Ripple Marks

The Story Behind the Story

BY CHERYL LYN DYBAS

ONE FISH, TWO FISH, COLD FISH...WARM FISH?

Opah is First Known Warm-Blooded Ocean Fish

*One fish, two fish, red fish, blue fish.
From there to here, from here to there,
funny things are everywhere.*

So wrote Dr. Seuss in his 1960 classic.

But nowhere among the cold fish—the only kind known to Seuss, or to science—was there a warm fish.

Now researchers have discovered that the opah is in fact just that. It pumps heated blood through its body as if it were a mammal or a bird.

It's a fish even Seuss didn't imagine.

The silvery, platter-shaped fish (*Lampris guttatus*) is also known as the moonfish, kingfish, redfin ocean pan, and Jerusalem haddock. It's found in oceans around the world, a few hundred meters down in cold, low-light waters. The opah moves by rapidly flapping its red pectoral fins as if they were wings.

COLD WATERS, WARM FISH

Fish that live in cold depths are usually slow moving; they conserve energy by ambushing their prey instead of chasing it. But the opah's continual fin-flapping heats its body and increases its metabolism, researchers report in the May 15, 2015, issue of the journal *Science*.

That warm-blooded advantage has turned the opah into a high-performance predator that swims faster, reacts more quickly, and sees more sharply, says fisheries biologist Nicholas Wegner of the National Oceanic and Atmospheric Administration (NOAA) Southwest Fisheries Science Center in La Jolla, California. Wegner is the lead author of the *Science* paper.

"Like everyone else, I thought the opah was a slow-moving fish similar to most other fish in cold environments," Wegner says. "But because it can heat up its body, it's an active predator that chases down prey like squid. And it can migrate long distances."

Wegner realized the opah was unusual when he and NOAA biologist Owyn Snodgrass, a co-author of the paper, and colleagues looked at a sample of its gill tissue. The scientists, including NOAA co-authors Heidi Dewar and John Hyde, glimpsed an unusual design. Vessels that carry warm blood into the fish's gills wind around those carrying cold blood back to its body core.

COUNTER-CURRENT HEAT EXCHANGE: DISCOVERED BY FISH

In engineering, the design is known as "counter-current heat exchange." The concept was invented in fish, it turns out, long before humans thought of it.

For an opah, it means that warm blood leaving its core helps heat up cold blood returning from its gills.

Wegner compares it to a car radiator, "but this is a natural adaptation that conserves heat. The unique location of the exchange in the gills allows the opah's body to maintain a warm temperature, even in colder waters."

There's never been anything like it, he says, "seen in a fish's gills. It's an innovation that gives the opah a competitive edge."

Southwest Fisheries Science Center, NOAA Fisheries Service

National Marine Fisheries Service biologist Nick Wegner preparing to insert a thermocouple into the pectoral musculature of a captured opah for simultaneous recording of environmental and internal body temperature following release.

Captured opah being brought onboard a fishing vessel for outfitting with an intramuscular temperature sensing data logger by National Marine Fisheries Service biologists.

Southwest Fisheries Science Center, NOAA Fisheries Service

National Marine Fisheries Service biologist Nick Wegner holding a recently captured opah.

Southwest Fisheries Science Center, NOAA Fisheries Service

INTO THE LIGHT:
FISH OF DIMLY LIT WATERS

The researchers collected data from opahs caught during fish surveys off the US West Coast. They found that the fishes' temperatures were warmer than those of the surrounding waters.

The biologists attached temperature monitors to the opahs and tracked the fish on dives down to several hundred meters. "We found that their body temperatures stayed steady even though the water temperatures dropped," says Wegner.

The fish had average muscle temperatures about five degrees Celsius above ambient water temperatures—even at hundreds of meters below the surface.

Mammals and birds often maintain warmer body temperatures than their surroundings, but the opah is the first fish that does so.

Other fish such as tunas and some sharks warm certain parts of their bodies, such as muscles, to increase their swimming performance, says Wegner. "But internal organs, including their hearts, cool off quickly and slow down when they dive to colder depths, forcing them back to the shallows to warm up."

Satellite-tracking shows that opahs spend most of their time in the depths, without regularly surfacing. Their higher body temperatures allow longer dives, increasing muscle capacity, boosting eye and brain functions, and helping the fish resist the effects of cold on the heart and other vital organs.

"Nature has a way of surprising us with clever strategies," says Wegner. "It's hard to stay warm when you're surrounded by cold water—but the opah has figured out how to do it."
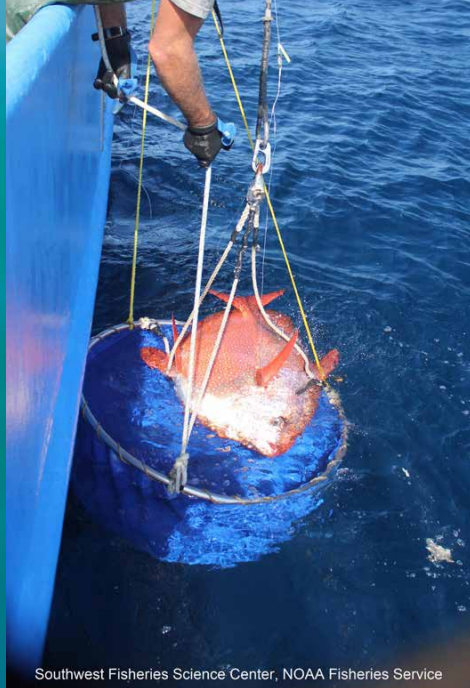
INCREASING NUMBERS OF
OPAHS OFF CALIFORNIA?

Surveys off California have found more opahs in recent years, "but we're not sure why," says Wegner.

Shifting currents or changes in water temperatures may be bringing the fish into the region, their prey may be more abundant, or, for unknown reasons, the opah population may be increasing.

Opahs caught during the research cruises have revealed a plethora of information. For example, genetic analyses show that opahs off California are likely a different species than those near Hawaii, where they're more common fish.

Opahs also have a unique gill structure. It may help scientists understand the fishes' ability to forage at various depths, from 50 meters at night to 200 meters during the day. The vertical movements are likely a result of opahs following prey with similar migrations.

In next steps, Wegner and colleagues are conducting research on whether an opah's diet changes with environmental conditions, and how the anatomy of an opah affects its swimming mechanics.

They also hope to tag more opahs to learn where the fish go, when—and why. "This research will provide the basic life history information we need to do population assessments," says Wegner.

Historical data may be of help, perhaps showing correlations between the opah's abundance and changes in sea surface conditions such as El Niño and La Niña.

OPAH: THE RESTAURANT

Despite opahs' presence off California, they're seldom snagged by fishers. In Hawaii, however, the fish are commercially caught and sold. The opah's rich meat is increasingly sought after in seafood markets and restaurants.

Opah is so popular in Aliso Viejo, California, near Newport Beach, that restaurant owner and chef Marc Cohen can barely keep it on the menu. Every week, Cohen serves at least 200 orders of opah, which, he says, "tastes like a cross between a sweet mahi-mahi and swordfish." The name of his eatery? In honor of what Cohen believes is "one beautiful fish," a seafood grill named Opah.

Cheryl Lyn Dybas (cheryl.lyn.dybas@gmail.com), a Fellow of the International League of Conservation Writers, is a contributing writer for *Oceanography* and a marine ecologist and policy analyst by training. She also writes about science and the environment for *National Geographic, Natural History, World Wildlife, Africa Geographic, BioScience, National Wildlife, Scientific American*, and many other publications.