The Fabulous Frogsicle - Natural Alaska

Written by Ned Rozell

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On these clear, blue, autumn mornings, when golden leaves flutter to the ground, the musk of highbush cranberries crinkles your nose and puddles glass over with a thin sheen of ice, a person may wonder what wood frogs were thinking when they hopped this far north.

These palm-size, desert-camo creatures have not a pinch of bodily insulation. Their smooth, clammy skin is more suited to a creature that needs to shed heat than one that needs to conserve it, yet they live in North Pole, in Livengood, all the way north to Anaktuvuk Pass. At the end of the cul-de-sac of cold-blooded creatures, they are the only amphibians that live north of the Arctic Circle (by comparison, more than 400 species of amphibian live in Ecuador). The lonely arctic frog is perhaps the most oxymoronic creature in Alaska.

A few northern scientists interested in bodily adaptations to cold have scratched their heads while pondering far-north frogs over the years. In 1972, a graduate student named Michael Kirton wondered where wood frogs went when the temperature dropped. He employed the best technology of the time—radioactive chips that he implanted under the skin of a few frogs—and that September, he took to the woods with a Geiger counter, carefully scanning the ground around the pond where he had captured the frogs weeks earlier. He heard the telltale radioactive clicks from his chips in places he didn't expect—the forest floor, far from where he captured the frogs.

Rana sylvatica doesn't need large ponds or lakes to breed. They sometimes choose bodies of water that capture spring snowmelt. Because these little pools often dry up before summer's end, laying eggs here is a gamble for a creature that begins life as a tadpole. That risky behavior pays off because those meltponds don't sustain fish that would eat a wood frog, and the forest near the shallow water warms more quickly than the area around a large pond, giving the frogs a jump on the breeding season.

The forest also comes to the frogs' aid when it's time to hunker down—late August or early September over much of their range in Alaska. The duff on the forest floor—moss and sticks, and dried leaves and needles—is loose enough for a determined frog to wedge its way in, kicking and shoving, until it is completely covered.

A few decades after Kirton's Geiger-counter experiment, miniature electronics evolved to the point where University of Alaska professor Brian Barnes thought transmitters were small enough for use with the tiniest creatures out there. Barnes—a physiologist who once got the arctic ground squirrel on the cover of the journal *Science* by finding that its body dropped below freezing during hibernation—enlisted his students in a study of the Alaska wood frog. Late in summer, they captured a few frogs in the Goldstream Valley north of Fairbanks. They superglued tiny transmitters to the backs of wood frogs, then let the frogs hop away. The class wanted the same information Kirton sought with the Geiger counter, but took the study one step further, placing tiny temperature probes next to the frogs as they settled for the winter. They wanted to see just how cold an Alaska frog could get.

They tracked one frog to the sand near a horse corral; another tunneled half a foot into loose moss. Until the insulating snow arrives, the frog isn't much protected by the blanket of dry forest litter, so it must steel itself to winter some other way. Beginning in September, as its Alaska home changes from liquid to solid, so does the wood frog.

Wood frog bodies survive this freezing in a novel way: by becoming sweeter. Triggered by cold, a frog's tiny liver begins cranking out glucose, which floods all the frog's cells. This sweet liquid allows cells to freeze without the points of ice crystals puncturing cell walls, which is what destroys our skin when frostbite claims the tip of a finger or toe.

As the cold autumn air pulls the heat from the ground, it does the same to the wood frog. First, the frog's eyes freeze hard as little ice cubes. Then its feet and toes become hard.

Awash in sweetness, the frog becomes ready for the deeper penetration of cold. As the fall days pass, deep cold migrates to a frog's internal organs, shutting them down and freezing them one by one. On a late fall or early winter day, a frog's final functioning organ, its heart, stops beating. If you were to dig up this frog and hold it in your hand, it would appear squashed, legs and arms tucked close to the body, eyes closed; a cold, polished stone.

Humans would die with frozen hearts, but that's where adaptations of the animal kingdom trump human cleverness and fiberglass insulation. In springtime, the frog warms—somehow its heart thaws before its extremities—and it hops away to breeding water to get to business.

For all their amazing machinery, frogs have their limits, too. In the lab, scientists have found that Lower-48 wood frogs perish when the temperature drops to about 20 degrees F. Barnes and his students found that the Alaska version of the frog survived air temperatures of 10 degrees F. The fact that air in northern Alaska sometimes drops 70 degrees colder than the frog's lower-lethal temperature shows the wonderful insulating quality of snow, which, with six inches or more, keeps the ground's surface near 30 degrees no matter how cold the air above it, allowing Alaska frogs to survive

An Alaska expert on amphibians has guessed that the wood frog long ago hopped across the land bridge from the equatorial regions of Asia. As generations passed, some wood frogs made it all the way to Georgia. But some remained, settling near the Arctic Circle, creating a bizarre and lonely niche wintering beneath the footprints of moose and caribou.

This northern life requires an Alaska wood frog to remain frozen for at least half the year. That's two of their four years on the planet as frogsicles, waiting out the winters with their brains frozen as hard as pondwater, without a croak of complaint.

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