Silent **birds**

When Captain Cook's crew stepped ashore on the Hawaii Islands in 1778 they started collecting birds from the forests. Little did they know just how useful their specimens would become 230 years later. **Jim Groombridge** explains how early naturalists have unwittingly enriched our ability to examine the process of extinction.

If you want to study extinction, Hawaii is a great place to start. Aptly named as the extinction capital of the world, half of the islands' 140 historically recorded native bird species are extinct, and some have vanished so recently that resident field biologists can recall them being common when they were children. Some of these extinct species have common names like 'O'o, 'O'u, and 'O'o'a'a – surely these are birds worth getting to know.

Figuring out why species have gone extinct is a real challenge. The disappearance of many island species in the last few hundred years could simply be that they provided a ready meal for invasive species such as rats and cats. These introduced mammal species escaped from ships such as Cook's *Discovery* and now thrive on almost all of the world's islands, gorging on the naïve island wildlife. But geneticists can explain extinction differently: as populations decline to a small size they rapidly lose the chance element of genetic diversity and, together with associated problems of inbreeding between related individuals, these genetic factors are believed to contribute to extinction – perhaps especially so for endemic species isolated on small islands.

The problem, ecologists argue, is that introduced mammals such as rats and cats are likely to exterminate a bird population well before genetic factors can play a role. Recent work has shown how we can explain historical bird extinctions on some islands purely by the presence of introduced mammalian predators, suggesting that rapid decline of bird populations by predation leaves little time for genetic effects of small population size to be felt. Humans might also have contributed by hunting birds for their valuable feathers. Indeed, on Hawaii early Polynesians prized feathers as currency to pay taxes to royalty, and, later, European collectors shot thousands of birds for the feather trade. Hence, disentangling which of these factors drive species to extinction is complex but such knowledge is crucial for conservation biologists working to restore endangered species.

So, has genetics played a role in recent extinctions? To answer this question for extinct species like the Hawaiian 'O'o and 'O'u, we can measure the genetic diversity in samples from historical museum specimens using a technology called microsatellite genotyping to examine their historical genetic signature. Doing the same for closely related species that are exceedingly common on Hawaii today such as the 'Apapane and 'Iiwi (pronounced eee-eee-vee) provides an ideal yardstick to compare extinct with extant. Thankfully, these four species caught the eye of naturalists and hunters alike throughout the 1800s and 1900s and are extremely well-represented

DNA from cloak feathers means we can extend our genetic understanding of extinction in Hawaii.

Top: Skin of the extinct Hawaiian 'O'o *Moho nobilis*.

Middle: An 'Apapane, *Himatione sanguinea*, shown fitted with a radio-transmitter, is a very common species on Hawaii.

Bottom: Skins of the extinct Akialoa, with their impressive bills.

in museum collections, with many hundreds to thousands of dated skins available worldwide.

We used 20 genetic markers to measure the level of genetic variation in close to 150 museum skins collected between 1887 and 1945 and in samples from modern populations. The emerging picture so far from a comparison of these historical genetic profiles suggests that some extinct species retained levels of genetic diversity broadly similar to those detected in the extant species during the 1800s and 1900s that are still common today. The levels of genetic diversity in the extinct 'O'u population seems to be well within that found in the common species, and we know from field records that the 'O'u population experienced a rapid decline to eventual extinction by 1980. Conversely, we found less diversity in the 'O'o population, which we believe reflects this species' lengthier demographic decline rather than hunting pressure by feather collectors.

But, do these different historical genetic signals reflect a true genetic picture? In many historical studies that use DNA, museum-aged specimens collected around the 1800-1900s are often all that's available, leaving us to wonder about the genetic make-up of populations before this. Cook's 'discovery' of Hawaii in 1779 marked the heavy ecological footprint of Europeans, but Polynesians inhabited the islands for well over a thousand years before this. Fortuitously, a remarkable genetic resource from Hawaii exists in the form of feathered cloaks made by early Polynesians and worn in battle by Hawaiian royalty. A priceless sample for any geneticist, these remarkable cloaks are constructed from feathers taken from many thousands of individual birds and designed with striking patterns using red, yellow, green and black feathers from the extinct 'O'o and 'O'u and the common 'Iiwi and 'Apapane.

Deriving DNA and genetic data from these cloak feathers means we can extend our genetic understanding of extinction in Hawaii to far more ancient bird populations. Feather and skin samples from some of these cloaks have already yielded the entire genetic make-up of some birds, and radiocarbon dating of feathers is now adding an exciting new perspective, allowing us to independently date our genetic data: for instance, one cloak of 'O'o and 'Iiwi feathers is between 550 and 600 years old, one of the world's oldest feather artefacts.

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The next step is to extend this historical genetic work to a larger set of Hawaiian bird populations, to look for broader trends between historical genetic diversity and differences in population trajectory. Luckily, almost 30 different island populations are available, each with a detailed demographic history and a rich collection of carefully catalogued and dated museum skins.

The ancient Polynesian feather-collectors on Hawaii and early explorers like Captain Cook whose collections now fill museums, have paved the way for an exciting new approach to our understanding of the genetic processes that drive extinction. ■

Dr Jim Groombridge is a lecturer in Biodiversity Conservation at the Durrell Institute of Conservation and Ecology (DICE) at the University of Kent and was awarded a NERC New Investigator's Award for this genetic work on Hawaiian avifauna, in collaboration with Dr. Robert Fleischer of the Smithsonian Institution and Professor Richard Nichols at Queen Mary, London. Dr Sarah Anderson carried out the genetic work. The project used the NERC Molecular Genetics Facility at Sheffield and the NERC/Arts and Humanities Research Council Radiocarbon Accelerator Unit in Oxford. Jim is an Associate Editor of *Conservation Genetics* and a member of the Editorial Review Board for Endangered Species Research.
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