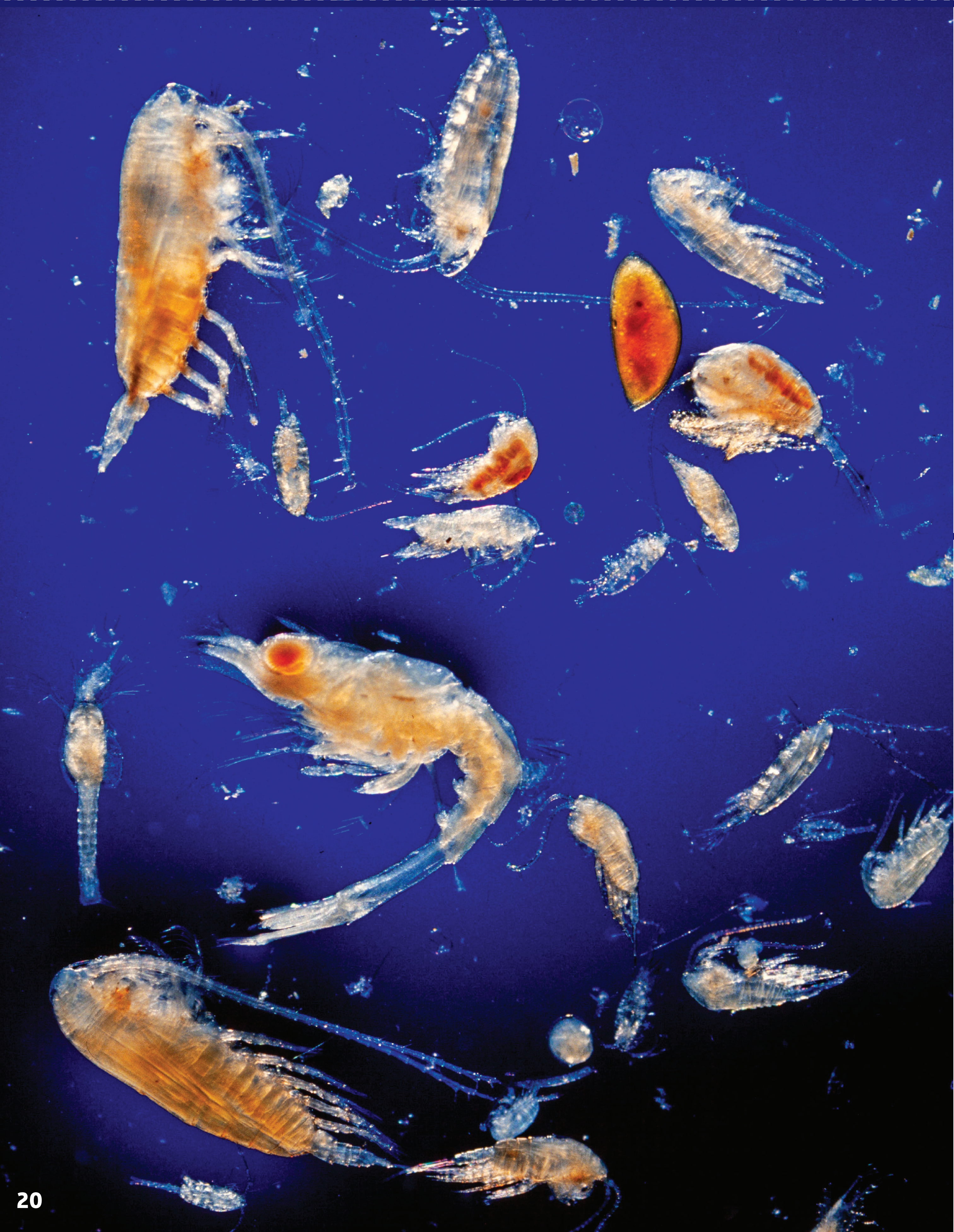


Tiny Critters, Massive Migration

by Nora Nickum

ROUND TRIP IN JUST ONE NIGHT

The largest migration on Earth happens across all its aquatic habitats, from ponds to the ocean, every single night.

Many of the travelers are *zooplankton*. This is a group that includes tiny crustaceans such as copepods and krill, as well as jellies and pelagic, or open-ocean, worms. Many fish and squid also make the journey. During the day, they hide in the dark depths. But at night, they move upwards in the water—hundreds of feet or more, in about 20 minutes. Then, when sunrise nears, they head back down.

