

The Outside Story

The Fascinating Adaptations of Frogs

By Rebecca Perkins Hanissian

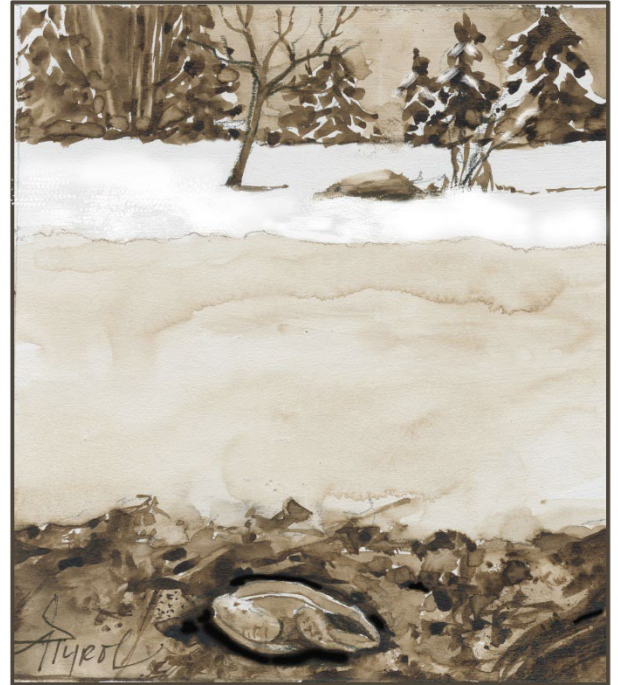
Frogs have hopped about Earth since before the time of the dinosaurs, and it shows. Celebrated for their amphibious lifestyle and cacophonous choruses, the long arc of frog evolution has yielded other awesome and efficient adaptations in organs from their lungs to their skin.

Research on green tree frogs demonstrates that frog lungs also assist in hearing. Like noise canceling headphones, frog lungs help dampen extraneous sounds – such as the calls of other frog species, insects, and airplanes – and allow females to hear the calls of their own species through the din. When frogs inflate their lungs, their thin, rib-less body walls vibrate with sound waves. The lungs transmit these waves to the inner ear, where they interact with sound waves arriving via the frog’s ear. Researchers believe the sound waves of noises other than species-specific calls interact with one another in a way (called “destructive inference”) that dampens them and allows females to better hear the males of her species.

Not only do frogs detect sounds with their lungs, but they can also drink and breathe through their skin. Frogs absorb water through their skin when submerged. Some terrestrial frogs also have a highly vascularized surface located near their hind legs – called a seat patch – that is responsible for more than 70 percent of total water uptake, despite constituting just 10 percent of the skin area. These frogs change their posture to depress the patch onto moist surfaces to control absorption.

Perhaps the most fascinating frog adaptation is the ability to breathe on land and in water via four respiratory systems. When submerged, adult frogs breathe exclusively through their thin skin (cutaneous respiration), which diffuses dissolved oxygen into blood vessels beneath the skin. Because their lungs are inefficient, frogs rely on supplementary cutaneous respiration while on land. Frogs do not have diaphragms to pull air into their lungs and rely instead on “buccal pumping” – expanding and contracting their closed mouth – to create a vacuum that drives air into and out of their lungs through their nostrils. Moreover, the lining of their mouth is a respiratory surface.

Almost all frogs begin their lives in the water as tadpoles. In this larval stage, frogs extract dissolved oxygen from water as it passes over their gills and skin, especially the highly vascularized skin of their temporary



tails. Eventually, the gills and tails of metamorphosing larvae degenerate, and lungs develop, allowing frogs to venture onto land.

As if skin breathing, metamorphosis, and selective lung listening aren't sufficient party tricks, frogs' eyes provide nearly 360 degrees of vision, allow them to see in low light and under water, and help them to swallow their food. Frogs do not chew their food but use modified teeth to hold their prey while they retract their eyeballs to push food into their esophagus.

According to Jim Andrews of the Vermont Reptile and Amphibian Atlas, one of the coolest adaptations of the frogs in our region is freeze tolerance. Freeze-tolerant species, including wood frogs and spring peepers, survive the winter in a semi-frozen state in the leaf litter below the snow. The liver releases sugars that act as anti-freeze within the frog's cells to prevent the cells from freezing and bursting. Meanwhile, the fluid between these cells freezes solid. "They're like frogcicles," Andrews said.

He also admires the resourcefulness of "satellite males." These male frogs, for whatever reason, lack good voices, be it the deep drone of a bullfrog or the high-pitched chirp of a peeper. Sensing their ineptitude, satellite males position themselves next to males with good voices and grab the females that are called in by them. "It's not unlike a junior high party, where kids jockey to sit with the cool kids," Andrews said.

Despite these remarkable adaptations, there exists some room for improvement. Male frogs embrace female frogs from behind to immediately fertilize the eggs as they are released. Andrews and colleagues have observed male frogs embracing everything from salamanders to trout, the latter being an especially poor choice, as trout eat frogs. "When hormones are raging," Andrews said, "they'll grab just about anything that moves and even sometimes things that don't, like cattail heads and dead mice."

So, maybe evolution hasn't yet solved all challenges frogs face. But, ready or not, frogs will emerge in the coming weeks eager to get the raucous party started.

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