Shackleton Scholarship: REPORT

Ceridwen Fraser, 2010

This report is submitted to detail the success of field research funded by the Shackleton Scholarship Fund. The funding allowed me to travel to the Falkland Islands in February 2010 in order to collect samples for my PhD work on seaweed genetics and climate change.

An icier Ice Age: evolutionary impacts of climate change in the Southern Hemisphere

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Background:

With global warming in the scientific spotlight, research into the evolutionary and biogeographic impacts of climate change is of enormous importance. Genetic analysis has the potential to revolutionise our understanding of palaeoenvironmental conditions. Although the use of genetic tools to elucidate the biological effects of climatic change is well established for Northern Hemisphere taxa, comparable research in the more oceanic Southern Hemisphere is lacking. In particular, our understanding of palaeoclimatic conditions in the Southern Ocean is disturbingly poor, and this knowledge gap hinders our ability to predict how future climate change will impact southern ecosystems.

Our recent Southern Hemisphere research (some of which was also funded by a Shackleton Scholarship, with collections made from the Falkland Islands in early 2008) has revealed startling new evidence that Last Glacial Maximum (LGM) conditions in the Southern Ocean were substantially colder than previously thought (Fraser et al. 2009, *PNAS* 106). Our genetic analyses of the widespread Southern Bull Kelp (*Durvillaea antarctica*) indicate that this species rapidly recolonised the subantarctic following the LGM, and also suggest that the extent of LGM sea ice may have been underestimated by existing climate reconstructions. It is well known that sea ice scour directly eliminates many marine organisms, and we therefore predict that, as for *D. antarctica*, postglacial recolonisation patterns will be detected in a range of other ice-sensitive subantarctic organisms. This ongoing research seeks to determine whether comparable genetic patterns are observed in other ice-affected seaweed species, and conversely, whether such patterns are not observed in ice-resistant taxa. This broadscale, multi-species genetic study will help us to determine the evolutionary impacts of historic climate change in the Southern Hemisphere.

The Falkland Islands are a key link in the subantarctic chain. My research uses powerful genetic tools to 1) examine how seaweeds in the Falkland Islands are connected to other populations, e.g., those in New Zealand and subantarctic islands, such as Marion Island in the Indian Ocean, and Gough Island in the Atlantic Ocean; 2) examine genetic variability within these species in the Falklands, and elsewhere in the subantarctic and along the coasts of New Zealand and Chile

Seaweeds – from large kelps to small moss-like algae – blanket the rocky shores of the Falkland Islands, forming a dominant part of the coastal landscape and ecosystem. How these species respond to climate change will have important implications for the ecology of the islands.

Summary of Falkland Islands field work:

Methodology and sites visited:

I collected small (<2cm^2) tissue samples of between 10 and 40 individuals of each of my seven target seaweed species. Samples were collected from intertidal and shallow subtidal rocky shores at low tide. As obtaining samples from multiple sites was important (to help show local genetic variation), I collected from several sites near Stanley (Cape Pembroke) and two sites on Sea Lion Island. Fortunately the seas were relatively calm during the entire week that I was sampling in the Falkland Islands, and collections were highly successful. In addition to sampling for my own (seaweed) research, while at the sites I also collected samples of intertidal molluscs (limpets, chitons etc) and other invertebrates (e.g., crustaceans) to assist the research of various colleagues. When marine sampling was not feasible (e.g., during high tide) I was able to collect terrestrial invertebrates (*Merizodus* sp.) for colleagues in France. In this way, I was able to maximise the scientific benefit of my time in the Falkland Islands. (All collections were approved and permitted by the landowners and relevant government agencies in the Islands).

Sampling from rock platform on Sea Lion Island, Falkland Islands, 11 February 2010

A record of collections is provided in the following table:

