Tiny frogs face a troubled future in New Guinea's tropical mountains

March 31 2017, by Paul Oliver And Mike Lee

A tiny Choerophryne frog from the Foja Mountains in New Guinea. This one is a calling male. Credit: Tim Laman, Author provided

At night, the mountain forests of New Guinea come alive with weird buzzing and beeping calls made by tiny frogs, some no bigger than your little fingernail.

These little amphibians – in the genus *Choerophryne* – would shrivel and dry up in mere minutes in the hot sun, so they are most common in the

rainy, cooler mountains.

Yet many isolated peaks, especially along northern New Guinea, have their own local species of these frogs.

So how did localised and distinctive species of these tiny frogs come to be on these isolated peaks, separated from each other by hotter, drier and rather inhospitable lowlands?

Our new study of their DNA, published this week in the open access journal PeerJ, reveals how they achieved this feat. It reveals a dynamic past, and more worryingly it highlights the future vulnerability of tropical mountain forests and their rich biodiversity.

A hotspot of frog diversity

New Guinea has an astounding diversity of frogs: more than 450 known species and counting. This is nearly double the diversity in Australia, a landmass ten times larger.

Remarkably, a majority of these species are in a single species-rich, ecologically diverse group that have dispensed with the tadpole stage.

Instead they hatch out of their eggs as tiny little replicas of the adults. Because they do not depend on still pools of water to breed, they do really well in the incredibly wet, but steep mountains of New Guinea.

A tiny Choerophyrne frog perched on a finger. Credit: Tim Laman, Author provided

One of our group (Stephen Richards) has been collecting DNA from frogs across New Guinea for the past 20 years. This work is at times arduous and painful. Having a leech worm its way into the back of one's eye, and then stay there for more than a week, is not pleasant.

But these trips are also extremely rewarding. So far we have described more than 70 new species, and discovered many more that await description.

They also provide opportunities to explore some of world's most wild places. Perhaps the best example is the first scientific expedition to the

remote Foja Mountains.

This isolated mountain range in northern New Guinea was previously almost unexplored, but revealed a treasure trove of diversity, including a "lost" bird of paradise, a completely new species of another bird, and a bizarre treefrog with an erectile nose.

We also found several species of *Choerophryne* frog. DNA from these allowed our team to test two potential ways that miniature frogs could have come to occupy distant mountain peaks that are separated by inhospitable lowlands.

Across the Fojas by frog

The first way involves mountain-top frogs evolving separately on each isolated peak, potentially from larger frogs capable of surviving in the hotter and drier, nearby lowlands.

If this were the case, the frog on any given mountaintop would be most genetically similar to frogs from adjoining lowlands.

The other way involves exploiting climate change. During past phases of global cooling (glacial periods), the colder, wetter, mountainous habitats of New Guinea expanded downhill, a process termed elevational depression.

Mud, glorious mud: The wet forests of the New Guinea Mountains are great for frogs, but pose challenges for biologists. Credit: Tim Laman, Author provided

If depression was extensive enough, the frogs on one mountain might have been able to travel across tracts of cool, wet lowlands to colonise other mountains.

Later, a warming climate would wipe out the lowland populations, leaving two isolated mountain populations, which might eventually become new species.

If this were the case, we would expect the frogs in different mountains to be genetically related, since they almost literally hopped from one peak to the other.

Our new study of the DNA of the little *Choerophryne* frogs indicates they used both routes to conquer the peaks of New Guinea.

In the remote Foja mountains, for example, there are three species of *Choerophryne*. One species has evolved *in situ* in northern New Guinea from nearby lowland frogs.

The other two are related to frogs from distant mountains of central New Guinea, and presumably moved across the intervening lowlands during cooler glacial periods.

The little frogs and the future

Why does it matter how the tiny frogs moved to their mountain habitats? Because it could be a warning to their future survival.

Tropical mountains have some of the most biodiverse assemblages of plants and animals in the world. Their ecosystems are also far more dynamic than is popularly recognised.

The cloud-shrouded summits of the Foja mountaintops were first reached by scientists in 2008. Credit: Tim Laman, Author provided

Just like glaciers, the movements of frogs (and other organisms) up and down mountains has tracked global temperatures. As we've shown, the global cooling in past glacial periods allowed the mountain-dwelling frogs to move down across the lowlands to find new mountain peaks.

But today, as global temperatures soar to levels not seen for millions of years, their habitable cool zones are heading in the other direction: shrinking uphill.

We have no idea how quickly these frogs will respond to these changes, but recent research elsewhere in New Guinea has found birds are already

shifting upslope rapidly.

We don't yet know what could happen to these cute little amphibians should temperatures continue to climb, and they in turn run out of mountainside to climb.

It's more than ten years since the first expeditions to the Foja Mountains, and this study provides a great demonstration of the ongoing value of the scientific data collected on these trips.

We now have a snapshot of the distinctive frogs (and many other animals) that live at the tops of these remote mountains, and a window into their past.

This provides an incredibly important resource to help us understand the dynamic history of these mountain forests, and reminds us that despite their inaccessibility, they face an uncertain future.

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