Oil pollution a threat to haddock

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Credit: University of Oslo

Haddock is an important fish species that has its most important spawning ground in and around Norway's northern Lofoten archipelago, where oil production is being planned. However, research now reveals that the roe and larvae of haddock are more susceptible to oil pollution than previously thought.

Since the mid-seventies, and to this day, the debate for and against oil

production along the Lofoten coastline have been a hot topic. PhD student and researcher Elin Sørhus at the Institute of Marine Research(link is external) and Centre for Ecological and Evolutionary Synthesis (CEES)(link is external) at UiO is now presenting research that is very relevant to the debate.

It reveals that even small and transient oil spills affect haddock larvae to such a degree that they struggle to reach adulthood.

"We wanted to see the effect acute oil spills had on haddock roe and larvae. We have discovered that haddock roe exposed to relatively low concentrations of oil for 24 hours develop serious injuries. And the injuries linger even though they get to develop in clean water afterwards," says Sørhus.

Sørhus defended this spring her PhD. Her paper revealed that oil spills have a dramatic effect on haddock roe.

To underline her argument Sørhus shows a picture of a haddock larvae that was exposed to oil pollution for 24 hours, before hatching from roe. The roe was then kept in clean water for 12 days before hatching.

The picture taken three days after hatching reveals a larva with a heart so deformed that one ventricle had completely stopped working.

Longer oil exposure also resulted in extreme changes to the cranium and the jaw, together with a quite underdeveloped heart.

"Larva with such severe injuries will never grow up," concludes Sørhus.

Cold Water Species are more vulnerable

Elin Sørhus has a lot of photos picturing different deformed haddock

larva. She has completed a long rage of experiments at the water laboratory at the Institute of Marine Research at Austevoll, outside the city of Bergen.

Her experiments have been conducted in big water tanks containing 50 litres of saltwater and with up to 6000 eggs in each tank.

The tanks have been supplied with a varying quantity of raw oil. The oil has additionally been broken down into lesser components to imitate the conditions of a real oil spill originating from an offshore platform.

Sørhus has then examined what happens when the tanks are exposed to low, increased and pulsating doses of added oil.

"The conclusion is that roe from haddock, a marine cold water species, has a dramatic response to oil pollution and among a varying list of injuries can develop a very deformed cranium at the larval stage. The response is more dramatic than previously detected in both freshwater and saltwater fish comfortable at slightly greater temperatures."

She believes that it is very probable that this dramatic response is not exclusive of the haddock, but of other cold water species as well.

Cardiac Edema and Cranial Injuries

Laboratory experiments involving zebrafish have previously shown that oil pollution causes the larvae to develop cardiac edema. Elin Sørhus is currently presenting a well-founded theory concerning why oil pollution is damaging haddock larvae more than zebrafish larvae and other fish species.

"A substantial difference between haddock and cod - for example - is that the haddock have a sticky outer eggshell. Consequently, drops of oil

have a tendency to get stuck onto the eggshell itself. In all practicality this means that the oil damages the egg even after the exposure. If we imagine a scenario where an oil spill hits the eggs right after eggs are spawned but withdraws quickly, the oil could nevertheless damage the eggs substantially regardless of the short exposure.

"A small and short lived oil spill in the middle of the haddock`s spawning period could be a fatal blow," says Sørhus.

She points out that the consequences of course are dependent on how great an oil spill we are talking about and to what degree the population would be exposed.

But what we are observing is that the haddock larvae can develop cardiac edema and other injuries even after dosages as minuscule as 0.7 micrograms of polyaromatic hydrocarbons (PAH) per litre. PAH is a class of chemical compunds that are a natural part of raw oil, Sørhus explains.

Concerned over the long-term effects

Elin Sørhus has investigated the short term effects of oil pollution on haddock roe and larva, but there are indications that the long-term effects also are very serious. She points out what happened after the Exxon Valdez tragedy, where an oil tanker caused a major oil spill along the coast of Alaska in 1989.

Herring larvae close to the oil spill showed proof of injuries and a high mortality, but the local stock of herring was relatively stable in the beginning.

However, three or four years later the stock collapsed completely, probably as a result of the delayed damage caused by very low levels of

oil pollution.

"We have to consider the possibility that something similar can transpire when it comes to our stock of haddock, especially with the knowledge that the haddock larvae is particularly vulnerable to oil pollution.

"It is possible to imagine that even smaller oil spills than I have in my research can lead to small heart damages. This could give rise to a haddock population that survives the larva stage, but have small deficiencies that could make the individuals swim slower. This could make them easy prey for other species and make them less effective in capturing food themselves. Long-term effects like these are totally reasonable compared with the results of my research," says Sørhus.

"The results of my research provides arguments, direct or indirect, for Norwegian politicians to think hard about the consequences and see the big picture when they are discussing oil production outside the Lofoten archipelago. Such oil production will take place in some of the haddock`s important spawning grounds and the haddock is an economically important species of fish."

Have detected the mechanism behind the injuries

Elin Sørhus has also conducted thorough studies of the genetics and the molecular biology behind the haddock larvae's injuries.

"The muscle cells in the heart have a lot of small channels of ions, pores and pumps in inner and outer cell membranes. They control both the transport of ions inside the cell itself and to the outside, all in complicated processes necessary to make the muscle able to contract," explains Sørhus.

Studies show that PAH components in oil has the ability to block these

channels and pumps inside the cardiac muscle cells and disturb the transportation of ions that make the heart beat.

Furthermore, this blockade empties the intracellular storage of calcium and this has some severe consequences. Calcium is in fact an important signal-molecule that actually ties together an outer stimulus to an inner regulation of genes.

Consequently, an emptied storage of calcium will have serious implications for both the regulation of genes and heart function.

"It looks like the misshaped jaws we see developing in haddock larvae is caused by the same mechanics. The PAH causes the jaw muscle to lose its ability to retract and henceforth the whole head can't develop normally," Sørhus explains.

More information: Elin Sørhus et al. Unexpected Interaction with Dispersed Crude Oil Droplets Drives Severe Toxicity in Atlantic Haddock Embryos, *PLOS ONE* (2015). DOI: 10.1371/journal.pone.0124376

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