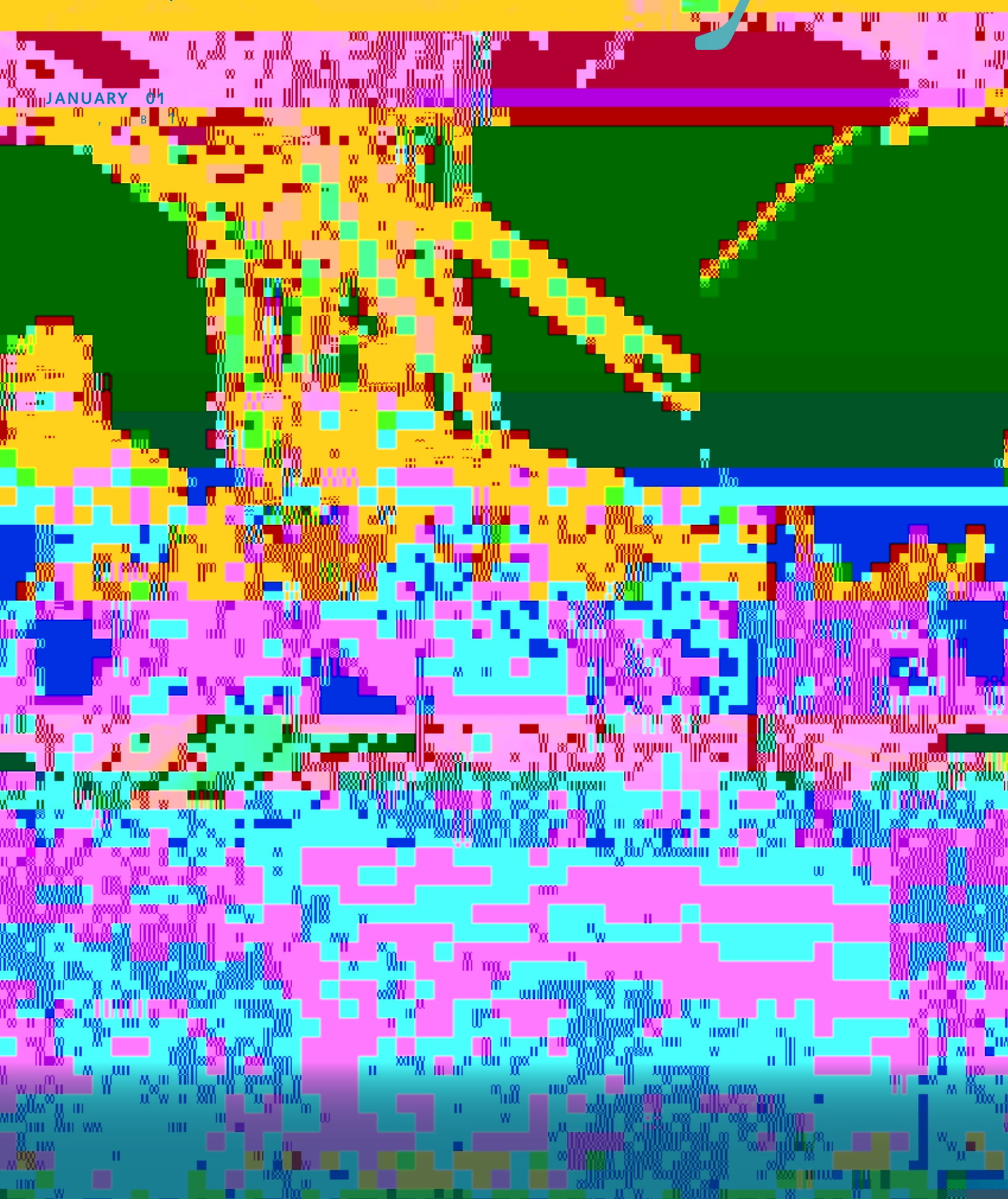




# Catalyst

JANUARY 01





1. The first part of the document discusses the importance of maintaining accurate records of all transactions and activities. It emphasizes the need for transparency and accountability in financial reporting.

2. The second part of the document outlines the various methods used to collect and analyze data. It includes a detailed description of the experimental procedures and the statistical techniques employed to interpret the results.

