in the marine environment. The ever growing number of electronic devices such as TV and computer screens and their casings add to the problem, they emit the polybrominated diphenylethers (PBDE) by diffusion. PBDE then enter the atmosphere and finally precipitate into water bodies. PBB, another group of brominated flame retardants including decabromobiphenyl, reach the sea in the industrial effluents of the synthetic material productions. As the sources of brominated flame retardants are diffuse and numerous, the emissions are difficult to control.

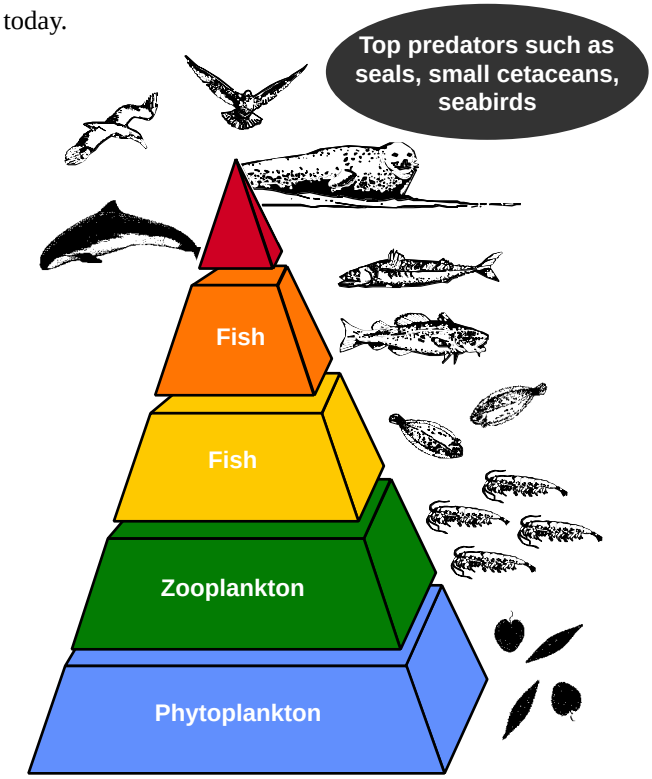
• Pesticides: DDT and Lindane are persistent chemicals and enter the sea via agricultural run-off. Application of DDT was banned in most western countries by the end of the eighties, production has since been reduced significantly. DDT is mainly used in developing countries, to control mosquitoes which act as malaria hosts. DDT is still present in seals as well as lindane, which is used extensively in sugar beet and oil rape seed production.

• A new persistent chemical, BCPS (Bis 4-chlorophenyl sulfone) has been found in the blubber of grey seals living in the Bothnian Bay and the Baltic Sea. BCPS is used in the production of high temperature polymers, as a reactive dye, and occurs as a by-product in pesticide synthesis. This is yet another chemical with the potential of interfering with the hormonal messenger system of marine mammals.

The input of endocrine disrupting chemicals into the environment has not slowed down. Hundreds of new chemical compounds are being released into the environment every year. In addition, EDCs that have been banned are being replaced by new compounds, that are sometimes potentially just as harmful as their predecessors. The reduction of inputs into the sea can only be achieved if the precautionary principle is applied. It is just a matter of time before the next catastrophe will take place. Marine mammals in contaminated coastal waters are especially at risk due to the high and chronic exposure they experience. Merely singling out chemicals like DDT and PCBs is not enough, a comprehensive policy, containing adequate testing methods and licensing requirements for EDCs, needs to be instigated urgently.

Case Studies

The existence of chemicals such as PCBs and DDT in the environment is particularly disconcerting, because they persist for years or decades and tend to accumulate along the food chain. Eventually the pollutants concentrate in top predators like seals. Persistent organochlorines, like PCBs and DDT are passed down generations. In the pregnant females they may affect the development of the foetus. Later persistent pollutants are transferred to the seal pup via the mother's milk. In the adults accumulation of EDCs carries on through the consumption of contaminated prey species. Despite the ban on PCBs and DDT in western countries years ago, considerabl levels of these compounds are still found in seals living in the North-East Atlantic today.