Date	Site	Latitude	Longitude	Species	N
7-Feb	Surf Bay, Falkland Islands	51°41'59.43"S	57°46'46.04"W	*Merizodus soledadinus*	50
8-Feb	Cape Pembroke, Falkland Islands	51°40'57.13"S	57°43'2.44"W	*Adenocystis utricularis*	18
8-Feb	Cape Pembroke, Falkland Islands	51°40'57.13"S	57°43'2.44"W	*Bostrychia*	15
8-Feb	Cape Pembroke, Falkland Islands	51°40'57.13"S	57°43'2.44"W	*Desmarestia ligulata*	15
8-Feb	Cape Pembroke, Falkland Islands	51°40'57.13"S	57°43'2.44"W	*Desmarestia* [med blades]	2
8-Feb	Cape Pembroke, Falkland Islands	51°40'57.13"S	57°43'2.44"W	*Desmarestia* [med, tough]	10
8-Feb	Cape Pembroke, Falkland Islands	51°40'57.13"S	57°43'2.44"W	*Desmarestia* [fine blades]	4
8-Feb	Cape Pembroke, Falkland Islands	51°40'57.13"S	57°43'2.44"W	*Herpodiscus* [fuzzy]	17
8-Feb	Cape Pembroke, Falkland Islands	51°40'57.13"S	57°43'2.44"W	*Herpodiscus* [fuzzy]	40
8-Feb	Cape Pembroke, Falkland Islands	51°40'57.13"S	57°43'2.44"W	*Herpodiscus* [non-fuzzy]	30
9-Feb	Cape Pembroke, Falkland Islands	51°40'57.13"S	57°43'2.44"W	*Durvillaea* holdfast fauna	many
9-Feb	Cape Pembroke, Falkland Islands	51°40'57.13"S	57°43'2.44"W	*Onchidella*	40
10-Feb	Sea Lion Island, Falkland Islands	52°25'45.60"S	59° 3'6.53"W	*Durvillaea* holdfast fauna	many
10-Feb	Sea Lion Island, Falkland Islands	52°25'45.60"S	59° 3'6.53"W	*Ulva*	4
10-Feb	Sea Lion Island, Falkland Islands	52°25'45.60"S	59° 3'6.53"W	*Gigartina sp. 1(?)*	10
10-Feb	Sea Lion Island, Falkland Islands	52°25'45.60"S	59° 3'6.53"W	*Herpodiscus* [fuzzy]	12
10-Feb	Sea Lion Island, Falkland Islands	52°25'45.60"S	59° 3'6.53"W	*Herpodiscus* [non-fuzzy]	1
11-Feb	Sea Lion Island, Falkland Islands	52°25'21.56"S	59° 3'53.43"W	*Herpodiscus* [fuzzy]	8
11-Feb	Sea Lion Island, Falkland Islands	52°25'21.56"S	59° 3'53.43"W	*Gigartina skottsbergii*	12
11-Feb	Sea Lion Island, Falkland Islands	52°25'21.56"S	59° 3'53.43"W	*Lessonia* [intertidal]	7
11-Feb	Sea Lion Island, Falkland Islands	52°25'21.56"S	59° 3'53.43"W	*Desmarestia ligulata*	6
11-Feb	Sea Lion Island, Falkland Islands	52°25'21.56"S	59° 3'53.43"W	*Desmarestia* [med, tough]	7
11-Feb	Sea Lion Island, Falkland Islands	52°25'21.56"S	59° 3'53.43"W	*Desmarestia* [fine blades]	10
11-Feb	Sea Lion Island, Falkland Islands	52°25'21.56"S	59° 3'53.43"W	*Bostrychia*	15
11-Feb	Sea Lion Island, Falkland Islands	52°25'21.56"S	59° 3'53.43"W	*Adenocystis utricularis*	24
11-Feb	Sea Lion Island, Falkland Islands	52°25'21.56"S	59° 3'53.43"W	*Codium fragile*	19
11-Feb	Sea Lion Island, Falkland Islands	52°25'21.02"S	59° 3'59.94"W	*Merizodus soledadinus*	50
13-Feb	Stanley, Falkland Islands	dive site		trochid snails	50?

Preliminary findings

Laboratory work (extraction of DNA, amplification of gene regions, and sequencing) is currently underway on these samples – I expect to have results ready for publication by early 2011. One preliminary finding is quite exciting, however: a parasite (*Herpodiscus durvillaeae*) of the common bull kelp (*Durvillaea antarctica*) has previously only been described from New Zealand, but samples collected during this trip to the Falkland Islands have already been identified as *H. durvillaeae*. This parasite therefore appears able to traverse thousands of kilometres of ocean, probably by rafting with detached bull kelp, to colonise distant shores. Further work will help to determine whether populations in New Zealand (and other Southern Ocean localities) are genetically distinct from those in the Falkland Islands.

This bull-kelp specimen from Sea Lion Island (Falkland Islands) was solid-bladed – several previous studies have recorded a solid-bladed 'species' of *Durvillaea* (e.g., *Durvillaea harveyi*) from southern Chile and the Falkland Islands, but my genetic research indicates that they are simply morphological variants of the widespread *Durvillaea antarctica*. This specimen also bears numerous infestations of the parasite *Herpodiscus durvillaeae* (samples inset), which has previously only been recorded from New Zealand.

Acknowledgments

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