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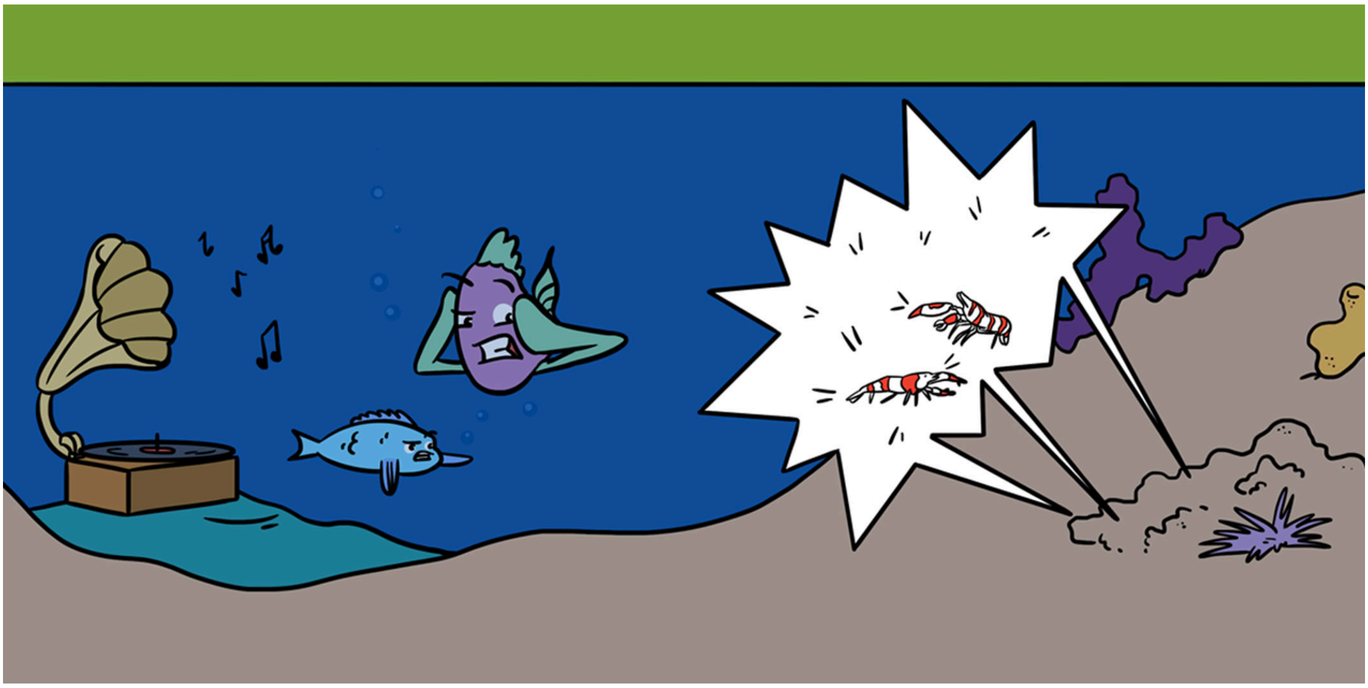

SNAPPING SHRIMP AND THEIR CRUSTACEOUS CACOPHONY

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AGES: 12–13

We humans are a noisy bunch. Our sounds fill the land and air around us, and even the oceans and seas. But we are not the only ones filling the sea with sound. Tiny snapping shrimp, also known as pistol shrimp, are some of the loudest animals in the ocean! They capture their prey by blasting it with a powerful shockwave from an enlarged claw. While the sound from each individual shrimp is small, the noise they make as a group has been known to mask the presence of submarines! How does something so small make such a loud noise? How can scientists use this noise to better understand the health of the seabed?

SNAPPING SHRIMP

Snapping shrimp, also known as pistol shrimp, are not at all like the little pink prawns that some people like to eat. They have a giant claw that gives them an uneven look (Figure 1). Snapping shrimp produce powerful **shockwaves** by snapping this oversized claw. The resulting

SHOCKWAVE

A wave of high pressure that moves faster than the speed of sound.

shockwave is used to communicate with other shrimp, to protect themselves and to hunt and kill their prey.

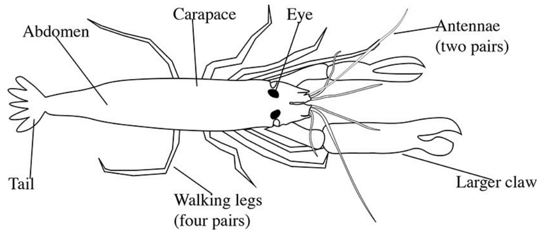

Figure 1

Figure 1

Snapping shrimp are crustaceans and typically have one claw larger than the other.

There are over 600 species of snapping shrimp in our oceans. They are part of the group of animals known as **crustaceans**. Snapping shrimp are the only marine **eusocial** animal, meaning they live in highly organised colonies, like those of bees, ants and mole-rats [1]. These shrimp can be hard to see because they like to hide amongst sponges, corals, stones and shells. They live in areas of the sea near to land where the water is warm and shallow. Snapping shrimp are found around Australia, Hawaii, the Korean peninsula and the Mediterranean Sea. Recently, due to global warming, snapping shrimp have been discovered on the coasts of the United Kingdom, an area once too cold for their survival.

