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Ecology, epidemiology and evolution of enteric microbes in fragmented populations of the endangered takahe (*Porphyrio hochstetteri*)

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Abstract

Pathogenic diseases are increasingly recognised as a challenge to the conservation of wildlife. Complex host-pathogen relationships and transmission dynamics in wild populations can limit our understanding of how pathogens contribute to the decline and endangerment of wildlife. Endangered wildlife populations maintained in reserves present a unique opportunity to investigate wildlife host-microbe relationships in a controlled semi-natural environment where diversity, abundance and the movement of species are restricted. The aim of this study was to investigate the prevalence and molecular differentiation of enteric bacteria carried by endangered takahe (*Porphyrio hochstetteri*). Through the use of network analysis and molecular epidemiology, the study explored the effects of geographic isolation and translocation on the prevalence, transmission and evolution of *Campylobacter* and *Salmonella* spp. within fragmented populations of takahe.

Translocation and conservation management has created a dynamic network of takahe populations which vary in their likelihood to maintain and transmit pathogens. My study suggests that range expansion following a significant bottleneck and intensive conservation management of takahe has had unforeseen consequences on microbial diversity. The management of takahe in different environmental settings has influenced the carriage of *Campylobacter jejuni* and *Campylobacter coli*. A newly discovered rail-associated *Campylobacter* sp. nova 1 was prevalent in all populations. However, more discriminatory whole genome analysis of isolates detected a significant biogeographic variation in *C. sp. nova 1* genotypes. Possible explanations for the observed pattern include the spatial expansion and isolation of hosts resulting in reduced gene flow of *Campylobacter* spp. and allopatric speciation, and the presence of heterogeneous environmental attributes or cross-species transmission of *Campylobacter* spp. from sympatric reservoir hosts. An assessment of vertebrate reservoirs in an island ecosystem indicated cross-species transmission of *Campylobacter* spp. was not likely to be a factor contributing to the maintenance and phylogeographical distribution of *Campylobacter* spp. in takahe.

This study was the first of its kind to explore microbial dynamics in a large proportion of a well-described but fragmented population of a wild bird. Results suggest historic and current management practices may be having unforeseen influences on enteric microbes, the consequences of which are unknown but could be detrimental to the health of translocated populations of takahe.
Acknowledgements

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Thesis structure and format

This thesis is presented as a series of seven chapters. Encompassed by a general introduction and discussion, five research chapters have been prepared and are presented as discrete papers for publication in peer reviewed journals.

Chapter one

General introduction introduces the concepts behind the research contained in this thesis by discussing and reviewing current literature on the principles of disease ecology and aspects of the epidemiology of infectious organisms in wildlife. The objectives of the study are summarised at the end of this chapter.

Chapter two

Network analysis of translocated takahe populations to identify disease surveillance targets has been published in the journal Conservation Biology (Grange et al. 2014).

Chapter three

Using a common commensal bacterium in endangered takahe (Porphyrio hochstetteri), as a model agent to explore pathogen dynamics in isolated wildlife populations is in press in the journal Conservation Biology.

Chapter four

Wildlife translocation and the evolution and population structure of a host associated commensal Campylobacter spp. is under review in the journal Proceedings of the National Academy of Sciences (PNAS) following publication of chapter 3.

Chapter five

Investigation of vertebrate reservoirs of Campylobacter spp. in an island ecosystem will be submitted to the Journal of Animal Ecology pending publication of chapters 3 and 4.
Chapter six

**Location specific prevalence of *Salmonella* spp. in endangered takahe (*Porphyrio hochstetteri*)** will be submitted to the Journal of Wildlife Disease.

Chapter seven

**General discussion** summarises the significant findings of this study. The relevance and implications of results are discussed and future research directions are suggested.

Chapter eight

**Literature cited** has been collated at the end of the thesis to reduce repetition. Literature is referred to in the format consistent with the format used for the journal Conservation Biology.

Chapter nine

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