A Tough Journey

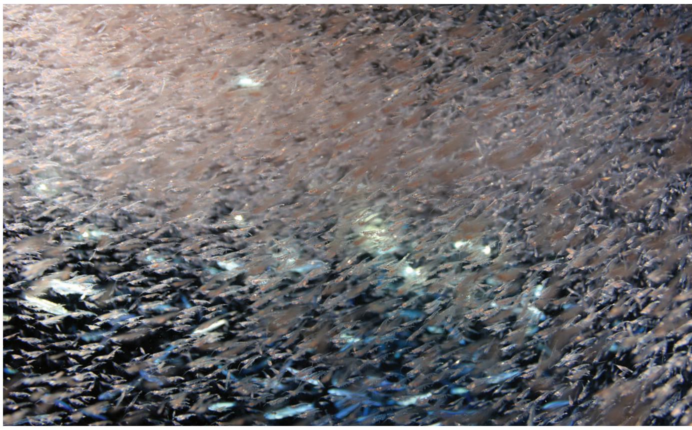
This *diel* vertical migration (*diel* means 24-hour) isn't an easy jaunt for zooplankton. They don't have a lot of power for movement and can be smaller than the white edge of your fingernail.

"If you scaled it to a human, that'd be like running a 10K [6.2 miles] to get your dinner and then a 10K before you went to bed—and doing it at twice the speed of an Olympic marathon runner," says Kelly Benoit-Bird. She's a senior scientist at the Monterey Bay Aquarium Research Institute in California.

This migration takes a lot of energy. A copepod or krill uses its swimming legs to motor up and down in the water column, but it isn't strong enough to fight sideways currents or tides. It risks getting swept away from its home range. So, why do zooplankton migrate if it's difficult and risky?

Zooplankton need to hunt for microscopic plant-like organisms called *phytoplankton*. These float near the surface and photosynthesize, or soak up sunlight to make energy. If zooplankton hang out at the surface, they'll find plenty to eat.

The problem is when the Sun is up, those surface waters can



Zooplankton, seen here in the ocean, migrate every day to feed and avoid being eaten.

be dangerous. In the light of day, birds, salmon, and tuna can spot the zooplankton and devour them. The deep is much safer. Down deep, though, snacks are tough to find. The cold water and lack of food slows a zooplankton's growth. They can't stay here, either.

So–nighttime, go up for dinner. Daytime, lie low.

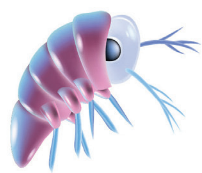
Time to Leave

Zooplankton get moving when the amount of light changes. Scientists figured out light was an important signal. They watched what happened when cloudiness, smoke, and solar eclipses reduced light levels in the water: Zooplankton changed their migratory behavior. Zooplankton also adjust their timing when the seasons change, making the days shorter or longer.

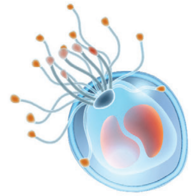
In the dark Arctic winter, zooplankton adapt even more dramatically. They migrate in response to moonlight instead of sunlight. And they go deeper when there's a bright full Moon, likely to better avoid the eyes of hungry fish and birds.

Jellies, also known as jellyfish, are both a type of zooplankton and a predator of zooplankton.

MEET VARIOUS TYPES OF PLANKTON

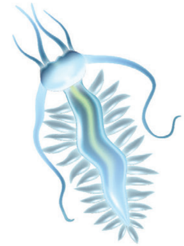


Amphipod

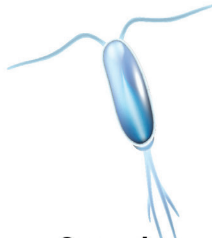


Zooplankton

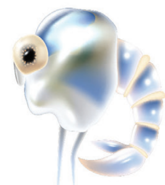
Moina



Artemia



Copepod



Daphnia

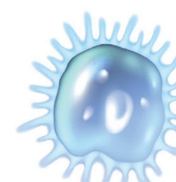
Brachionus

Krill

Atlanta

Phyllosoma

Rotifer



Phytoplankton

PUZZLING IT OUT FOR 200 YEARS

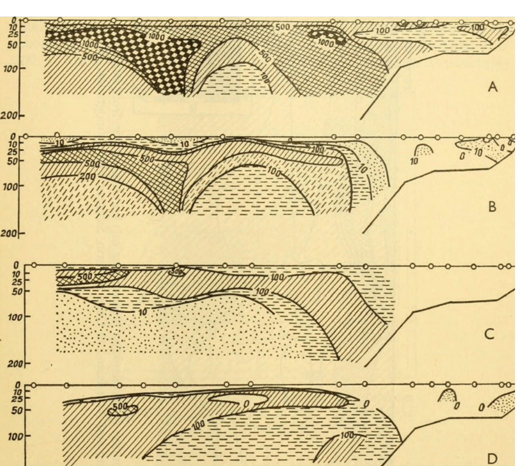
A French naturalist named Georges Cuvier first documented this daily mass migration in the early 1800s. He observed that water fleas disappeared and reappeared in the upper waters of a lake every day. A little over a century later, the US Navy noticed strange measurements from their sonar that seemed to indicate the seafloor was moving up and down. Scientists eventually figured out the sonar had been pinging off a layer of vertically migrating animals such as zooplankton. Today, scientists like Benoit-Bird purposely use sonar to study diel vertical migration.