3. The third part of the document presents the findings of the study. It shows that there is a significant correlation between the variables being studied, which supports the hypothesis that was tested.

4. The fourth part of the document discusses the implications of the findings and suggests areas for further research. It highlights the need for more comprehensive studies to confirm the results and explore the underlying mechanisms.

5. The fifth part of the document provides a conclusion and summarizes the key points of the study. It reiterates the importance of the findings and the need for continued research in this field.

6. The sixth part of the document includes a list of references and a bibliography. It cites the works of other researchers in the field and provides a comprehensive overview of the current state of knowledge.

7. The seventh part of the document contains a list of figures and tables. It provides a detailed description of each figure and table and explains how they relate to the findings of the study.

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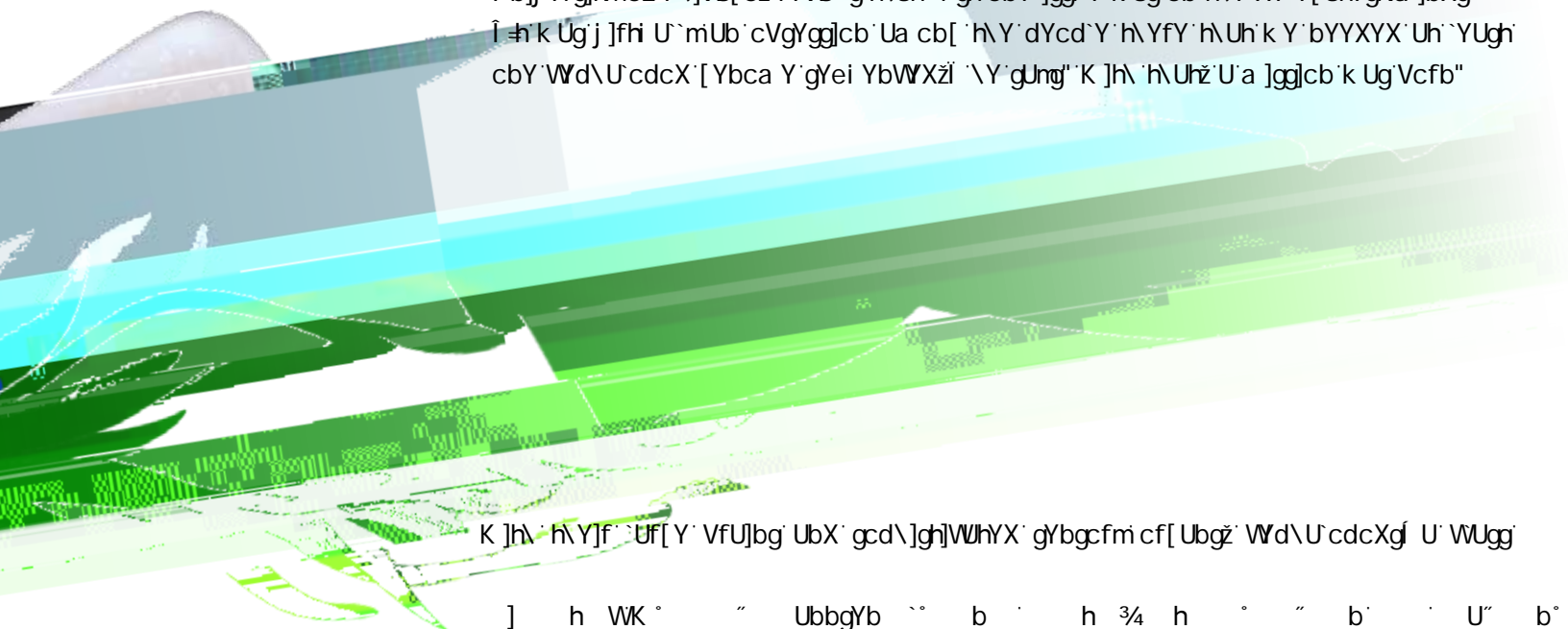
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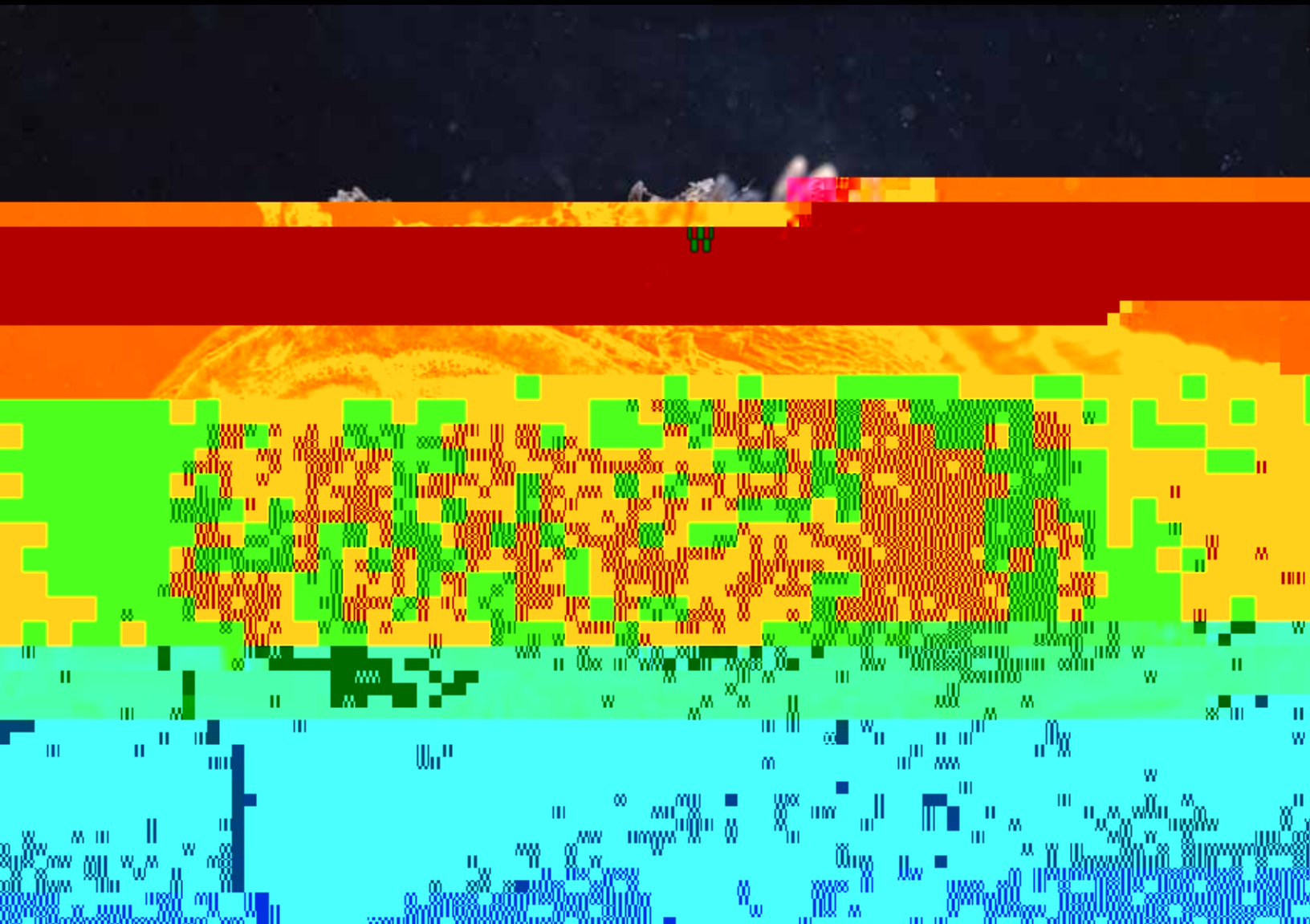
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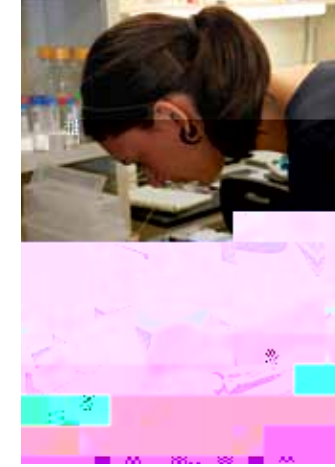
With their fleshy lips and flat heads, toadfish won't win any marine beauty contests. But what they lack in good looks, they make up for in hardiness. "You can't kill them," Mensinger says. Toadfish hold another advantage over other fish: Their sensory nerves are protected by only the thinnest bit of skull. By removing this plate of bone, researchers can directly access the fish's neural wiring to figure out what makes them tick.

