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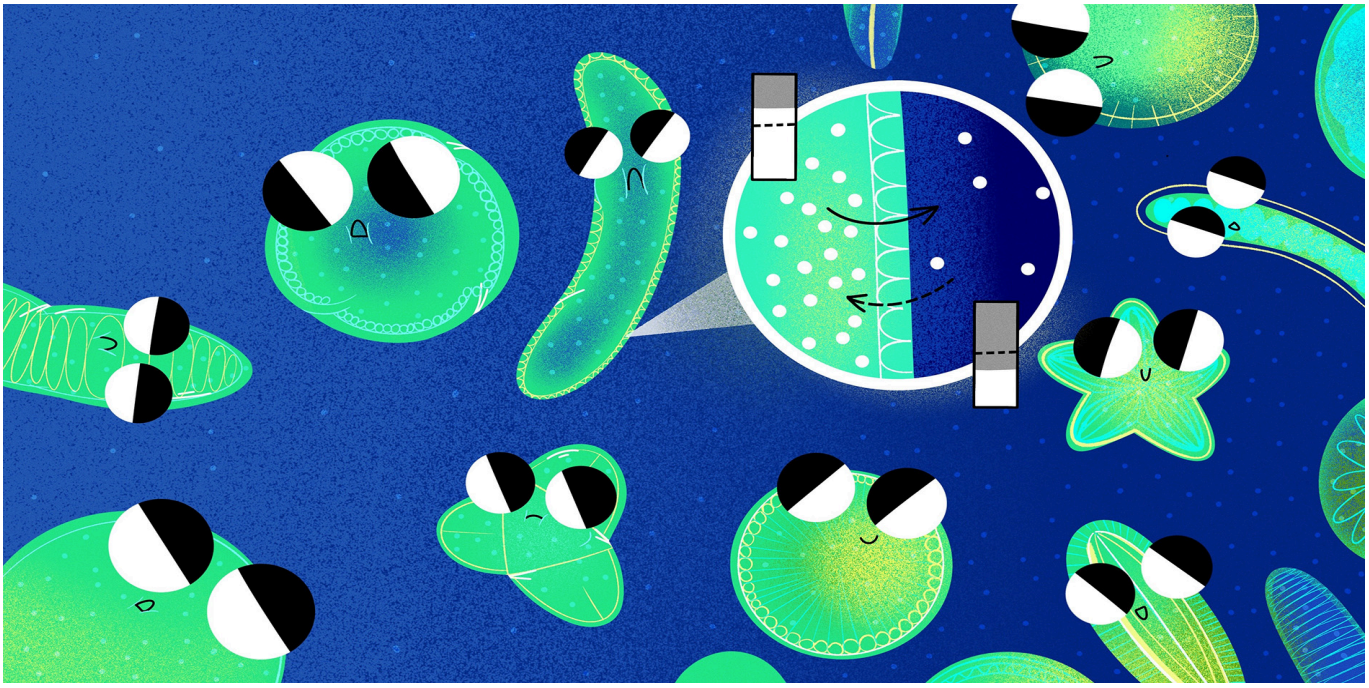

SALTY, BRACKISH, OR FRESH—SALTINESS MATTERS FOR AQUATIC SPECIES!

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YOUNG REVIEWERS:

ETHAN
AGE: 11

LORENZO
AGE: 12

PAOLO
AGE: 9

Did you ever eat too much salty popcorn? What happened afterwards? You probably became really thirsty. There was so much salt in the popcorn that the saltiness in your body got out of balance. The same way your popcorn can be too salty or just right, the saltiness in our oceans and coastal seas can be right or wrong for the marine life. You can tell the difference between salty ocean water and fresh lake water from their different tastes and smells, and from the fact that you can float easier in the ocean. However, the effects of saltiness are much more important for animals, plants, algae, and other organisms that live in the water—for them, saltiness is a matter of life and death.

