



CHEMTrust

Protecting humans and wildlife
from harmful chemicals

EFFECTS OF POLLUTANTS ON THE REPRODUCTIVE HEALTH OF MALE VERTEBRATE WILDLIFE - MALES UNDER THREAT



SUMMARY AND OVERVIEW

A CHEM Trust report by Gwynne Lyons



CHEM Trust's aim is to protect humans and wildlife from harmful chemicals. Based in the UK, it was set up in 2007 to take over the mantle of WWF-UK's work on toxic chemicals. CHEM Trust's particular concerns relate to chemicals with hormone disrupting properties, persistent chemicals that accumulate in organisms, the cocktail effect and the detrimental role of chemical exposures during development in the womb and in early life. CHEM Trust passionately believes in the conservation of biodiversity and in the importance of wildlife protection. Furthermore, monitoring wildlife populations can provide vital insights into contaminant-related threats to human health, the protection of which is of paramount importance.

Both wildlife and humans are at risk from pollutants in the environment. CHEM Trust is working towards a time when chemicals play no part in causing impaired reproduction, deformities, disease, deficits in brain function, or other adverse health effects. Human exposure to some undesirable chemicals may arise from contamination of the food chain and from the use and disposal of many everyday products such as TVs, computers, cars, construction materials, toys, toiletries and cosmetics.

CHEM Trust is committed to engaging with all parties, including regulatory authorities, scientists and medical professionals to increase informed dialogue on the harmful role of some chemicals. By so doing, CHEM Trust aims to secure agreement on the need for better controls over certain chemicals, and thereby to prevent disease and protect both humans and wildlife.



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Abbreviations and Technical Terms.

a BHC	alpha benzene hexachloride (related to Lindane insecticide) alternatively called alpha hexachlorocyclohexane.
anti-androgenic	a hormone disruptor which works against the male hormone, androgen.
cryptorchidism	undescended testes (bilateral refers to both testes, and uni-lateral cryptorchidism means one testis is undescended).
EDCs	endocrine or hormone disrupting chemicals. The term ‘endocrine disrupting chemicals’ is interchangeable with the term ‘hormone disrupting chemicals’ or ‘hormone disruptors’. Hormone disruptors are substances, not naturally found in the body, that interfere with the production, release, transport, metabolism, binding, action or elimination of the body’s natural hormones, which function as chemical messengers.
Dioxins	polychlorinated dibenzodioxins (PCDDs), combustion products.
DDT	dichloro diphenyl trichloroethane, an insecticide.
DDE	dichloro diphenyl dichloroethylene, a contaminant or breakdown product of DDT insecticide.
DNA	deoxyribonucleic acid.
Furans	polychlorinated dibenzofurans (PCDFs), combustion products.
HCB	hexachlorobenzene, a fungicide.
OCs	organochlorine chemicals.
Oestrogenic	hormone disruptor mimicking the female hormone, oestrogen.
Ovo-testes	eggs developing in the testes / intersex features.
PCBs	polychlorinated biphenyls, a now banned persistent pollutant which was used principally in electrical equipment.
TDS	testicular dysgenesis syndrome.
TSH	thyroid stimulating hormone.
VTG	vitellogenin, the egg yolk precursor protein made by females.

section 1

summary and overview

This paper provides a review of the reported effects on the reproductive health of male vertebrate wildlife, which are known or suspected to be associated with pollutants. Males of species from each of the main classes of animals in the vertebrate sub-phylum (including bony fish, amphibians, reptiles, birds, and mammals) have been affected by chemicals in the environment, particularly chemicals with hormone disrupting properties. Man made chemicals that can disrupt the male and/or female sex hormone may adversely affect the ability of an organism to reproduce, although chemicals which affect reproduction by other mechanisms are also of concern.

All vertebrates have similar sex hormone receptors, which have been conserved in evolution. Therefore, observations in one vertebrate wildlife species, may serve to highlight pollution issues of concern for other vertebrates, including humans. Indeed, given the widespread presence of endocrine disrupting chemicals in the environment, effects are likely to be occurring in more species than those currently reported. Endocrine disrupting chemicals (EDCs) derail the body's chemical messenger system, the hormones, and therefore this term is used interchangeably with the term 'hormone disruptors'. Auxiliary signalling chemicals such as enzymes, growth factors, and so forth, may also be disrupted. There is much "cross talk" in the body, and, for example, pollutant related disruption of brain neurochemistry can be an early step in reproductive impairment. The mounting concern is such that between 1998 -2007 the European Commission invested 161 million Euros into research into the phenomenon of endocrine disruption.