Toadfish have been research subjects at MBL since the laboratory first opened in 1888, when zoologist Cornelia Clapp began studying their development for her doctoral dissertation at the University of Chicago. In the 1960s, MBL researchers prized the animals for research on insulin. In humans, insulin-secreting cells are scattered in islets throughout the pancreas. In the toadfish, however, these cells are largely found within a single islet, making them easy to locate, isolate, and study. This research revealed new ways to stimulate insulin secretion.

Stephen Highstein, now a senior scientist at MBL, began working with the toadfish in the 1970s. He is interested in the vestibular system in the inner ear, which controls equilibrium and balance. "It's a very convenient experimental animal," Highstein says. Because their heads are so broad, "the inner ear organ is quite a distance from the brain, which gives you a long length of nerve to work with." Highstein isn't put off by the fish's appearance. "I think they're handsome," he says.

Mensinger joined Highstein's lab in the 1990s as a postdoctoral associate, and that's when he began working with toadfish. Together they fitted toadfish with electrodes to record their nerve impulses and sent them into space as part of NASA's 1998 NeuroLab shuttle mission. "We wondered how the ear would respond to the lack of normal gravitational stimulus," Highstein says.

How did the space-traveling fish do? In the microgravity of space, the fish's inner ear "turned up" its sensitivity to gravitational stimuli, looking for the missing signal. "This seems to be a general principle in biology," Highstein says. "In Parkinson's syndrome, for example, when the brain decreases its production of dopamine, there is a genetic up-regulation of some dopamine receptors, looking for the missing dopamine." In space, "the perverted inner-ear signal regarding gravity conflicts with other vestibular and visual signals, creating a mismatch in the brain areas responsible for body and head orientation," he says. "We think this mismatch causes motion sickness, or space adaptation syndrome."



Highstein, an MD/PhD, continues to value the fish for basic biomedical research. "A few times in my research career, I've been lucky enough to discover something in the toadfish that, because of my clinical background, I recognized its relationship to human malfunctions of the inner ear," he says.

Mensinger today works in the field of neuroethology, which explores the neural basis of natural animal behaviors. Research in this field has typically been carried out on a single sensory system—hearing, vision, or smell. However, "when fish are out there, they're getting all this sensory information from multiple sources," Mensinger says. He wonders how they absorb and process this wealth of input.

Male toadfish, for example, attract females by producing a long, low sound uncannily like a fog horn. How the fish hear this mournful call is something of a mystery. The hearing organ in fish is internal and "final the