WHY DOES SALTINESS VARY IN OCEANS AND SEAS?

If you have ever gotten a mouthful of ocean water, you know that it is really salty! But did you know that saltiness is almost the same in all of the world's open oceans: approximately 35 g/L? This means that in

one L of water, there are 35 g (6 teaspoons) of salt. However, there are places where saltiness can be much lower, such as in ocean water close to the coasts, and in smaller seas. That is because rivers and groundwater channels bring fresh water to these parts of the ocean. The fresh water then mixes with salty ocean water and forms what is called **brackish water**. Interestingly, the saltiness in your body is about the same as the saltiness of brackish water. Hence, your eyes will not burn if you swim in brackish water, like they would in salty ocean water or in fresh water, where the saltiness is different from that in your eyes.

BRACKISH WATER

A mixture of salty ocean water and fresh water.

SALTINESS: A MATTER OF LIFE AND DEATH

Some people like their meals saltier than other people do. Similarly, some underwater animals and plants like saltier water than others. However, for you, saltiness is a matter of taste; but for underwater organisms, it is a matter of life and death. Organisms that live in salty water have a lot of salt in their bodies. If they move to fresh water, too much water flows into their bodies to balance out the salt, causing them to swell up and die. In contrast, organisms that live in fresh water have only a little salt in their bodies. If they move to salty water, water comes out of their bodies to try to create balance, causing them to get too dry and die (Figure 1).

