

When Fish Talk, Scientists Listen

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Midshipman fish shown inside their nest in the rocky intertidal zone of northern California. There are newly fertilized eggs and larvae on the "roof" of the nest. Photo: Margaret Marchaterre, Department of Neurobiology and Behavior, Cornell University

(PhysOrg.com) -- A male midshipman, a close relative of the toadfish, doesn't need good looks to attract a mate – just a nice voice. After building a nest for his potential partner, he calls to nearby females by contracting his swim bladder, the air-filled sac fish use to maintain buoyancy. The sound he makes is not a song or a whistle, but a hum; more reminiscent of a long-winded foghorn than a ballad. Female midshipman find it very alluring, and they only approach a male's nest if he makes this call.

In a paper published this week in *Science*, three Marine Biological Laboratory (MBL) visiting investigators show that the sophisticated neural circuitry that midshipman use to vocalize develops in a similar region of the central nervous system as the circuitry that allows a human to laugh or a frog to croak, evidence that the ability to make and respond to sound is an ancient part of the vertebrate success story.

The research is presented by Andrew Bass of Cornell University, Edwin Gilland of Howard University College of Medicine, and Robert Baker of New York University Medical Center.

"Fish have all the same parts of the brain that you do," says Bass, the paper's lead author. The way our brains work is also similar. Just as we have neurons that coordinate when our larynx and tongue change shape to produce words, toadfish and midshipman orchestrate the movement of muscles attached to their swim bladder to produce grunts and hums.

Using larval toadfish and midshipman, the group traced the development of the connection from the animal's vocal muscles to a cluster of neurons located in a compartment between the back of its brain and the front of its spinal cord. The same part of the brain in more complex vertebrates, such as humans, has a similar function, indicating that it was highly selected for during the course of evolution.

Scientists have known for decades that these fish make sounds, but they are not the only species whose hums, growls, and grunts have meaning. "There's reason to suggest that the use of sound in social communication is widespread among fishes," Bass says.

This research is an example of the growing field of evolutionary neurobiology, which aims to understand the evolution of behavior through neurobiology. According to Bass, fish are an incredibly successful group, making up nearly half of the living species of

vertebrates, and vocal communication may be partly responsible. "The kind of work we're doing contributes to answering questions as to why these animals are so successful," Bass says. "We're only touching the tip of the iceberg here."

The majority of this research was completed at the MBL over the past five years, although the question of how fish communicate through sound first came to Bass as a graduate student studying the neurobiology of fish at the University of Michigan. In the summer of 1986, Bass, then a summer instructor at the MBL, met Robert Baker, who was also researching the neurobiology of fish calling. For years they discussed fish social behavior with the roots of the hypothesis tested in the Science paper first published in 1997 and the research to test that hypothesis beginning in 2003. "The whole project began at the MBL," Bass says. "It's where collaborations happen."

Audio Files

The hum is the advertisement call that males use to attract females to their nest. The growl and grunt are aggressive calls that males produce when defending their nest against intruders. Audio credit: Margaret Marchaterre, Cornell University

Toadfish vocalizations: (.wav format)

-- [Growl](#)

-- [Grunt](#)

-- [Hum](#)

Citation: Bass, A.H., E.H. Gilland, and R. Baker. 2008. Evolutionary Origins for Social Vocalization in a Vertebrate Hindbrain-Spinal Compartment. *Science* 321: 417-421.

Provided by Marine Biological Laboratory

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