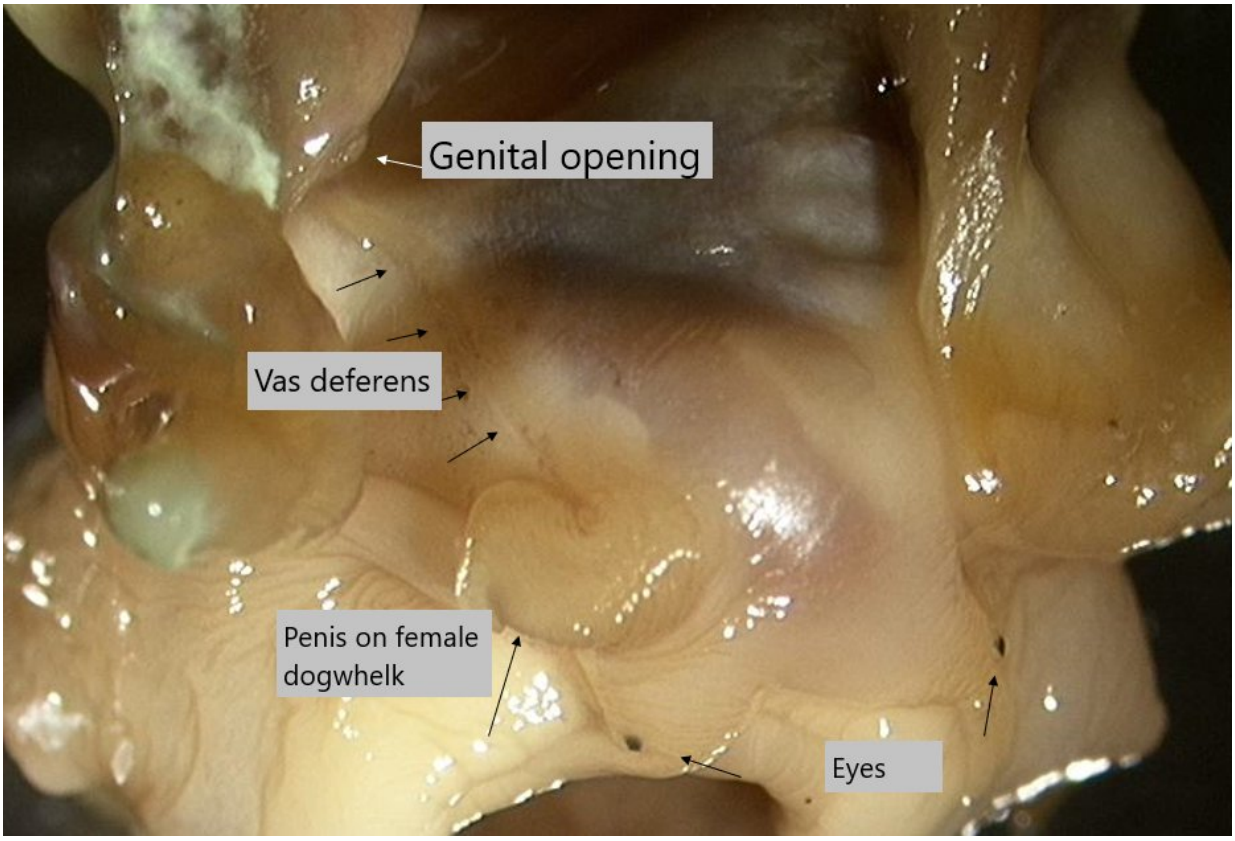
Infertile snails have recovered along the Norwegian coast

November 29 2018



Imposex of female dogwhelk with fully developed penis and vas deferens from Karmsundet in 1998. Credit: Lise Tveiten, NIVA

The environmental pollutant TBT can mimic hormones to the extent that it sterilizes female snails and make them grow non-functional penises

and vas deferens. But for the first time since monitoring started up in 1991 and the total ban of TBT entered force in 2008, only fertile dogwhelk have been found along the Norwegian coastline.

