**////Title: Harnessing Water Fleas to Purify Wastewater**

**////Standfirst:**

Water-treatment processes are essential for water reuse in municipal, agricultural and industrial applications. Wastewater treatment ensures our safety and prevents sickness and death from parasites and contaminants every year. However, certain chemical contaminants, such as pharmaceuticals and pesticides, are difficult to remove from water, and can accumulate in the food web, eventually entering our food supply and potentially causing adverse health outcomes. Dr Luisa Orsini [Loo-ee-sah Oar-see-nee] and her colleagues at Daphne Water Solutions Ltd have developed a cutting-edge water-bioremediation technology, which is based on the use of small aquatic invertebrates called water fleas. By removing harmful contaminants from water, the sustainable and eco-friendly technology enables water reuse, while protecting human health and the environment.

**////Main text:**

Thanks to our collective knowledge of biology, chemistry and engineering, water-treatment technology has come a long way in recent decades. In high-income economies, methods are available to remove pathogens from water and make it safe to drink. Other technologies, such as ozone and chlorine treatments, are often used to disinfect wastewater, so that it can be reused or safely released into the environment. However, these methods are not routinely applied because they require high operational energy and significant infrastructure. They can also generate toxic by-products that are harmful for the environment and humans.

In addition, these processes aren’t perfect, and some contaminants still make it through the treatment stages, especially persistent chemicals. Many of these contaminants, which often originate from industry and agriculture, can have a serious impact on our health and the environment.

Furthermore, many water-treatment technologies that are widely used in high-income countries are too expensive for less fortunate parts of the world. Because of this, contaminated water is responsible for millions of preventable illnesses and deaths each year, due to drinking, bathing and irrigating crops. As climate change is also causing water scarcity in many developing nations, there is an urgent need for effective new treatment methods that can decontaminate water, enabling its reuse. By developing such wastewater-treatment technologies and making them widely available, we can reduce the impact of water shortages, and work towards an environmentally just future where everybody has access to safe, clean water.

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Towards this aim, Dr Luisa Orsini and her colleagues at Daphne Water Solutions Ltd have been working hard to develop a green technology, which is based on the use of small aquatic invertebrates called water fleas, also known as Daphnia [daff-nee-ah]. Barely the size of a sesame seed, these tiny crustaceans are found in bodies of water all over the world. As part of their natural life cycle, Daphnia can enter dormancy. The team identified dormant strains of Daphnia within lake deposits that have decontamination abilities superior to their modern descendants. These strains make Daphne Water Solutions distinctive and more efficient than other biological solutions and previous attempts at using Daphnia in water decontamination.

Water fleas are used by many regulatory bodies to assess the safety of our waters. Their transparent bodies mean that their physical health can be monitored while they are still alive, providing an accurate indication of the quality of the water they are in. As water fleas actively filter the water they are in, they uptake algae, bacteria and pollutants.

In regulatory science, the effect of contaminants can be quantified using Daphnia, algae and fish to determine the safe use of chemicals. Dr Orsini took this idea and flipped it on its head; instead of using water fleas to check the quality of water, why not use them to improve it? As they naturally filter everything in the water, including contaminants, they could work as tiny vacuum cleaners, helping to remove contaminants from water. Research by the Daphne Water Solutions team had shown that Daphnia populations revived from lake deposits can effectively remove up to 95% of chemical contaminants from wastewater. So, the question was how to employ them effectively.

The team designed a containment system that allows the water fleas to treat wastewater, while still keeping them contained. Their solution involves a system of containment devices that sustain the Daphnia population, while allowing water and contaminants to pass through. The water fleas thrive in these devices, extracting any unwanted pollutants from the water, and transforming them into harmless by-products, or trapping and concentrating them in their bodies.

The system can transform large volumes of water, from which removal of chemicals is challenging and expensive, into small volumes of tractable biomass containing concentrated chemical contaminants. This biomass is then sustainably treated to destroy any residual contaminants, and the Daphnia population can be reused, closing the production cycle without any waste. This is an important feature supporting the net-zero carbon emission ambition that global governments made at the Climate Change Summit in Glasgow in 2021.

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The team found that the water fleas were highly effective at removing contaminants from water. Not only were they able to remove dangerous substances that can harm human health, but they were also able to remove excess nutrients – nitrogen and phosphorus – that can cause eutrophication in aquatic environments. Eutrophication describes the excessive growth of algae and bacteria, which reduces the level of dissolved oxygen in a body of water, with devastating consequences for aquatic life. By reducing this effect, water fleas not only show potential for water decontamination, but also for addressing other environmental issues.

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Where Daphne Water Solutions really shines though, is how green it is compared to alternative technologies. Existing treatments often require large-scale mechanical or chemical processes, which can be costly in terms of energy and other resources, as well as pollution. Daphne Water Solution is a carbon-negative green technology that enables clean growth, while preserving natural resources, including biodiversity.

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Through inventive thinking and a dedication to a cause, Dr Orsini and her team have designed and developed a new technology that could revolutionise water decontamination, enabling water reuse. Water reuse is an urgent necessity, especially in less fortunate countries affected by climate change. The innovative solution offers a new approach that is highly effective, while also protecting human health and the environment. To scale up their technology, the researchers are now collaborating with water companies in Brazil, South Africa and the UK. Their ambition is to make the technology widely available and to deliver clean water for all. The team is looking for investors to accelerate the commercialisation of the technology across many geographic territories.

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This SciPod is a summary of the information held in patent document ‘Using Daphnia for bioremediation’. Patent Information: [*WO/2021/116229*](https://patentscope.wipo.int/search/en/detail.jsf?docId=WO2021116229&_cid=P12-KQ81GH-95326-1).

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