From one day to the next, exactly when zooplankton migrate is also influenced by other factors. These can include temperature, how hungry they are, how much food is available, whether there are predators around—and other circumstances that are still a mystery. "Sometimes we'll see some animals stop migrating, and others keep going," Benoit-Bird says. "We're trying to untangle the 'why' and the 'so what'—what impact does that have on the animals that eat them?"

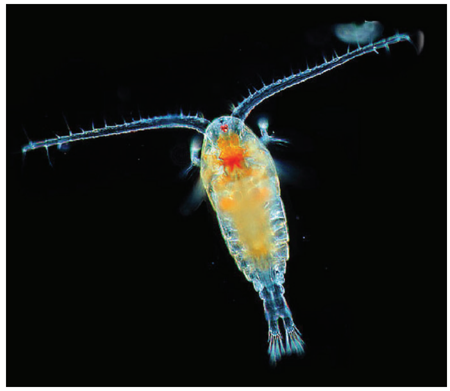
Look at those eyes! A zooplankton under a microscope.

One recent discovery is that smaller animals start migrating upwards before the Sun has gone down. Meanwhile, bigger animals, which are easier for predators to spot, wait and go up when it's darker. They often move more than an hour and a half after the little critters.

Benoit-Bird and her colleagues also discovered that zooplankton change their travel plans to evade fish they fear might eat them. They saw when schools of fish appeared, zooplankton zipped downwards and went deeper than they did on other days.



This 1956 diagram shows the definite movements of copepods in the Bering Sea.



Copepods, a small form of zooplankton, take different forms.

Sound and DNA

Scientists use tags to track large animals such as whales or sea turtles. But zooplankton are way too tiny for tags. So, scientists have tended to focus on tracking where zooplankton are concentrated, and how and when those clusters move.

One method is to go out on a boat, tow a net through the water, empty it out, and count how many zooplankton there were at a given depth at a particular time of day. But because the vertical migration happens quickly, scientists may only get one sample per night. That isn't enough to get a detailed understanding of the animals' behavior.

Benoit-Bird started using another tool: sonar. Echosounders send out short pulses of sound that hit patches of vertical migrators and bounce back. This reveals detailed movements happening over a short period of time.

But since the sound data shows up as pixels on a computer screen, it's still a mystery exactly what kind of animals Benoit-Bird has found. She began putting an SUV-sized robot into the ocean to do more investigating. Using a video camera on the robot, she can look more closely at an area the sonar has identified as dense with little animals. The first time she did so, she was excited to see a bunch of four-inch-long (10 cm) squid. They put out plumes of ink as they became aware of the robot in their midst.

To identify tinier animals, the underwater robots can also collect water samples. Back in the lab, Benoit-Bird's colleagues search those samples for DNA left behind when the zooplankton shed or pooped. The DNA might reveal the zooplankton were tiny translucent shrimp, krill, or baby lanternfish.

Sticking Together

When you scoop zooplankton up with a net, Benoit-Bird says, "you see a huge jumble of animals all together, and you think that's how they live." Tools like sonar have helped her figure out that zooplankton and other small migrators are, in fact, organized. They migrate up and down with others just like them—pals of the same species and size. "They stay with their friends," Benoit-Bird says. As with a school of fish, sticking together helps zooplankton reduce their individual risks of being eaten.

"In the ocean there are no trees to hide behind, no holes," Benoit-Bird points out. "The only tool they have is moving up and down and trying to stay with their neighbors."

Just think—zooplankton are doing this coordinated dance, as Benoit-Bird describes it, somewhere on Earth this very moment.

REVERSE COMMUTERS

Some zooplankton migrate in reverse. They go up in the daytime and swim down deep at night. That's probably so they can steer clear of predators (including bigger zooplankton) that don't hunt visually and that have gone down in the daytime to escape their own predators. It's still an effort to eat without getting eaten.

Nora Nickum works at the Seattle Aquarium and is the author of the upcoming middle-grade book *Superpod: Saving the Endangered Orcas of the Pacific Northwest* (Chicago Review Press, April 11, 2023). Her daily migration is horizontal and involves walking her first grader to school.