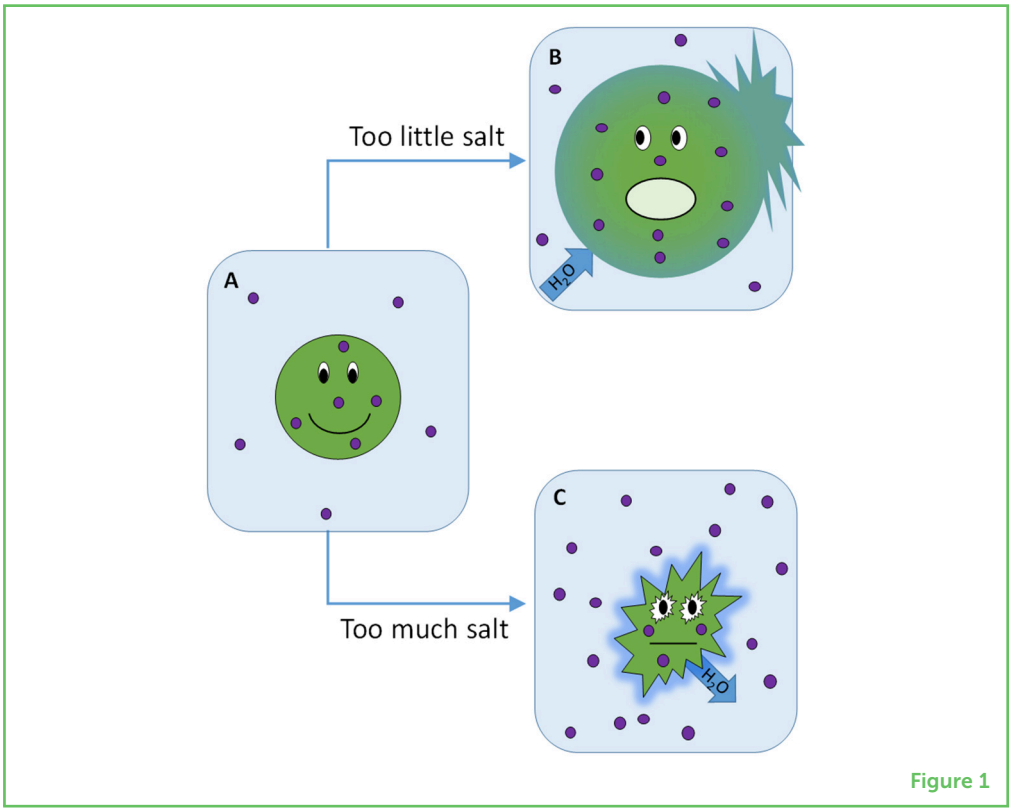

Figure 1

Figure 1

Saltiness is a matter of life and death for organisms that live underwater. **(A)** When the saltiness of the organism's body is the same as the saltiness of the water (H_2O), the organism thrives. **(B)** When the organism goes into water with saltiness that is lower than the saltiness inside its body, too much water moves into the organism to try to achieve balance, and the organism swells up and may explode. **(C)** If the organism moves into water with saltiness that is higher than the saltiness inside its body, too much water moves out of the organism, and it shrivels up and may eventually die.

BENTHIC

Living on the bottom of the ocean.

DIATOMS

One-celled, microscopic algae that have silica in their shells. They can live alone or build colonies with many individuals attached to each other.

ZOOBENTHOS

Animals living in and on the seafloor.

DIFFERENT NUMBERS OF SPECIES IN DIFFERENT KINDS OF WATER

Our research group lives and works on the coast of the Baltic Sea, which is a small coastal sea in Northern Europe. The Baltic Sea is special in terms of saltiness because it varies from salty oceanic water (>24 g/L) in the southwest, to brackish water (5–18 g/L) in the middle, to less salty and even fresh water (0–4 g/L) in the north and east (Figure 2). That is why we wanted to study how saltiness affects various species. We focused on algae (called **benthic diatoms**) and animals (called **zoobenthos**) living on the seafloor. Diatoms are tiny one-celled algae that live everywhere where there is water. They are important

