High level of heavy metals in crab meat

Crab meat is a popular seafood, but it sometimes contains large amounts of environmental toxins. The content is so high in many places in Norway that consumption of brown crab meat should generally be discouraged.

Clinical laboratories sometimes receive enquiries about heavy metal poisoning following the consumption of crab meat. Patients' symptoms are often diffuse, and can include pain in the extremities, paraesthesia, fatigue and mood swings. Many patients also have elevated levels of heavy metals, such as mercury, cadmium and lead. It is not clear whether the heavy metals explain the symptoms, but they are potent neurotoxins capable of causing the symptoms described (1).

It has become increasingly clear that all levels of heavy metals are harmful to living organisms. They can have carcinogenic effects, and cause damage to most organs, even in minute quantities (1). The limits for acceptable intake of mercury, cadmium and lead have therefore been lowered significantly over the past 50 years (2–4). Intake thresholds or diagnostic cut-off points have still not been established for many metals. One such example is tin, which is found in seafood (5), and is neurotoxic and harmful to the liver (6).

In line with international agreements, emissions of heavy metals have been reduced (7). Between 1995 and 2019, emissions of cadmium and mercury were reduced by 80 %, and arsenic by 35 % (7). Emissions of lead to air have also been significantly reduced, though ammunition remains a considerable source of lead in soil (7).

Nevertheless, there are still large accumulations of both inorganic and organic pollutants in Norwegian fjords, where the concentrations of heavy metals are 2–4 times higher than in Norway's coastal waters (8). The Sørfjorden in Hardanger is an example of the extensive pollution caused by industrial activity. Here the levels of cadmium, lead, mercury, dioxins and polychlorinated biphenyls are so high that the recommendation is not to eat crab, shellfish or fish from parts of the fjord. The Norwegian Food Safety Authority (NFSA) keeps a list of areas where the consumption of certain types of seafood is not recommended (9).

«Patients' symptoms are often diffuse, and can include pain in the extremities, paraesthesia, fatigue and mood swings»

Environmental toxins in crab meat

Consumption of white crab meat, crab roe and brown crab meat is common in Norway. Brown crab meat mainly consists of the crab's hepatopancreas, where most of the environmental toxins are found. The European Food Safety Authority (EFSA) has set a maximum concentration for cadmium of 0.5 mg/kg wet weight for white crab meat, but no such limit has yet been set for brown crab meat (10). The Norwegian Institute of Marine Research found that some crab paste and stuffed crab shells purchased from Norwegian grocery stores in 2016 contained up to 1.8 mg and 1.4 mg of cadmium per kilo respectively (11).

Ervik et al. examined crabs caught in the Mausundvær archipelago in Trøndelag, and show that there has been a significant increase in toxic metals in brown crab meat in recent years (12, 13). Between 2016 and 2018, the average level of cadmium increased by 137 %, lead by 22 %, mercury by 133 %, copper by 22%t, and arsenic by 31 %. In 2018, brown crab meat had a median cadmium concentration of 11.9 mg/kg dry weight (3.7 mg/kg wet weight) and a maximum concentration of 202 mg/kg dry weight (63.1 mg/kg wet weight), which is 7 and 126 times higher respectively than the EFSA's maximum allowed concentration of 0.5 mg/kg wet weight in white crab meat (13).

