CHEMTrust
Protecting humans and wildlife from harmful chemicals

A CHEM Trust Briefing - Why Mollusc Toxicity Tests for Endocrine Disrupters and Other Chemicals are Needed

Summary

Endocrine disrupting chemicals (EDCs) are chemicals which derail the endocrine or hormone system. Hormones are the body's internal chemical messengers and they control a number of vitally important biological functions. Exposure to endocrine disrupting chemicals is suspected to play a role in many human diseases and disorders including defects in baby boys' genitals, low sperm counts, testicular cancer, breast cancer, deficits in IQ, obesity and diabetes. Moreover, effects due to exposure to EDCs have already been seen in many wildlife species. It seems that molluscs are very sensitive to certain chemicals with endocrine disrupting properties – and therefore it could be particularly useful to employ molluscs in laboratory tests to identify such chemicals.

Many of the diseases which have been linked to endocrine disruptors have increased in the population at large, and many scientists have already recommended action to reduce exposure to these chemicals. The EU, along with other countries who are members of the OECD (Organisation for Economic Co-operation and Development), are trying to devise test methods to identify which chemicals in commerce today have these potentially damaging endocrine disrupting properties.

Non-animal test methods can pick out some chemicals with hormone disrupting properties, but not all. A test method utilizing molluscs should be seen both as a vital tool to identify chemicals which could harm these important creatures and to potentially identify some hormone disrupting chemicals implicated in disorders in other animals, including man. Furthermore, such a test method utilizing an invertebrate species (an organism without a backbone) would not generate such a high intensity of concern as testing on vertebrate animals. Indeed, in the EU, in accordance with Directive 86/609/EEC, it is necessary to replace, reduce or refine testing on vertebrate animals, whenever possible.

Molluscs currently offer an opportunity for developing new EDC-sensitive test methods, and are likely to be the best non-vertebrate animal test option.

International agreement on test methods is important as it allows mutual acceptance of data. Therefore, CHEM Trust calls

i) for the European Commission and EU Member States to support (as a matter of urgency) the OECD finalisation and validation of mollusc test methods, including a partial life cycle test using *Potamopyrgus antipodarum*.

ii) for industry and other OECD countries to contribute resources and to support this initiative.

iii) for the EU (and other countries) to ensure that when these test methods are available, one or more are used in standard toxicity testing programmes for chemicals, including pesticides.

Molluscs are at Risk of Extinction

Molluscs include terrestrial, freshwater and marine snails, mussels, clams, octopus, squid and slugs, and unfortunately many mollusc species are at risk of extinction. More than 40% of the documented extinctions of all animal species are molluscs, exceeding that of any other major taxonomic group[1, 2]. Loss and degradation of their habitats are the primary reason for their decline, although the experience with tri-butyl tin (TBT) (see below) suggests harmful chemicals may also play a role.

Why Protecting molluscs from Further Extinction is a Priority.

Extinction of invertebrate species receive much less media attention than vertebrates, even though they perform many vital functions and make up nearly 99% of all life on earth[3].

Molluscs are vital to sustaining many ecosystems. Molluscs are the 2nd most diverse animal group (there are 93,000 described species in existence[4]) and have adapted to all of the main environments of our planet—marine, freshwater, and terrestrial. They provide food for fish mammals and birds and are important recyclers of plant and animal waste, keeping water and soil clean and healthy. Molluscs are considered excellent indicators of ecosystem health in general[e.g.5,6,7,8,] and as they are particularly sensitive to changes in their environment, they can act as early warning sentinels of habitat deterioration[9].

Molluscs also provide valuable food for humans and are used in medicine. Mussels, clams, oysters and squids are also commercially exploited for human consumption. Compared to the meat of other animals, mollusc meat has a high protein content and is relatively low in fat[10]. Today, fisheries in Europe, Japan and the US alone produce over half a billion kilos of oyster meat each year[11]. In addition to food, many molluscs benefit human health from their use in medicine. For example, the deadly venoms of some molluscs are today being used to help victims of strokes and heart disease[12], and to produce a revolutionary new drug (Ziconotide) for chronic pain control for patients with cancer and AIDS[13]. Extracts from other snails have been found to be strong growth inhibitors of cancer and of penicillin-resistant strains of bacteria. Moreover, the substances that molluscs produce to attach themselves to rocks, piers, and other hard surfaces are being tested for possible use as glue in surgery and as cement for bone fractures[14].

Mollusc biodiversity should be considered a vital resource that humans have an ethical obligation to protect. CHEM Trust and other conservationists argue that "humans have an ethical obligation to protect all species, that diversity and natural beauty are highly prized by mankind, and that biodiversity is a vital resource ..." John Pickrell, 2006[15].

Chemical Contaminants Contribute to Population Declines in Molluscs

Most aquatic mollusc species are highly sensitive to pollution partly because of their permeable skins. For example, there are reported cases of species disappearing in some locations and this being associated with the acidification of water[16,17] and with exposure to chemical contaminants[e.g.9,18,19]. The best documented case of population decline associated with exposure to pollutants was the world wide decline in 150 species of gastropod molluscs (snails), as a result of exposure to minute quantities of the anti-foulant paint TBT (tri-butyl tin) leaching from ship hulls and leisure craft in the early 1980s[20]. TBT masculinized and sterilized the female molluscs by causing the development of male reproductive organs (penis and male reproductive duct; a condition known as imposex)[21] (see Figure 1). It also caused abnormal shell formation in some types of oysters (see Figure 2). These effects of TBT caused the collapse of many shell fisheries. The ban on the use of TBT-based paints required by EU legislation (76/769/EEC and Regulation (EC) No 782/2003) has helped some populations recover to a certain extent but because the total ban was not in place for several years and because of the persistence of TBT, there are still many areas where mollusc populations are impacted.

