

When the chill hits: respective role and importance of low molecular weight cryoprotectants, ice-binding proteins and skin microbiota in supercooling amphibians (SUPERCOOL)

When temperatures drop below freezing, most animals either hibernate, freeze and survive it, or simply avoid the cold. But some (rare) species have evolved an extraordinary survival trick: they supercool. This means that their bodies can get colder than 0°C (the freezing point of water) without actually freezing, a bit like a liquid staying fluid in a freezer. This research project, called SUPERCOOL, focusses on understanding how certain amphibians, like tropical amphibians living high in the mountains, can pull off this incredible feat. Unlike insects or reptiles, amphibians have wet skin and watery bodies, which makes supercooling extremely difficult for them (animals with more water in their bodies are generally more likely to freeze). And while some amphibians survive freezing by letting ice form inside them (a better-known strategy called freeze tolerance), supercooling species avoid freezing altogether, even in freezing conditions.

So far, very few amphibian species are known to supercool, and almost all of our knowledge comes from cold regions like the Arctic or temperate zones. But what about amphibians living in high tropical mountains? We recently discovered unexpected hidden ability to withstand experimentally-induced freezing temperatures in a unique group of tropical toads with ancient evolutionary roots. In stark contrast with the few confirmed supercooling amphibians, these toads live in a frost-free environment, are active all-year round and remain comfortable by choosing spots in their environment where temperatures are more stable. We still do not know how common or important supercooling is for those species, or how they manage it.

With this project, we aim to find out what allows these animals to stay unfrozen in freezing conditions. We will explore (1) whether glucose (a sugar found in the body) helps prevent ice from forming; (2) whether certain skin bacteria can block ice formation, kind of like a natural antifreeze; (3) whether these tropical frogs have special antifreeze proteins in their blood or tissues, like those found in polar fish for instance.

To do this, we will measure temperature tolerance, identify helpful skin bacteria, and study the proteins that might be at work. SUPERCOOL will be the first deep dive into how amphibians avoid freezing, bringing together biology, microbiology, and chemistry.

Why does this matter? Because learning how animals survive cold without freezing could inspire new cryoprotection techniques in medicine or biotechnology. And as the climate changes and extreme weather becomes more common, knowing how animals cope with sudden cold could help us protect vulnerable species in the wild.



How do some amphibians avoid freezing?
Discovering the secrets of “Supercool”
toads