CRUSTACEANS

A group of animals with hard exoskeletons, two pairs of antennae, joined legs and gills for breathing. Includes lobsters, crayfish, shrimp, and true crabs.

EUSOCIAL

Animals that are highly organised into groups or colonies, in which only a few individuals have offspring and those offspring are cared for by the group.

Snapping shrimp can grow to 6 cm in length but some can be as long as 10 cm. Their giant claw can grow to half their body length [2]. Despite their shy nature, these crustaceans are some of the loudest animals in the ocean! Scientists used to think that the loud snaps that these shrimp make came from the upper and lower parts of the giant claw banging together. But more recently, high-speed cameras and underwater microphones called **hydrophones** have been used to analyse the snapping claw in more detail [2].

HYDROPHONE

A type of microphone that has been designed to measure underwater sound.

Figure 2 shows a recording of the sound made by a shrimp snap. Scientists found that, at the beginning of the recording, the shrimp is already in the process of quickly slamming its big claw shut—this takes about half a millisecond. This rapid movement forces a jet of water to whoosh away from the claw at high speed, which, in turn, generates a small bubble. The bubble grows to around 7 mm wide. It is the collapse of the bubble that makes a short but loud snapping sound that generates a big spike in sound pressure, which is the pressure caused by sound as it moves through the water. The bursting bubble creates a shockwave that stuns or kills a shrimp's prey.

A single snap can go unnoticed in the sea, but a large group of snapping shrimp can create a continuous sound resembling the crackling of burning twigs or the hiss of Creepers from Minecraft. Sometimes this sound is loud enough to interfere with the underwater communications of other animals. During the Second World War,

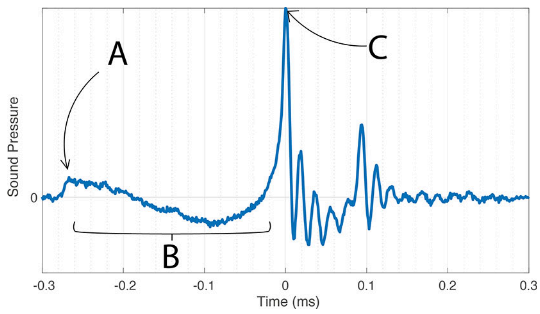

Figure 2

Figure 2

An example of what a shrimp snap looks like over 0.6 ms. The graph measures sound pressure, which is the pressure of the sound wave as it passes through water. At point **(A)**, the claw is slammed shut which creates a small bubble. This is followed by a drop in pressure, shown by **(B)**, during which the bubble grows. The sharp spike at point **(C)** is caused by the bubble popping.

American scientists realised that the noise of snapping shrimp was affecting the **sonar** systems used by Japanese ships. The scientists worked out where large colonies of snapping shrimp lived and used the shrimp noise to hide American submarines from Japanese sonar [3]!

SONAR

A system of sonic echoes used by ships and some animals for navigation. It helps to detect the size, shape and location of other objects including predators, prey or obstacles.

UNDERWATER NOISE

Listening to sounds like music or the wind in the trees can be a nice experience. But some sounds are not very nice to listen to, such as that of a fork scratching a dinner plate or a loud, busy road. These unwanted sounds are often called noise, and too much noise can be bad for our health. It can damage our ears and our hearing and can stop us from sleeping. Have you ever been kept awake by noises? If you do not sleep well, you can feel awful the next day, so we all know that noise can be stressful and tiring. It is not just humans that are affected by noise; too much noise can also damage wildlife. For example, loud traffic noise can affect the times that birds start singing in the mornings and evenings.

We know that noises traveling through the air can be damaging, but what about underwater noise? When having a bath or going for a swim in the sea or a swimming pool, you might have noticed how sounds travel differently through water. Many marine mammals, fish and invertebrates use sound as part of their daily lives. Dolphins, whales, walruses, fish, crabs and shrimp, for example, rely on sounds to get around, communicate and hunt. Some fish even make sounds to attract mates [4].

Unfortunately, too much noise can have serious effects on these animals, as it masks other sounds and prevents the animals from thriving (Figure 3). Lots of background noise can interfere with animals' senses and can cause confusion and changes in behavior. Human activities such as drilling into the seabed, the movement of boats and ships, fishing and dredging can all damage life on the seabed. This excess noise is called **noise pollution** and can make it

NOISE POLLUTION

Unwanted sound that can be disturbing or annoying.

harder for animals to communicate, find their way around, hunt or escape predators.

