Genetic secrets of the world's toughest little bird

July 16 2013

A foraging Hume Ground Tit (Parus humilis). Credit: Wikipedia

Scientists from Griffith University have taken part in an international study which has revealed the genetic secrets of how a small bird can survive in one of the most hostile environments on earth.

The ground tit (*Parus humilis*), lives in the Tibetan plateau, the largest

high-altitude land mass in the world. This study has found molecular signatures in the ground tit genome which reveal how it copes with the extreme living conditions of this habitat.

Professor David Lambert and Dr Sankar Subramanian from Griffith University's Environmental Futures Centre took part in the study.

"We have long known that these birds are well adapted to living with low oxygen levels, typical of high elevation, but until now we have had only a limited understanding of the genetic background of these adaptations," Dr Subramanian said.

"In this study we have identified the genetic modifications of the species which make this possible," he said.

Findings of the study gave been published in a paper entitled "Ground tit genome reveals avian adaptation to living at high altitudes in the Tibetan plateau" in the prestigious journal *Nature Communications*.

Unlike its tree-dwelling relatives, the drab-coloured little songbird lives exclusively above the tree line at 3,300 to 5,400 m, on rocky steppes and grasslands of the Tibetan plateau. As a consequence of its location, it also behaves differently by foraging on the ground and digging burrows or tunnels for roosting and nesting. It looks different too with a longer, straighter bill, longer legs, larger body size and paler overall plumage.

Because of all these divergent characteristics, the ground tit was long considered to belong to the crow family. Only later was it was shown not to be not the world's smallest corvid, but rather the world's largest tit.

"Our genomic study further confirms this taxonomic conclusion. The ancestor of the ground tit split off from other tits between 7.7 and 9.9 million years ago," Dr Subramanian said.

The study also reveals how the ground tit genome can be characterised by a range of adaptations to the environment it calls home.

"One major adaptation is a positive selection for genes involved in hypoxia response and skeletal development, similar to those expressed in other organisms in high-altitude environments such as Tibet and the Andes," Dr Subramanian said.

"We have also found in this bird an expansion of genes involved in fatty acid metabolism in ground tits apparently to withstand the extreme cold," he said.

Another surprising adaptation has been the apparent loss of genes to provide immunity against pathogens, including viruses and bacteria.

"It is possible that this is because there are fewer microorganisms present in the Tibetan plateau and therefore a decreased risk of opportunistic infections," Dr Subramanian said.

And a reduced capacity to smell may well be another casualty of life on the Tibetan Plateau.

"This could be a consequence of the limited variety of scents to be found in the arid, alpine meadow environment, but that doesn't explain why the yak, a species that also inhabits the Tibetan Plateau, has an increased number of olfactory receptor genes compared with cattle," Dr Subramanian said.

"To fully understand the loss of olfactory receptor genes in the ground tit, further comparisons need to be made with genomes of closely related species inhabiting lower altitudes."

The genomic study of the ground tit provides new understanding of the

unique adaptations necessary for a high-altitude environment, adding to knowledge of strategies for survival found in other high-altitude species.

More research will need to be done comparing genomes from closely related species inhabiting high altitudes and lowland environments to further explore the genetic foundation of these adaptations.

Provided by Griffith University