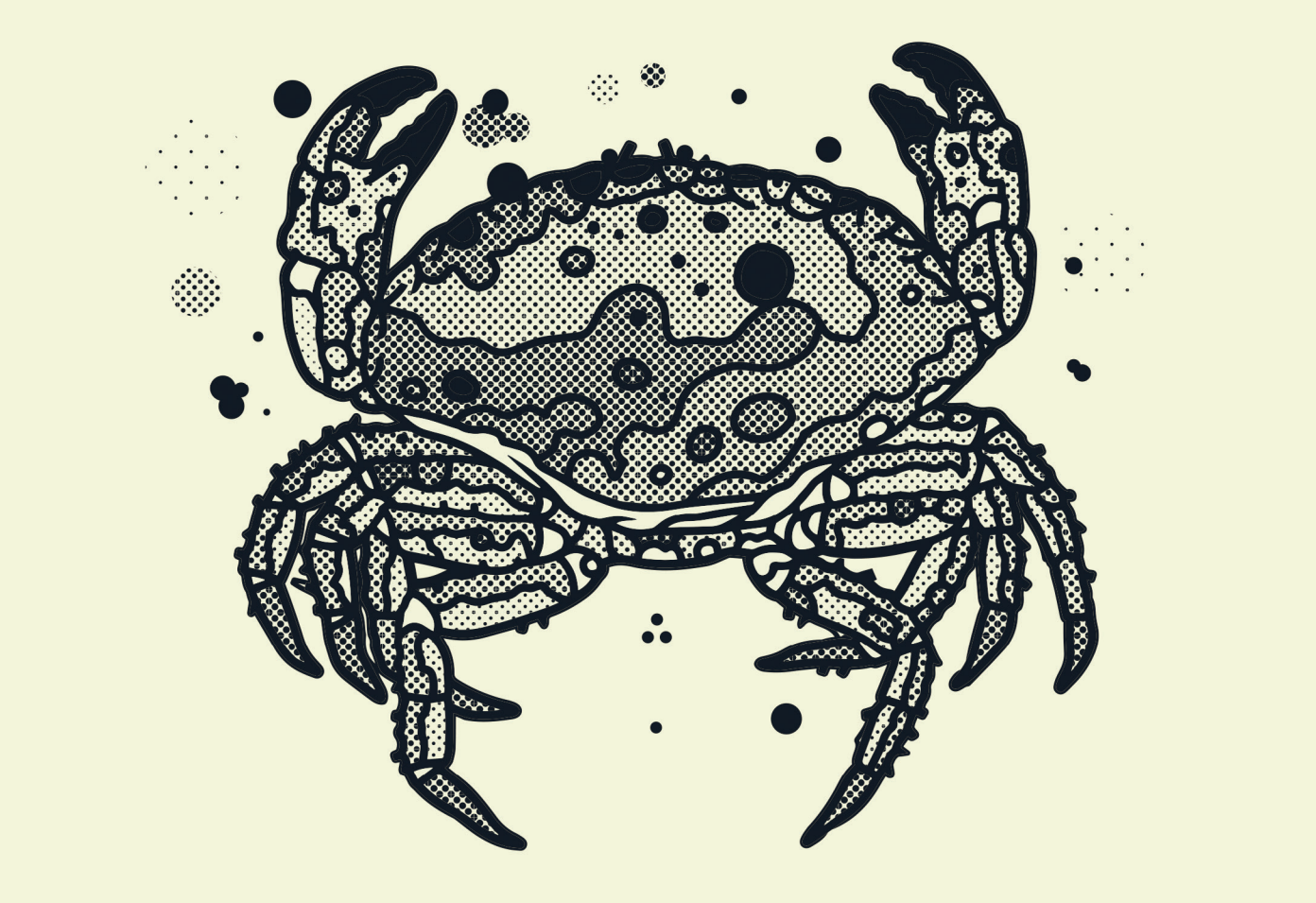
Where does the pollution come from?

The increase in heavy metals over a relatively short period of time indicates that crabs are exposed to ongoing and increasing pollution. It has been difficult to explain this, as emissions of various toxic elements have generally been reduced in Norway. The crabs in the study by Ervik et al. were caught

Table 1 Emissions of arsenic and some heavy metals in Norway in 2018

	Arsenic (As)	Cadmium (Cd)	Mercury (Hg)	Lead (Pb)
Emissions from aquaculture				
Mean concentration in fish feed in 2018 (mg/kg) (15)	2.4	0.16	0.03	0.04
Content in 1.8 million tonnes (consumption 2018) (kg) (15)	4 320	288	54	72
Mean concentration in farmed salmon and trout, 2018 (16)	0.89 mg/kg	< LOQ1	0.02 mg/kg	< LOQ1
Content in 1.35 million tonnes of salmon and trout (production figures 2018) (kg)	1 202	-	27	-
Emissions: content in fish feed minus content in produced salmon and trout (kg)	3 118	288	27	72
Total emissions in Norway				
Emissions in Norway in accordance with the Norwegian Environment Agency in 2019 (7)	23 tonnes	1 000 kg	500 kg	87 tonnes
Addition from aquaculture in 2018 (%)	+ 14	+ 29	+ 6	+ < 0.1

[1] LOQ: Limit of quantification



Illustrations: Børge Bredenbekk/byHandstekst

at various locations in one of Norway's main aquaculture areas (12, 13). There are ten fish farms in this area, the oldest of which has been in operation since 1996.

