Rare Chinese frogs communicate by means of ultrasonic sound

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Artist's rendering of Amolops tormotus. By Margaret Kowalczyk

First came word that a rare frog (Amolops tormotus) in China sings like a bird, then that the species produces very high-pitch ultrasonic sounds. Now scientists say that these concave-eared torrent frogs also hear and respond to the sounds.

The findings, to appear in the March 16 issue of *Nature*, represent the first documented case of an amphibian being able to communicate like bats, whales and dolphins, said corresponding author Albert S. Feng, a professor of molecular and integrative physiology at the University of Illinois at Urbana-Champaign.

Feng, a researcher at the Beckman Institute for Advanced Science and Technology, was introduced to the frog species by Kraig Adler, a Cornell University biologist who had learned about it while conducting a survey of amphibians in China. Feng continues to study frogs and bats to understand how the brain processes sound patterns, especially in sound-cluttered environments in which filtering is required to allow for communication.

Feng and colleagues previously reported that males of the species make these high-pitched bird-like calls, with numerous variants in terms of harmonics and frequency sweeps. Some sounds exceeded their recording device's maximum capability of 128 kilohertz. Human ears hear sound waves generally no higher than 20 kilohertz. The frogs studied inhabit Huangshan Hot Springs, a popular scenic mountainous area, alive with noisy waterfalls and wildlife west of Shanghai.

"Nature has a way of evolving mechanisms to facilitate communication in very adverse situations," Feng said. "One of the ways is to shift the frequencies beyond the spectrum of the background noise. Mammals such as bats, whales and dolphins do this, and use ultrasound for their sonar system and communication. Frogs were never taken into consideration for being able to do this."

Adler had drawn attention to the species because the frogs do not have external eardrums, raising the possibility of unusual hearing abilities. "Now we are getting a better understanding of why their ear drums are recessed," Feng said. "Thin eardrums are needed for detection of ultrasound. Recessed ears shorten the path between eardrums and the ear, enabling the transmission of ultrasound to the ears."

To test if the frogs actually communicated with their ultrasonic sounds, Feng and colleagues returned to China with their recording equipment and a special device that allowed playback of recorded frog calls in the

audible or ultrasonic ranges. They observed eight male frogs under three experimental conditions (no sounds, playback of calls containing only audible parts and playback of just ultrasonic frog calls).

During playback, the researchers watched for evoked calling activity in which a male frog begins calling upon hearing calls from other frogs in the area. Six frogs responded to ultrasonic and audible sound ranges, with four responding with calls in both ranges. One frog called 18 times to ultrasonic calls, including four very telling rapid responses, Feng said. Another frog did not respond to ultrasonic stimulation but produced calls 18 times to an audible prompt.

Clearly, Feng said, some of the frogs indeed communicated ultrasonically. They have the ability to do so, but for some reason some frogs do and some don't, he said. "We believe that all of them have the capacity to respond to the ultrasound."

Ultrasonic communication likely will be found in other amphibians and birds, Feng said, but, until now, no one has bothered to look into it.

"Humans have always been fascinated by how some animals can discern their world through a sensing system vastly different from our own," Feng said. "The electromagnetic sense in fishes and homing pigeons, polarized light vision in ants, chemical sensing of pheromones in insects and rodents, echolocation by ultrasound in bats and dolphins, are just a few examples.

"That frogs can communicate with ultrasound adds to that list and represents a novel finding, because we normally think such ability is limited to animals equipped with a sophisticated sonar system," he said. "This suggests that there are likely many other examples of unexpected forms of communication out there."

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Source: University of Illinois at Urbana-Champaign