

Water fleas on 'happy pills' have more offspring

October 29 2020, by Steinar Brandslet



Water fleas are small zooplankton found in large numbers in almost all kinds of water. They are affected by chemicals and substances such as drug residues that can be found in processed wastewater. Credit: Per Harald Olsen, NTNU

Zooplankton can grow faster and produce more offspring when exposed to a substance that affects human happiness.

"These [substances](#) are antidepressants, so-called 'happy pills,' which are often used in the treatment of smoking cessation and depression. Our

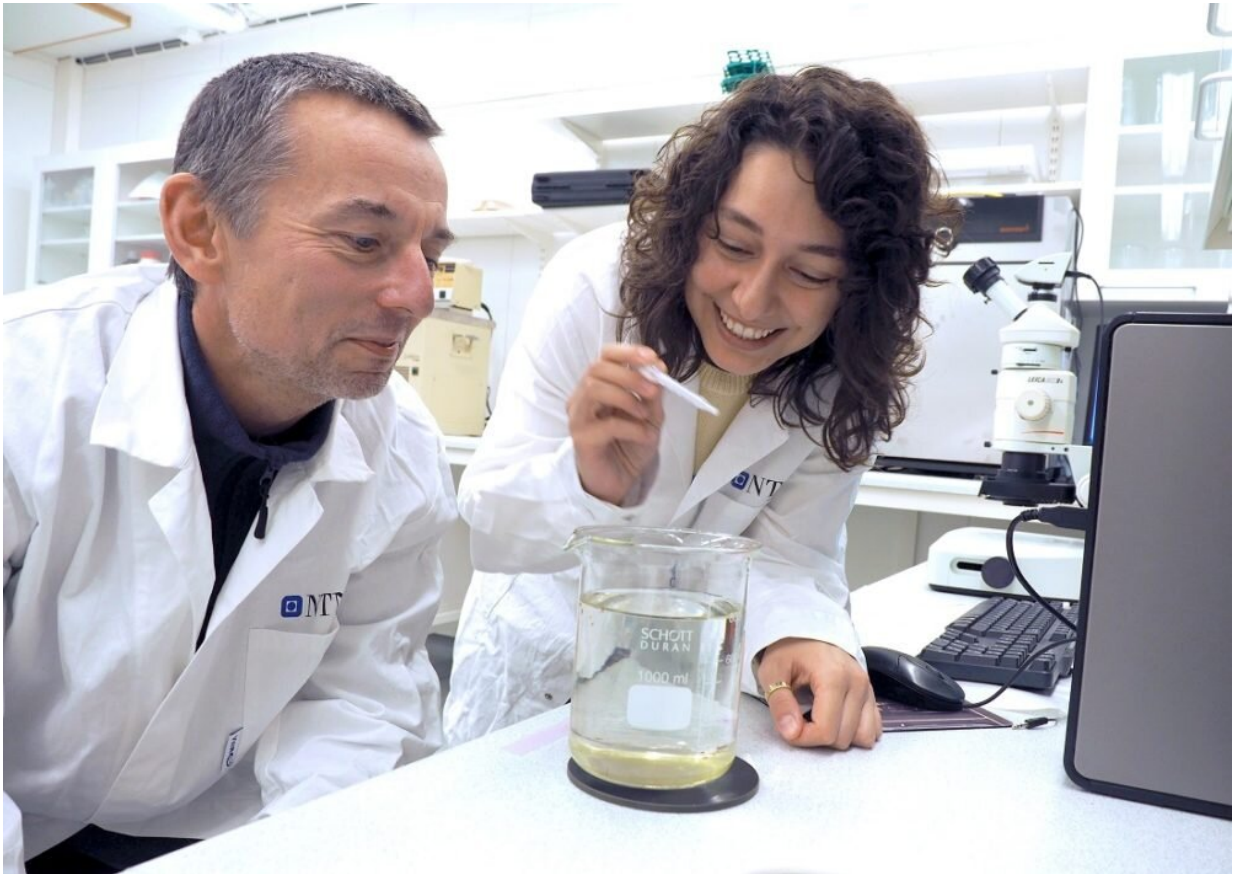
wastewater is one pathway for the substances to end up in nature," says Professor Sigurd Einum at NTNU's Centre for Biodiversity Dynamics (CBD) in the Department of Biology.

Studying how animals are impacted

A research group at NTNU is studying how different substances affect animals. Einum and Professor Veerle Jaspers from the same department are leading the group. Ph.D. candidate Semona Issa is the first author of their recently published article. She is also affiliated with the Centre for Biodiversity Dynamics.

The researchers have investigated how changes in the level of the drug [dopamine](#) affect daphnia, a small genus of water fleas. Water fleas are zooplankton that are found in large numbers in many kinds of water. They are important for controlling the growth of algae and bacteria, and also as prey for a number of species.

There are over 400 species of water fleas. The group studied the *Daphnia magna* species, which is common in freshwater in large parts of the world.



Professor Sigurd Einum and PhD candidate Semona Issa working in the laboratory. Credit: Per Henning, NTNU

Dopamine affects feeling of happiness

"Dopamine is a neurotransmitter that is produced naturally in the body, and which raises or lowers the activity in various nerve cells. Among other things, dopamine can trigger a feeling of happiness," says Einum.

There's a constant flow of substances that affect dopamine levels into the environment, primarily from treated wastewater. When people on antidepressants use the toilet, their waste is treated to remove harmful pathogens, but wastewater treatment doesn't remove drug residues that

are excreted in waste, such as residues from antidepressants or birth control pills. In Norway alone, doctors prescribe more than 100 million doses of antidepressants a year.

The researchers measured the effect of higher concentrations of both dopamine and the drug bupropion in water fleas. Bupropion is used to reduce depression and to help people quit smoking. The drug affects the concentration of dopamine in human cells.

"We're finding that this substance also affects various characteristics of water fleas, like [growth rate](#) and age at sexual maturation," says Einum.

The effect was most evident when little food was to be had in the surroundings.



Credit: AI-generated image ([disclaimer](#))

Effect could be short-lived

Apparently, bupropion causes water fleas to grow and produce offspring faster.

"A faster life cycle is usually a sign of stress," says Issa. "But we don't know if this is a short-term effect."

"Water fleas that are exposed to higher dopamine levels could undergo behavioral changes that make them more vulnerable to being eaten, for example, but we haven't tested that yet," Einum says.

"Faster growth due to increased dopamine levels also reduces the amount of energy that can be used for immune function. It could make the water fleas more vulnerable to parasites and diseases," says Issa.

We don't yet know for sure that higher dopamine levels are any advantage over time, nor do we know why [water](#) fleas do not naturally produce higher levels of dopamine.

It could be that increased production of dopamine can also increase so-called oxidative stress. This can cause harmful substances to accumulate when the cell releases energy. Oxidation of dopamine occurs in the nerve cells where dopamine is produced. Then reactive oxygen compounds are formed that damage the cells.

More information: Semona Issa et al. Dopamine mediates life-history responses to food abundance in *Daphnia*, *Proceedings of the Royal Society B: Biological Sciences* (2020). [DOI: 10.1098/rspb.2020.1069](https://doi.org/10.1098/rspb.2020.1069)

Provided by Norwegian University of Science and Technology

Citation: Water fleas on 'happy pills' have more offspring (2020, October 29) retrieved 28 April 2024 from <https://phys.org/news/2020-10-fleas-happy-pills-offspring.html>

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