Figure 1. Normal female snail (left) compared with an imposex snail (right). The developing penis pouch (pp) and the male reproductive duct (vas deferens; vd) seen in the imposex snail are absent in the normal female snail in which the opening to the oviduct (OvL) is clearly visible.

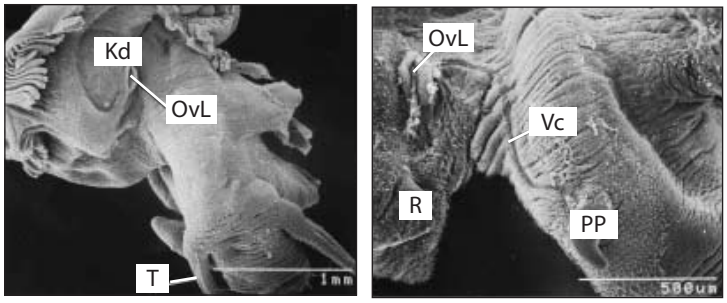
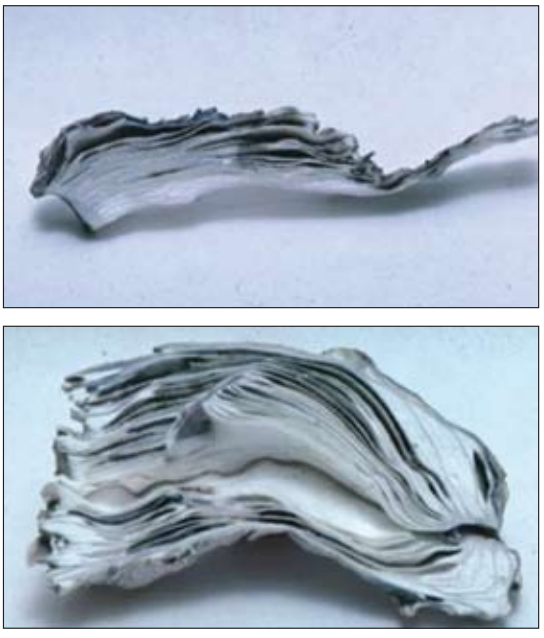


Figure 2. Normal oyster shell (top) compared with an abnormal shell in a TBT contaminated area (bottom).



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Current Screening Tests for Endocrine Disruptors do Not Achieve a Very High Level of Health Protection for Molluscs.

A plethora of chemical contaminants are now known to cause endocrine disruption in vertebrate animals (fish, amphibians, birds, and mammals)[22] and test methods are being developed in order to screen chemicals for these effects[23]. In molluscs, however, despite the historic story of TBT-induced population declines, there is still no chemical safety testing method that would identify TBT as an endocrine disrupting substance. Moreover, available information suggests that current vertebrate and invertebrate regulatory screening tests for EDCs would not be protective for molluscs (see Table 1).

Table 1. A summary of No Observed Effect (safe) Concentrations (NOECs) for two well known endocrine disrupting chemicals in molluscs, compared with other invertebrate and vertebrate groups.

	MOLLUSC	CRUSTACEA	FISH	FROG
Tributyltin[24,25,26]	**2.0ng/L**	**140ng/L**	**1000ng/L**	**NA**
Bisphenol-A[27]	**2100ng/L**	**>3146000ng/L**	**16000ng/L**	**60400ng/L**

The table illustrates clearly that reproduction in the most sensitive mollusc species is more sensitive than in the most sensitive crustacean, or aquatic vertebrate. Although the Bisphenol A test data on molluscs are a matter of some controversy, this again serves to highlight the need for a reliable test method using molluscs.

In summary, it can be seen that basing regulation of chemicals on test data that does not include tests on molluscs will be likely to leave these species unprotected. This highlights the need for internationally agreed test methods using molluscs and for regulatory regimes that require chemicals to undergo such testing[28].

Mollusc Tests Are Now Needed.

Recognising that the endocrine (hormonal) signalling system of invertebrates is likely to differ in some respects from that of vertebrates, recommendations for the development of invertebrate tests for screening EDCs have been made at workshops in 1998 and 2001 attended by international experts in the field[29,30]. Currently developed regulatory tests are, however, based on arthropod animals (insects and crustaceans) that have distinctly different reproductive and developmental endocrine systems[31] compared with many other invertebrate groups.

Unfortunately, as yet there is no internationally agreed OECD test method on molluscs. The time it is taking to agree such a test method is reprehensible. In July 2009, some 20 years after imposex was discovered in mollusc in the wild, the OECD published a draft "Detailed Review Paper on Mollusc Life-Cycle Toxicity Testing for Endocrine Disrupters and Other Chemicals" prepared jointly by British and German experts[32]. The paper concluded that there is a need for life-cycle testing of molluscs as "mollusc species are ecologically and economically important, and are known to be uniquely sensitive to a number of EDCs and other substances." It recommended that work should begin on optimisation and validation of tests on three mollusc species. In one of these species, *Potamopyrgus antipodarum* (the mud snail), a test method (partial life cycle test) is nearly ready.

CHEM Trust considers that the necessary final details of partial life cycle test on the mollusc, Potamopyrgus antipodarum, should be quickly addressed, so that it is validated and implemented as soon as possible. Furthermore, additional test methods should also be finalised and validated as a matter of urgency, including those utilizing other mollusc species, as there is a wide diversity in the modes of reproduction in the different classes of molluscs.

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About CHEM Trust

CHEM Trust is a UK charity which aims to protect humans and wildlife from harmful chemicals so that they play no part in causing impaired reproduction, deformities, disease or deficits in neurological function.

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