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New study supports controversial evolutionary theory

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A paper published today in *Nature* provides strong support for a controversial 50-year-old-evolutionary hypothesis of how species are formed.
The paper uses a north Queensland frog species, the green-eyed tree-frog Litoria genimaculata to test the theory.

The study examines what happens when two lineages (genetic groups) from the same species, which have been geographically isolated for thousands of years, come together again and overlap in a hybrid zone.

Will they hybridise, or have they evolved to become two different species?

Study lead author Conrad Hoskin of The University of Queensland's (UQ) School of Integrative Biology said the research provided strong support for a theory termed “reinforcement” proposed over 50 years ago.

“Often in nature, populations of a species are isolated from each other and then come back together after some period of time and hybridise,” he said.

“The theory of reinforcement is based on the idea that if it's bad to hybridise (for example if the hybrid young are of poor health or sterile) then there's an advantage to you if you can recognise your own population and avoid hybridising with the other population.

"Because choosy females do better as they avoid hybridising, differences may evolve between the two populations in how they choose mates. For example, two frog populations may evolve differences in their mating calls where they overlap and females may become more choosy based on these call differences."

In the new Nature paper, Mr Hoskin and his colleagues conclude that where populations of the green-eyed tree-frog are in a hybrid zone, this process of reinforcement has occurred and has led to the formation of a distinct new species of frog within the hybrid zone.

Mr Hoskin said the more classic and widely accepted theory of how species arose was called allopatric speciation.

"Allopatric means that the populations are isolated from each other — for example by a mountain range, a river, or across islands," he said. "Without gene flow between the populations, differences can accumulate due to chance or due to adaptation of the populations to different environments.

"These differences may become so great with time that should the populations once again be connected, they may not interbreed — either because they don't recognise each other as potential mates or because it is no longer possible to produce fertile offspring even if they tried to mate."

The new paper links the theory of reinforcement to the theory of allopatric speciation by showing that the change in frog call and mate choice in one of the populations in the hybrid zone (due to reinforcement) has been so great that this population will now not even breed with the isolated main population of its own lineage outside the hybrid zone (allopatric speciation).

“Therefore the paper is interesting because it not only provides strong support for the theory that species can arise by reinforcement, but it also shows that the effect of this reinforcement can have bigger consequences than is generally acknowledged,” he said.

“Here we have a very interesting situation where it appears that a distinct frog species has arisen quickly (over thousands of years) due to a combination of two processes of speciation, reinforcement and allopatry.”

Mr Hoskin said reinforcement had been simulated by selection experiments and by mathematical modelling.

“However, speciation by reinforcement is hard to demonstrate in nature as it requires many lines of evidence if it is to be tested rigorously,” he said. “Therefore the process has remained controversial. In particular there has previously been little evidence to suggest reinforcement can also drive allopatric speciation.”

Study co-authors are UQ researcher Megan Higgie (also completing a PhD in the School of Integrative Biology), Keith McDonald of Queensland Parks and Wildlife Service in Atherton and Professor Craig Moritz of the University of California at Berkeley.

The research tested the theory with molecular data, experimental crosses, field measurements and mate choice experiments in a north Queensland hybrid zone between two lineages of the green-eyed tree frog.

This mottled greeny-brown frog — only the length of a pinky finger — has a camouflaged lichen appearance. The stream-breeding frog species is found in a continuous rainforest area in the wet tropics between Townsville and Cooktown.

"From previous research we know that during the cooler, drier periods of the glacial cycles over the last couple of millions of years, two deeply divergent genetic lineages of this frog species formed in northern and southern rainforest refuges," he said.

"In the past 6000 or 7000 years the northern and southern rainforest areas have reconnected, bringing the two frog lineages back in contact with each other."

Mr Hoskin said like most frogs, mate choice in the species resulted primarily from female choice of a single, genetically determined trait — the male frog call. This makes frogs one of the best groups for studying evolutionary processes such as the reinforcement theory.

Mr Hoskin's PhD thesis on speciation in rainforest frogs is being supervised by Associate Professor Hamish McCallum at UQ, Professor Craig Moritz at the University of California and Dr Jeremy Austin at the University of Adelaide.

Source: University of Queensland