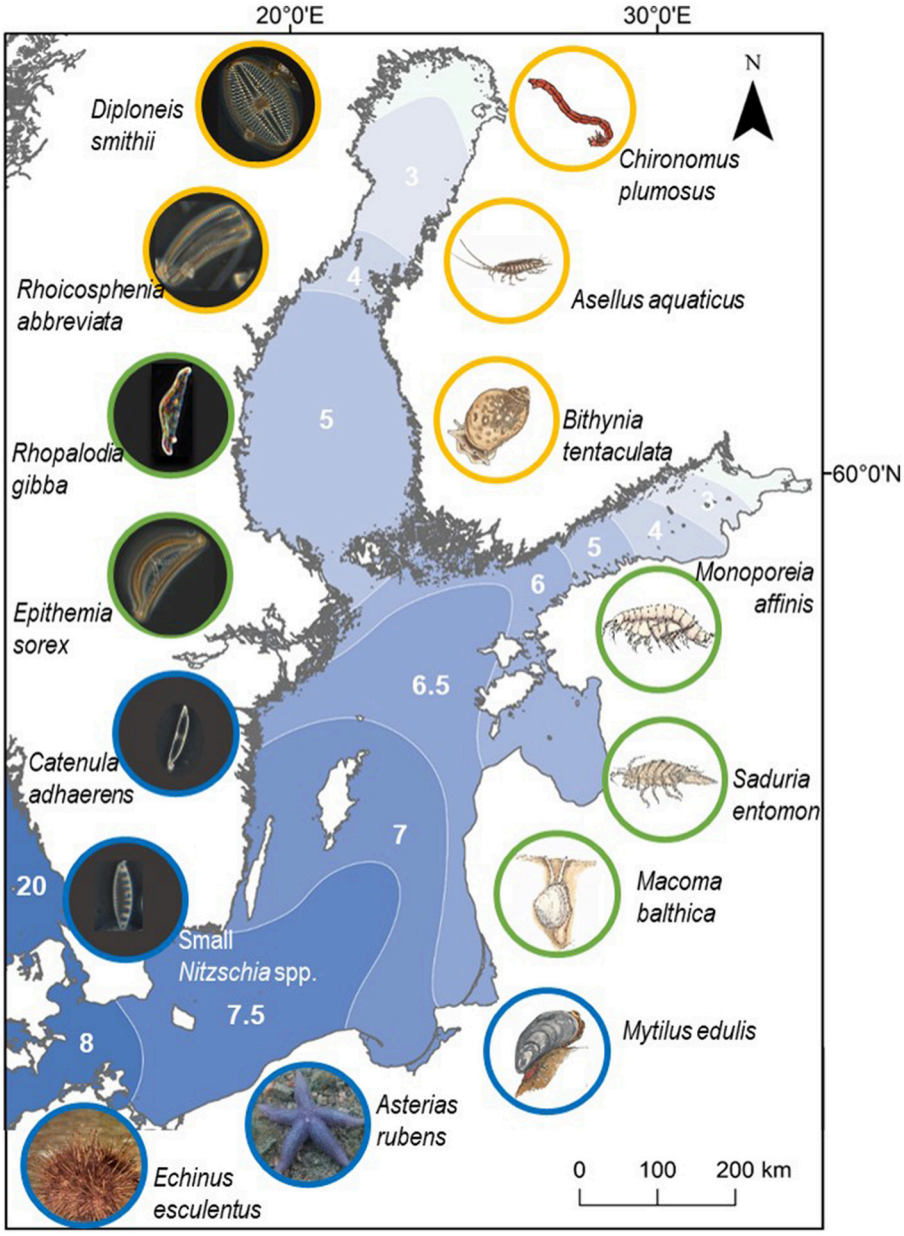

Figure 2

Different species of diatoms **(left side)** and zoobenthos **(right side)** live in different areas of the Baltic Sea, and one of the most important reasons for this is the variation in saltiness. Species that like fresh water (yellow circle), species that tolerate brackish water better than others (green circle), and species that prefer it salty (blue circle) are shown. Numbers show the saltiness level of each area in mg/L (Drawings by Juha and Karri Flinkman, photo of *Asterias rubens* by Camilla Gustafsson, other photos by authors).

because they make oxygen for us to breathe and they are food for small animals, such as zoobenthos. Zoobenthos live either buried in the **sediment** or they roam around on the seafloor. They are important for keeping the sediment healthy and they are also food for other animals. Zoobenthos include sea stars, sea urchins, crustaceans, bristle worms, oysters, clams, and cockles.

SEDIMENT

Sand, clay and other insoluble particles that have collected on the seafloor. Most parts of the world's seafloor are covered in sediment.

We collected samples from the seafloor in various parts of the Baltic Sea and used a microscope to identify species of diatoms and zoobenthos. We noticed that the number of species was different between areas with different saltiness [1]. The number of species of diatoms and zoobenthos was high in southern areas with high saltiness. For example, we counted up to 109 species of diatoms in one sample. The number of species was also high in the northern fresh water area but, toward the brackish water area in the middle, the number of species decreased [2, 3]. This is because only few species tolerate brackish water, which contains too much salt for species that are used to living in fresh water and too little salt for species that are used to living in the salty ocean. Another reason for the low number of species in brackish water is that brackish water areas are small, rare, and far apart, so only a few organisms have adapted to living there [4].

The number of species present, whether they are diatoms, animals, or other organisms, is important for the entire ecosystem. Ecosystems with many species often function better because each species has its own important "job" in the ecosystem, keeping it healthy. Often, ecosystems with many species can cope better with environmental changes, because even if one or two species do not survive, there are still many others left. Thus, species-poor brackish water ecosystems need to be protected, because they are home to unique plant and animal **communities** and can be vulnerable to environmental change.

COMMUNITY

Group of species that are found together.

SALTY, FRESH, OR BRACKISH?

Changes in the number of species between salty, brackish, and fresh water were not the only differences that we found in the communities of diatoms and zoobenthos. We also found completely different types of species and different sized species between salty areas and fresh water areas. Communities in brackish water were mixtures of both.