"This is an excellent example that restrictions on pollutants certainly help," says marine biologist and researcher Merete Schøyen at Norwegian Institute of Water Research (NIVA).

For 27 years, NIVA has monitored TBT (tributyltin) and reproductive disorder – so called imposex – in dogwhelk along the Norwegian coastline. NIVA has unique data on the levels and trends of the pollutant and its effects, and the news about the newly recovered dogwhelk populations are published in a scientific paper and in NIVA's research report to the Norwegian Environmental Agency.

A unique health indicator

The dogwhelk is abundant on the shore along the entire Norwegian coastline in more wave exposed area, and in this regard, is especially suitable for monitoring the biological effect of TBT.

"The measure of imposex is a very good and easy biological measure of the chemical impact," says Schøyen.

"The severity of the TBT pollution in female dogwhelk can be seen with the naked eye, and can be easily assessed by measuring the length of the penis and the developmental stage of the vas deferens," Schøyen says.

The TBT- and imposex monitoring of dogwhelk is part of the monitoring program Contaminants in coastal waters of Norway ("Miljøgifter i norske kystområder – MILKYS") which NIVA conducts, commissioned by the Norwegian Environmental Agency. NIVA has operated MILKYS since the beginning of the 1980s.

Dogwhelk with characteristic thick shell, where the last turn is 80 %. The shell has spiral shaped strips and downward ribs that form a square pattern. The opening is shaped like an outer thick lip, and the tagged edge shows adult individual. The siphon channel is short and marked. The thickness and shape vary, up to 4 cm height and over 2 cm width. The shell colour varies and reflect their food. The shell is white when it eats barnacles, and grayish when the snails have eaten blue mussel. Credit: Lise Tveiten, NIVA

One boat, one snail

TBT was previously used in antifouling ship paints. In contact with water, TBT leaked from the paint and mixed with the water masses. In highly trafficked sounds and canals, like Færder in the outer Oslofjord,

and in Karmsundet close to Haugesund, the levels of TBT built up to high concentrations.

"Dogwhelk are especially vulnerable to TBT; only 1 ng per litre of sea water can harm the snail. This could be attributed to just one freight ship with TBT-containing antifouling paint sailing by," explains Schøyen.

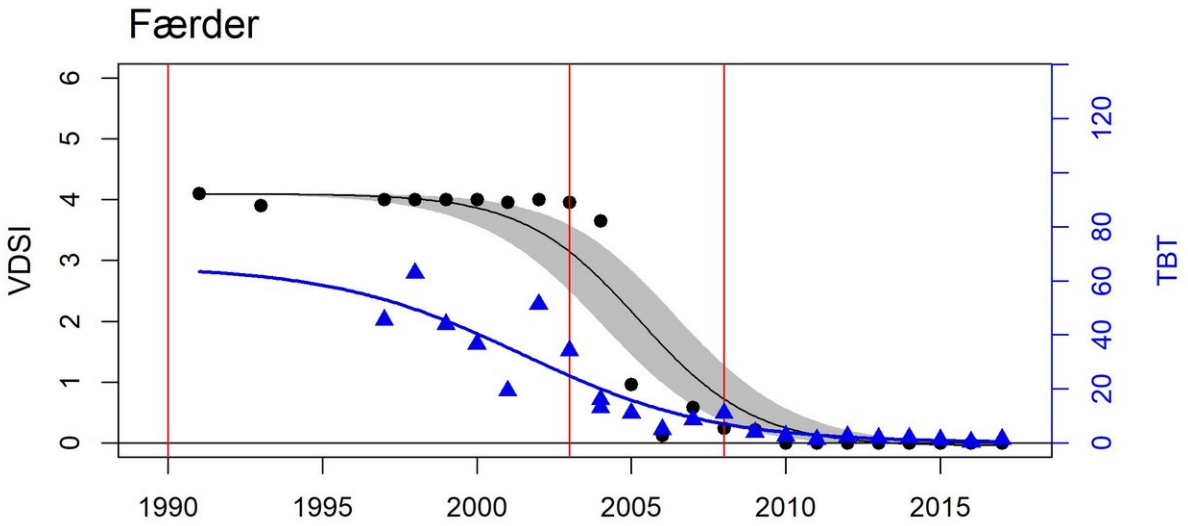
Dogwhelk accumulate TBT by eating blue mussel and barnacles, both of which are filter feeders. Because TBT has an affinity to attach to biological materials and particles in the sea water, it can be easily taken up by organisms that filter sea water for food.