In 2018, a total of 1.35 million tonnes of farmed salmon and trout (wet weight) were sold in Norway, which required 1.8 million tonnes of fish feed (dry weight) (14). The fish feed contains both inorganic and organic pollutants. The environmental toxins that are not deposited in the farmed fish are left at the bottom of the fjord under open farming cages, in the form of uneaten feed and fish faeces.

Table 1 shows measurements of arsenic, lead, cadmium and mercury in fish feed, farmed salmon and trout, taken by the NFSA and the Norwegian Institute of Marine Research (Seafood Data) in 2018 (15, 16). Emissions from fish farming are calculated as content in fish feed minus content in produced salmon and trout. After comparing this with data from the Norwegian Environment Agency on total emissions in Norway (7), we calculated the share that comes from aquaculture. The aquaculture industry is not listed as a source of emissions of these substances on the Norwegian Environment Agency's website. The environment status page on the website specifically states that emissions of cadmium from fish feed are not included in the calculation of total emissions (7). If we include the emissions from aquaculture, total emissions of cadmium are an incredible 29 per cent higher (Table 1).

The emissions from uneaten feed and fish faeces are spread or accumulated depending on local currents and will impact on the facilities to varying degrees. In 2013, the Norwegian Environment Agency examined cadmium and copper levels in crabs caught at a distance of 80–1000 metres from three salmon farms in Sogn og Fjordane, Møre og Romsdal and Nord-Trøndelag respectively (17). Aquaculture uses around 1700 tonnes of copper annually to impregnate farming nets (figures from 2019), and around 80–90 % of this leaks into the sea and accumulates on the seabed (18).

The study concluded that there were no clear indications that fish farms are a source of cadmium in the marine environment. However, at two of the farms, the mean level of cadmium and copper was 1.6–2.4 times higher in brown crab meat caught 80 metres from the farm compared to 1000 metres. At the third facility, the level of cadmium and copper was the same regardless of the distance to the facility. At all locations, the levels of cadmium and copper were co-variants (Spearman correlation coefficient 0.9–1.0), which suggests that they stem from a common source.

Arsenic, lead, cadmium and mercury are natural elements and as such do not expire. As salmon and trout are farmed in an ongoing process with only a three-month break between each production cycle, toxic

elements will accumulate in fjords where farming takes place.

Are crabs edible?

In several places in Norway, crabs are so contaminated that the NFSA advises against all consumption (19). It is clear that many Norwegian fjords have a significant pollution problem. The studies by Ervik et al. show that in just six years there has been a considerable increase in dangerous environmental toxins in crabs caught at Mausundvær (12, 13), which is particularly worrying.

The NFSA currently has several recommendations for how much crab meat different groups in the population can eat based on threshold values for various environmental toxins, but these only apply to white crab meat. The absence of a threshold value for brown crab meat does not, however, mean that its environmental toxins are not dangerous. The NFSA therefore recommends that pregnant women do not eat brown crab meat (20). However, the content of environmental toxins in brown crab meat is so high that we believe this recommendation should apply to everyone.

The accumulation of environmental toxins in crabs and other marine life is a marker of the state of our fjords' health. The increasing toxic content in crab meat is a sign that developments are going in the wrong direction. Aquaculture's contribution to this is significant (Table 1).

If this development is allowed to continue, all seafood from the fjords will become a risk to health and inedible. Neither healthcare personnel nor the general public seem to be aware of this problem.

We are calling for measures to control these emissions. We must demand that those doing the polluting clean up after themselves, and that emissions are discontinued. Protecting life in the fjords means protecting life for us all.

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