The diatom communities of the salty areas consisted mainly of species that are small and lie low to avoid being eaten. Toward the brackish and fresh water areas, we found more large and prominent species.

The zoobenthos species behaved in the opposite way. Salty areas had many big marine species, such as the sea urchin and sea stars.

GLACIAL RELICT

Species that was already around after the last ice age approximately 12,000 years ago.

These species cannot live in brackish water. The species that we found thriving in brackish water were quite few, but important, because they are food for many fish species. Common species in the brackish area were the Baltic clam and the blue mussel. We also found **glacial relicts**, which are species that were already around during the last ice age, approximately 12,000 years ago [1]. In fresh water areas, there were many small species, such as the faucet snail and various species of insect larvae, including the midge larvae [2, 3].

Diatoms and zoobenthos also affect one another. Large diatoms are an easy takeaway meal for zoobenthos. The high number of zoobenthic species in salty areas is likely to reduce the number of large diatom species. Due to this, diatom communities in salty areas mainly consist of small and low diatom species, because the large ones are eaten by zoobenthos.

WHAT DO OUR FINDINGS MEAN FOR THE FUTURE?

Saltiness is one of the most important factors determining where underwater organisms can live. In the future, climate change may alter the saltiness of oceans, especially in areas close to coasts where rivers bring fresh water from land to the ocean. This means that species that we are used to seeing at our favorite beach may not survive there anymore and may be replaced by new species that are adapted to the new saltiness. At the same time, the functioning of the whole ecosystem may change, because the new species may do their job differently than the ones they replaced.

We all can still help our precious oceans to stay healthy and functioning. We can clean up the beach, we can use less plastic to make less ocean debris, and we can reduce our carbon footprint by walking and riding a bike instead of taking a car. And most importantly, we can learn to understand our oceans better, because we will love only what we understand and conserve only what we love.

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REFERENCES

1. Villnäs, A., and Norkko, A. 2011. Benthic diversity gradients and shifting baselines: implications for assessing environmental status. *Ecol. Appl.* 21:2172–2186. doi: 10.1890/10-1473.1
2. Bonsdorff, E. 2006. Zoobenthic diversity-gradients in the Baltic Sea: continuous post-glacial succession in a stressed ecosystem. *J. Exp. Mar. Biol. Ecol.* 333:383–391. doi: 10.1016/j.jembe.2005.12.041
3. Ojaveer, H., Jaanus, A., MacKenzie, B.R., Martin, G., Olenin, S., Radziejewska, T., et al. 2010. Status of biodiversity in the Baltic Sea. *PLoS ONE* 5:e12467. doi: 10.1371/journal.pone.0012467
4. Remane, A. 1934. Die Brackwasserfauna. *Verandlunge der Deutschen Zoologischen Gesellschaft.* 36:34–74.

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CONFLICT OF INTEREST: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

YOUNG REVIEWERS

ETHAN, AGE: 11

My name is Ethan. I play the piano and take martial arts classes. I like video games and to read. My favorite thing to do is hang out with my friends, play video games, and read. I have a one-eyed pug named Loki. I love sharks and when I am older, I want to be a conservation biologist and swim with sharks.

LORENZO, AGE: 12

I am a sports enthusiast who is into everything from football to judo. Recently, I have been competing in judo since last year. I am not just muscles, I am good in math and physics at school. However, what I cherish the most is hanging out with my friends and having a good time together. Chess is another interest of mine. My mum is my favorite opponent, but let us be real, I have got her in checkmate more times than I can count!

PAOLO, AGE: 9

I am genuine curious and have a deep love for observing nature: plants, animals, fungi, and more. What intrigues me the most are insects; I am even comfortable capturing spiders with my bare hands! I bring various types of insects at home, much to the delight of my mum. As a birthday present, I received a terrarium, which I now use to spend hours observing my collection of insects. My dream is to become a scientist or a veterinarian.

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