Food pyramid through which persistent EDCs accumulate

Reproductive Failure

High concentrations of PCBs and DDT are also found in adult harbour seals living in the North Sea and Irish Sea, especially along the highly contaminated coastal area close to the river Dee estuary by Liverpool. Many of the female Dee seals have the same abnormalities in their reproductive tracts as observed in the Bothnian Bay ringed seals (*Pusa hispida*) studied previously by Helle & Olsson (1976).

In the Bothnian Bay study a strong correlation was found between high PCB levels in the seal blubber and low reproductive rates. It is most likely, that the lowered fertility was caused by the frequently found malformations in the female reproductive tract, for example occlusions and stenosis of the uteri, which makes it impossible for material to pass from ovary to horn and the notably high rate of implantation failures. Only 27% of the mature females living in the highly contaminated Bothnian Bay waters were pregnant. In comparison 80-90% females were pregnant in low level pollution areas. There are indications that implantation of the fertilised egg had occurred in half of the non-pregnant Bothnian Bay females (enlarged uteri and scars on uterine walls), but abortion or reabsorption of the egg had followed. Visible signs of abnormal reproductive

systems persist in Baltic seals (Andersson 1992) and Jenssen (1996) states *"Exposure to these persistent compounds has also been suspected to be the cause of decreasing populations of Baltic grey seals."*

The life-history of harp seals (*Phoca groenlandica*) in the Barents Sea seems to be changing. An appreciable reduction in the fecundity of females during the past 30 years has occurred. The average age of sexual maturity in female seals shifted from 5.5 years between 1963-72 to 6.7 years from 1976-85 and to 8.1 years in the 1990-93 sample period (Kjellqwist 1995).

In Dutch coastal waters, organochlorines aresuspected of contributing to the decline of harbour seals. Scientists have shown that if seals are fed fish from polluted sea areas the number of follicles and the number of pubs they produce can be reduced (Reijnders, 1986).

Immunosupression Study

In 1994 de Swart et al. completed a semi-field study, in which one group of harbour seals (*Phoca vitulina*) was fed on highly contaminated herring from the Baltic Sea and another seal group was fed on herring from less contaminated areas. In comparison, a clear deficit was observed in the immunoeffeciency of the seals in the "pollution" group after two and a half years. PCB levels in the blubber of the seals fed on Baltic Sea herring was significantly higher and correlated with an impairment of natural killer cell activity, important in the first line defence against viruses. It was concluded that PCBs are immunotoxically active and can result in a low host resistance. This is most likely to cause an increase in the incidence and severity of infectious diseases. The organochlorine concentrations in seals kept in semi-field conditions were generally lower than body burdens found in many free-ranging seals living in polluted areas. It is therefore expected that environmental contamination affects the immune function of these free-ranging seals at least as seriously as observed in seals kept in semi-field conditions for the study.

Skeletal Defaults

Baltic grey seals (*Halichoerus grypus*) born after 1960, the period when pollution levels started to get very high, had a significant increase in levels of skull asymmetry. About 30% of seals showed abnormal skull development, in comparison to the group of seals born before 1940, the "pre-pollution" group. The Bothnian Bay seals studied by Helle & Olsson (1976) showed the occurrence of hormonal osteoporosis in many seals, which may also cause skeletal defaults, as the bone tissue is degenerating.

In relation to all EDCs, WWF believes that

• The OSPAR Commission should take immediate action to phase out and eliminate already identified endocrine disruptors. Furthermore endocrine disrupting properties should rank high under the prioritisation process for hazardous substances to be considered for such measures;

• Current toxicity tests need to be improved with re-testing of substances undertaken;

• Research needs to be adequately funded, prioritised and co-ordinated;

• An international task force needs to be set up to assess the potential effects of hormone disrupting chemicals and opportunities to reduce their use;

• The European Commission should establish a unit or working group on endocrine disrupting chemicals.

Text prepared by Catherine Zucco and Patricia Cameron

References / Further Reading

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