A secret war between cane toads and parasitic lungworms is raging across Australia

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Credit: Pixabay/CC0 Public Domain

When the first cane toads were brought from South America to Queensland in 1935, many of the parasites that troubled them were left behind. But deep inside the lungs of at least one of those pioneer toads lurked small nematode lungworms.

Almost a century later, the toads are evolving and spreading across the Australian continent. In new research published in *Proceedings of the Royal Society B*, we show that the lungworms too are evolving: for reasons we do not yet understand, worms taken from the toad invasion front in Western Australia are better at infecting toads than their Queensland cousins.

An eternal arms race

Nematode lungworms are tiny threadlike creatures that live in the lining of a toad's lung, suck its blood, and release their eggs through the host's digestive tract. The larva that hatch in the toad's droppings lie in wait for a new host to pass by, then penetrate through its skin and migrate through the amphibian's body to find the lungs and settle into a comfortable life, and begin the cycle anew.

Parasites and their hosts are locked into an eternal arms race. Any characteristic that makes a parasite better at finding a new host, setting up an infection, and defeating the host's attempts to destroy it, will be favored by natural selection.

Over generations, parasites get better and better at infecting their hosts. But at the same time, any new trick that enables a host to detect, avoid or repel the parasites is favored as well.

So it's a case of parasites evolving to infect, and hosts evolving to defeat that new tactic. Mostly, parasites win because they have so many offspring and each generation is very short. As a result, they can evolve new tricks faster than the host can evolve to fight them.

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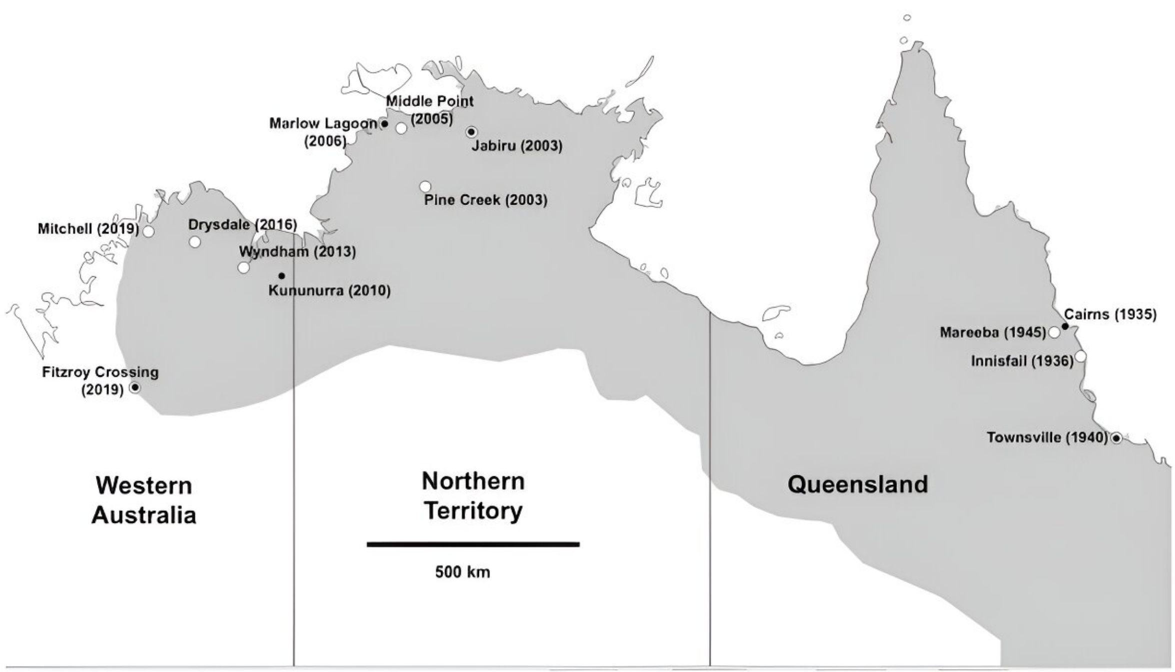
The march of the toads

The co-evolution between hosts and parasites is most in sync among the ones in the same location, because they encounter each other most regularly. A parasite is usually better able to infect hosts from the local population it encounters regularly than those from a distant population.

But when hosts invade new territory, it can play havoc with the evolutionary matching between local hosts and parasites.



Since their introduction near Cairns in 1935, cane toads have steadily spread westward across Australia. Credit: Brown, Shine, Rollins / Proceedings of the Royal Society B

Since cane toads were released into the fields around Cairns in 1935, the toxic amphibians have hopped some 2,500 kilometers westwards and are currently on the doorstep of Broome. And they have changed dramatically along the way.

The Queensland toads are homebodies and spend their lives in a small area, often reusing the same shelter night after night. As a result, their populations can build up to high densities.

For a lungworm larva, having lots of toads in a small area, reusing and sharing shelter sites, makes it simple to find a new host. But at the invasion front (currently in Western Australia), toads are highly mobile, moving over a kilometer per night when conditions permit, and rarely spending two nights in the same place.

At the forefront of the invasion, toads are few and far between. A lungworm larva at the invasion front, waiting in the soil for a toad to pass by, will have few opportunities to encounter and infect a new host.

Lungworms from the invasion front

When hosts are rare, we expect the parasite will evolve to get better at infecting the ones it does encounter, because it is unlikely to get a second chance.

To understand how this co-evolution is playing out between cane toads and their lungworms, we did some experiments pairing hosts and parasites from different locations in Australia. What would happen when toad and lungworm strains that had been separated by 90 years of invasion were reintroduced to each other?

To study this we collected toads from different locations, bred them in captivity and reared the offspring in the lab under common conditions.

We then exposed them to 50 lungworm larvae from a different area of the range, waited four months for infections to develop, then killed the toads and counted how many adult worms had successfully established in their lungs.

As expected, worms from the invasion front were best at infecting toads, not just their local ones. Behind the invasion front, in intermediate and old populations we found that hosts were able to fight their local parasites better than those from distant populations.

While we saw dramatic differences in infection outcomes, we have yet to determine what biochemical mechanisms caused the differences and how changes in genetic variation of host and parasite populations might have shaped them.

More information: Gregory P. Brown et al, A biological invasion modifies the dynamics of a host–parasite arms race, *Proceedings of the Royal Society B: Biological Sciences* (2024). DOI: 10.1098/rspb.2023.2403

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