Section 2 summarises the effects reported in male vertebrate wildlife. These include altered hormone levels, reduced number of sperm, genital deformities and deformities of other structures under sex hormonal influence. Many of these reported effects are known or suggested to be due to exposure to EDCs in the environment. Feminization of the males of numerous vertebrate species is now a widespread occurrence, with many males of egg laying vertebrate found to be abnormally producing the egg yolk precursor protein,

vitellogenin. Vitellogenin (VTG) is synthesized by the liver of non-mammalian vertebrates and induced in response to oestrogen. A decrease in male sex hormone, or in the ratio of the male:female sex hormones can lead to weak male secondary sex characteristics including intersex reproductive organs (part female ovary, part male testis), small penis, ineffective mating behaviour, and possibly low fertility. This review also highlights some species where reduced reproduction has been noted, but this may be due to effects of contaminants on the female of the species, rather than the male. Moreover, the mechanisms of action by which some of the effects occur are not known with certainty.

In male vertebrate wildlife the following effects, which are known or suspected to be caused by pollutants, have been reported.

In fish: abnormal secretion in males of VTG; altered spermatogenesis; eggs developing in testes (ovo-testes/intersex); intersex genital apparatus; and poor reproductive success.

In amphibians: abnormal production of VTG by males and ovo-testes/intersex features.

In reptiles: abnormal production of VTG by males: sex hormone disruption; ovo-testes; smaller phallus in alligators and shorter estimated penis length in turtles; decreased hatching; and decreased post hatch survival.

In birds: abnormal VTG production in male birds; deformities of the reproductive tract; embryonic

mortality; reduced reproductive success including egg-shell thinning; and poor parenting behaviour.

Effects in the males of numerous mammalian species have been reported, and include the following.

In rodents: reduced sperm; reduced testes weight; and reduced reproduction.

In otters and/or mink: reduced baculum (penile bone) length; smaller testes; and impaired reproduction.

In seals and/or sea lions: impaired reproduction (including implantation failure, sterility, abortion, premature pupping).

In cetaceans: reduced testosterone levels; impaired reproduction; and hermaphrodite organs.

In polar bears: intersex features and deformed genitals; reduced testes and baculum length; low testosterone levels in adult males; and reduced cub survival.

In black bears: undescended testes.

In Florida panther: abnormal sperm and low sperm density; undescended testes; and altered hormone levels.

In deer: antler deformities; undescended testes; and testicular abnormalities, including cells predictive of testicular cancer.

In eland (an antelope): abnormal testes, including impaired spermatogenesis.

These findings are tabulated in Table 1, and are discussed in more detail in Section 2. Taken together, it can be seen that feminisation or de-masculinisation of males is widespread.

Section 3 provides an overview of some of the findings in wildlife living in polluted environments. This section also highlights the difficulties of identifying which particular pollutants are to blame for such effects, and summarises the concern about effects due to simultaneous exposure to more than one chemical, the so called 'mixture effect'. Several oestrogenic and anti-androgenic chemicals that have been found in polluted rivers and lakes are noted, as is the anti-androgenic activity found in discharges from UK sewage works. Furthermore, this section highlights that concern for the long-term health of wildlife populations and humans is enhanced because several laboratory studies have suggested that disorders, such as deficits in sperm production, can be passed on to subsequent generations, who themselves have not been exposed. Such effects are termed transgenerational.

Section 4 draws conclusions and recommendations. It underlines the similarities of the reported effects in male vertebrate wildlife, and therefore notes the concern for human male reproduction. Conclusions are also reached regarding the need for tighter regulation of EDCs in order to reduce exposures. In addition, the need for ongoing monitoring of wildlife is also highlighted, as is the need for more research to understand the long-term implications of chemical exposures for life on earth.

section 1

summary and overview

(cont)

Table 1: Effects reported in wildlife which are known or suggested to be linked to chemical contaminants

		Reduced reproduction	Intersex / Abnormal Testes	Deformities of sex linked structure / reduced phallus/ baculum	VTG in male	Other Sex linked effect
FISH	Fish	Y	Y	Y	Y	
AMPHIBIAN	Frogs/Toads	Y	Y		Y	Reduced no. of nuptial pads in males
REPTILE	Alligator	Y	Y	Y		
	Turtle	Y	Y	Y	Y	
BIRDS	BIRDS	Y	Y		Y	Egg shell thinning
MAMMALS	Rodent	Y	Y			
	Otter	Y	Y	Y		
	Mink	Y		Y		
	Seal / Sea Lion	Y				
	Whales (Cetaceans)	Y	Y			
	Polar Bears	Y	Y	Y		
	Black/Brown Bears		Y			
	Panther	Y	Y			
	Deer	Y	Y			Deformed antlers in males
	Eland		Y			

Y = Effect reported and known or suggested to be linked to contaminants



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