Affects the hormone balance

TBT in female dogwhelk effects the balance of oestrogen and androgen hormones. As a result, a female dogwhelk can develop a penis vas deferens. In the most severe cases, the vas deferens completely covers the vaginal opening, and the snail becomes sterile, unable to lay eggs and reproduce. This effect is irreversible for the individual, and may potentially reduce the population size.

"Local dogwhelk populations over large areas in the North Atlantic Ocean have been severely reduced due to imposex and female sterility resulting from TBT pollution," Schøyen says.

But those times have passed.



The figure shows both significant decreasing gender disturbance/imposex (black graph) and TBT concentrations (blue graph) of dogwhelk from Færder, from sick snails in the 90's to healthy snails today. The national TBT ban for boats shorter than 25 meter in length in 1990, longer than 25 meter in 2003, and the global total ban for revenue and use in 2008, are marked as red vertical lines. After the TBT ban for larger boats, the decline is significant, and after the total ban, the levels have remained low and stable the last 10 years. Credit: Dag Ø. Hjermann

Prohibition provides improvement

In 2017, Schøyen and her colleagues at NIVA could not find a single case of imposex in dogwhelk, for the first time since the monitoring started in 1991.

Schøyen finds it particularly interesting to see the prevalence of imposex in relation to the years when the various TBT restrictions entered force (See figure from Færder):

"The synchronous decrease in both TBT concentrations and imposex in dogwhelk coincides with the TBT bans. The use of TBT was prohibited for marine vessels shorter than 25 meters in length in 1990. This lead to a decrease in TBT levels in dogwhelk, but the degree of reproductive disorder remained high. Decreased imposex was not evident until the restrictions were extended to vessels longer than 25 m in 2003. After the total TBT-ban in 2008, the occurrence of imposex stayed low," she explains.

Important long-term monitoring

Even if the TBT ban has undoubtedly been a success, NIVA is not yet done with their investigations of dogwhelk. They will continue monitoring until 2020.

"Long time series are valuable for the management because time trend analyses can give an early warning of unwanted change. The authorities need strong scientific evidence to make good regulatory decisions. Long-term monitoring provides a basis for judging the success of environmental policy and regulations," Schøyen explains.

Downward trends in TBT concentrations is also evident in blue mussel. But even if the direct emissions of TBT from ships and land sources have ceased, the problem of TBT impact on organism is not gone. Leakage of TBT from sediments and certain landfills may persist for decades. This year's sampling of dogwhelk is already done.

"I am excited to see if the levels stay low in the future," Schøyen says.

More information: Merete Schøyen et al. Levels and trends of tributyltin (TBT) and imposex in dogwhelk (Nucella lapillus) along the Norwegian coastline from 1991 to 2017, *Marine Environmental Research* (2018). DOI: 10.1016/j.marenvres.2018.11.011

Contaminants in coastal waters of Norway 2017. Miljøgifter i norske kystområder 2017. Norwegian Environment Agency/Miljødirektoratet. M-report no. 1120/2018.
NIVA-report no. 7302-2018. 201 pp. ISBN 978-82-577-7037-2. ISSN 1894-7948. www.miljodirektoratet.no/no/Pu … ters-of-Norway-2017/