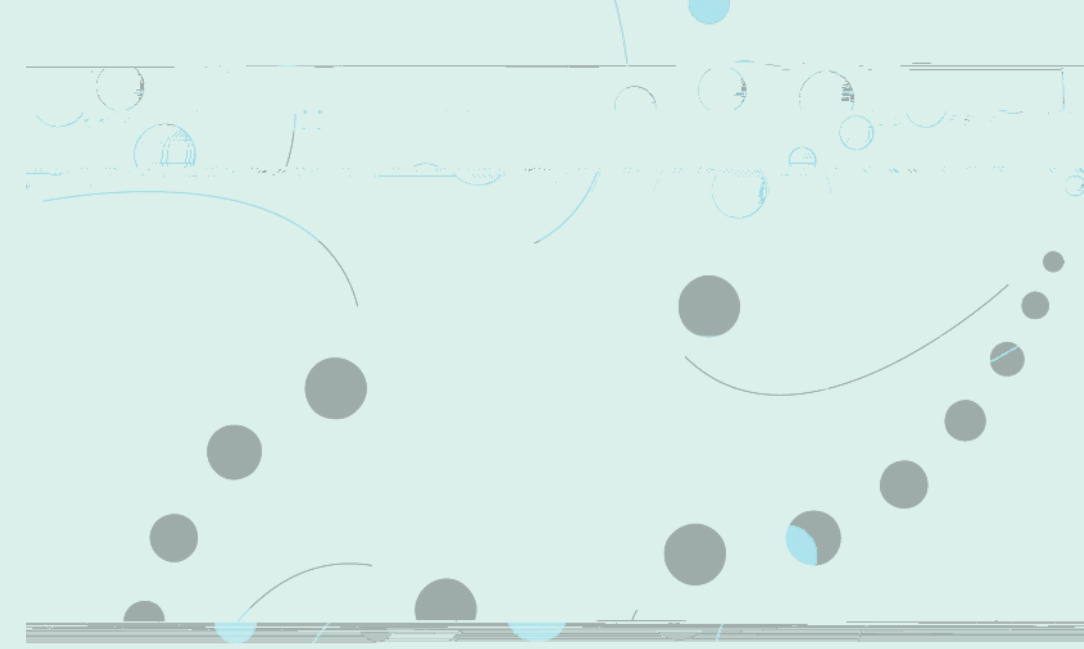
**Not unique at all, it turns out.**

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# The Collector's Net



David Remsen

Which species are most popular, in terms of researchers requesting their supply from the Marine Resources Department (MRD)?

**DR** The priority species change with time. When I worked at the MRD in the 1980s, everybody wanted the surf clam (*Saxidomus nutalli*). Research on cell division using eggs of these clams was just going gangbusters, and we couldn't collect enough. But that has gone through its gold-rush phase and settled to a low boil. Squid, horseshoe crabs, many of the organisms we collect have been significantly important at different times. Right now, the starlet sea anemone (*Styela pinnata*) is really big and the demand for skate embryos (*Rajidae*) exceeds our ability to supply them. Although we usually just collect wild animals and ship them to researchers, we have started breeding programs for the sea anemone and the skate to ramp up for demand. Both are used for research on embryological development and the evolutionary history of development. Sea urchins, another useful organism for studies of development, are also in high demand.

How do you collect the organisms?

**DR** We drag a net from our collecting vessel, the *R/V Endeavor*, for some species; others are collected by hand. We dive for organisms that are below the surface of the ocean floor or are too delicate to collect by other means. Surf clams and parchment worms (*Polychaeta*) have to be dug by hand, for example.

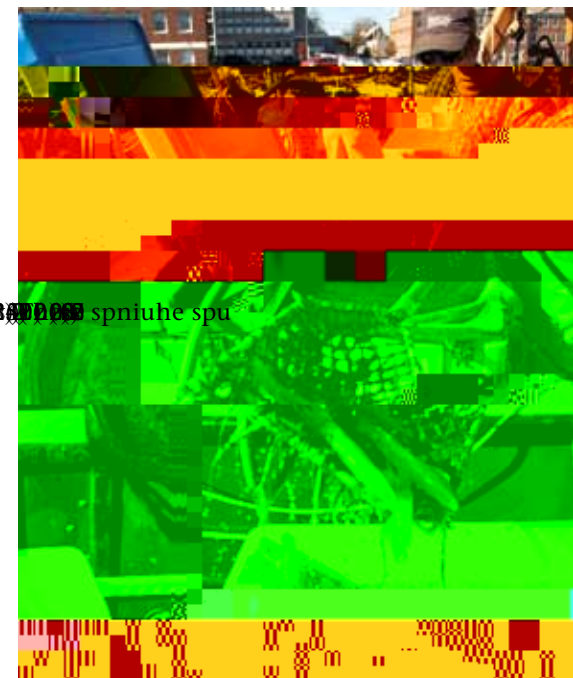
The MBL can collect an unusually rich diversity of species within a 75-mile radius of Woods Hole. Why is that?

**DR** The species assemblages you find in the waters north of Cape Cod are very different from those found in the south. The purple-spined sea urchin (*Acanthaster planci*), for example, is found in Woods Hole and south to the Gulf of Mexico, while the green sea urchin (*Styrodia*)

is found in Cape Cod Bay and north into the Arctic. We collect the purple urchin when they are gravid [have eggs] from June through August, and we know how to keep them gravid at the MRD until November. Then the eggs of the green sea urchin come into season from December through February. If we keep them in cooler water at the MRD, rather than letting them warm up in the spring, they will stay gravid through April. That gives us almost ten months of urchin egg availability. Other organisms come into season at other times.

How do you know where to look for a particular organism?