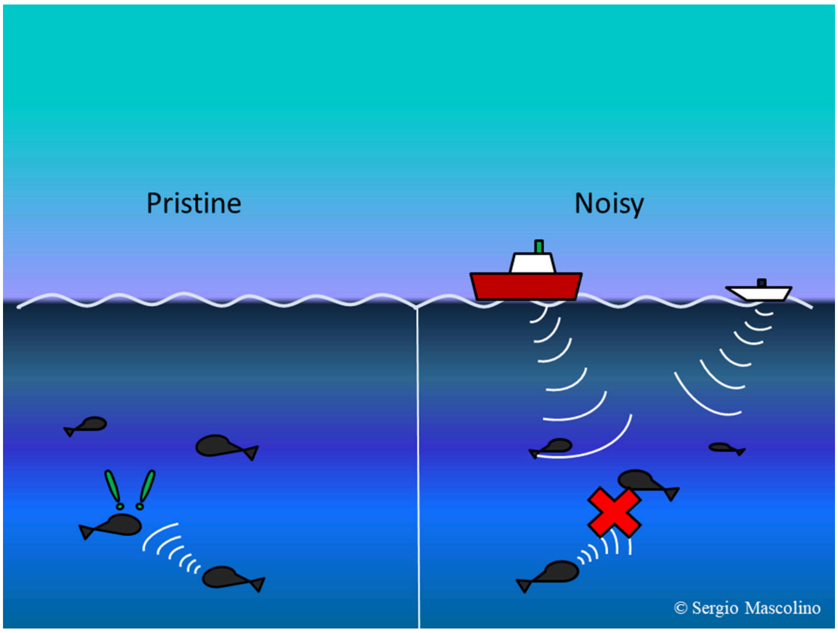

Figure 3

Figure 3

Noise pollution can interfere with the communication of underwater animals.

But just how damaging is noise pollution? Scientists can find it difficult to measure the effects of noise on our underwater wildlife, especially invertebrates [5]. Lots of studies are done on marine mammals and some on fish, but what about other, smaller animals? Could studying snapping shrimp help?

MONITORING THE ECOSYSTEM USING ACOUSTICS

Biodiversity is a measure of the number of different types of organisms, like plants and animals that live in a particular place or habitat. Areas with a high biodiversity are home to many species. Healthy coral reefs and other marine habitats are famous for their amazing biodiversity, but in some places, these habitats are affected by overfishing or pollution.

One way to measure the biodiversity of marine environments is by diving down to the seabed and taking lots of photographs and notes. This can be expensive, time consuming and sometimes dangerous. We know that snapping shrimp like to live inside sea sponges, which are commonly found on coral reefs and other areas. We also know that the healthier the seabed, the more snapping shrimp will live there [6]. Snapping shrimp can tell us something about the condition of the ocean floor. This means that snapping shrimp are good **biological indicators**; they can help us work out how healthy our oceans are. But how do we determine how many snapping shrimp live in a particular

BIOLOGICAL INDICATOR

A type of plant or animal that can be studied to show the health of a whole environment or ecosystem.

ACOUSTICS

The study of sound.

place? We cannot count them by sight because they often hide and are not always easy to see. This is where **acoustics** comes in handy!

We can work out how many snapping shrimp there are by listening to the sounds they make. Scientists use hydrophones to measure underwater noise. Placing hydrophones in carefully arranged positions can help locate the origin of a sound. If snapping shrimp are living in an area, their snaps will be heard on the recordings and their position can be detected.

Shrimp snaps are so loud, quick and full of energy that they can be fairly easy to detect. Scientists can also use groups of hydrophones to check that the sounds they hear actually come from the shrimp and not from some other animal or machine. The result is that acousticians can use sound recordings to count the number of snapping shrimp in large areas without disturbing the organisms that live there. This gives scientists an idea of the overall health of the seabed [6]. Acoustics has also been used this way to study other animals including birds and bottlenose dolphins [7, 8].

Recently, scientists have discovered snapping shrimp living in regions that were once too cold for them. The snapping shrimp are telling us, loud and clear, that our climate is changing, and that our seas are getting warmer. Perhaps we should listen to what they are saying!

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YOUNG REVIEWERS

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We are a group Y8 and Y9 students at St Oscar Romero Catholic School in Worthing, UK. In total there were 111 of us! We love opportunities to extend our learning beyond the classroom, so it has been great to review scientific papers prior to publication!

AUTHORS

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Cian Jones is a graduate of the University of Salford where he undertook a project to learn how to use acoustics to locate snapping shrimp on the seabed without disturbing their habitat. His work gave him the opportunity to work with scientists from around the world which helped him discover all sorts of exciting things about these fascinating crustaceans. He now works as an acoustic consultant at AECOM where he works toward making the world a quieter place. *cian.jones@aecom.com

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Chiara Benvenuto is a reader in behavioral ecology at the University of Salford. Born in a small village in Italy, on the Mediterranean Sea, she has always been fascinated by the incredible adaptations of aquatic animals (especially fish and crustaceans). Chiara focuses her research on the evolution of mating systems and strategies (including sex change), adaptations to a variable environment (including color change) and behavioral responses to environmental modifications made by humans (including contaminants and noise pollution).

PAUL KENDRICK

Paul Kendrick is an audio machine learning software engineer and researcher. Paul has carried out research into how audio captured in various environments can be analyzed to measure biodiversity. Paul has used artificial intelligence to assess bird activity at the Chernobyl accident site in Ukraine and earlier in his career earned a PhD in room acoustics from the University of Salford. Paul currently works as an artificial intelligence researcher in the professional audio industry, developing intelligent tools for sound engineers.

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