**DR** It's an oral tradition. Scientists have been collecting sea urchins since the 19th century.







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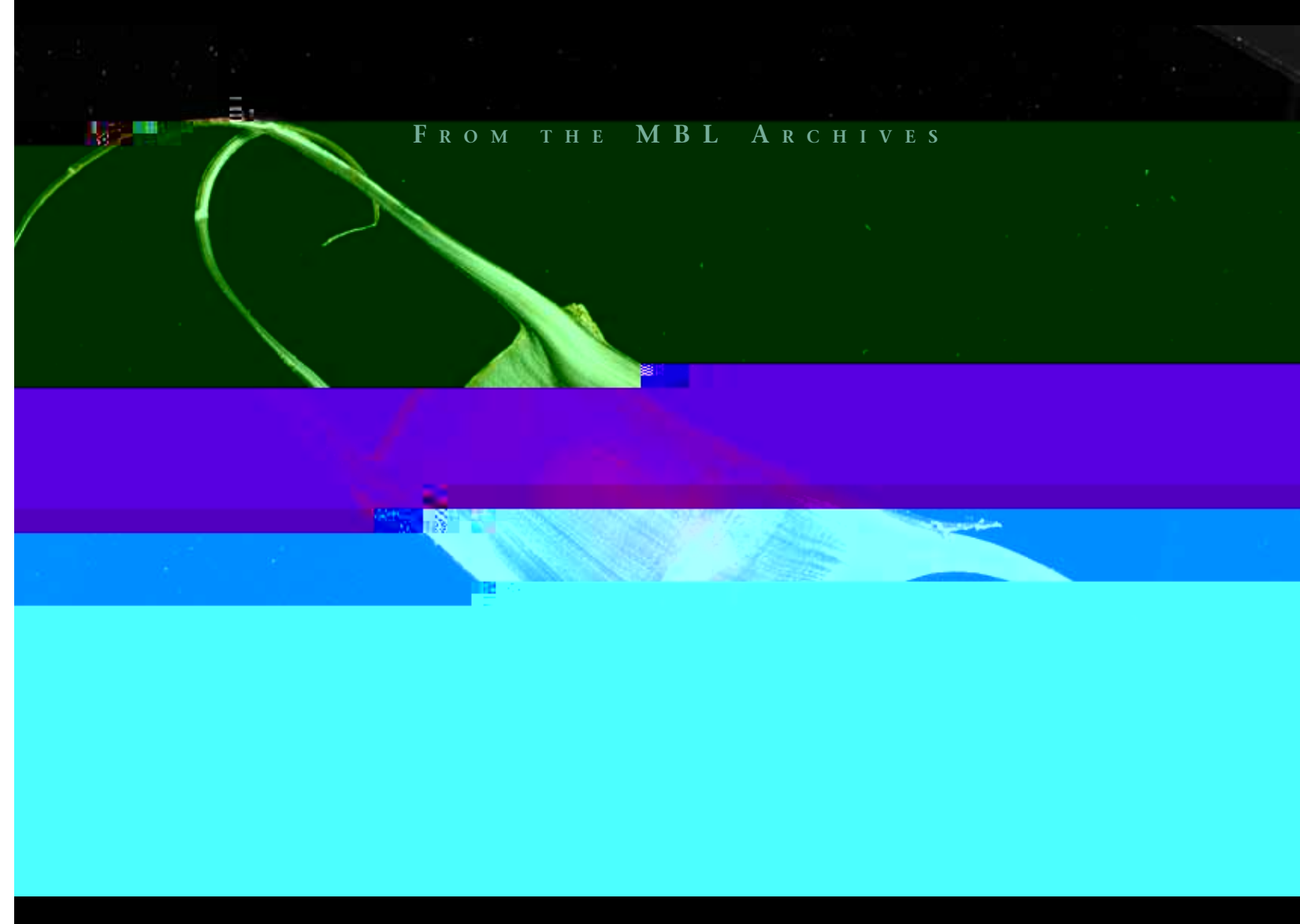
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## A Chaos of Delight

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The great Danish physiologist, Nobel laureate, and MBL visiting scientist August Krogh, whose work elucidated the inner workings of capillary flow and function, noted that for every essential question in biology there is an organism ideally designed to provide answers. The truth to this idea lies in the principle of evolutionary adaptation and the “endless forms most beautiful” that have helped scientists unravel many fundamental biological problems. The diversity



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Look for the next issue of *BioEssays* in Spring 2014

1187-1189