Control of Temperature adaptation in Notothenioid Fish (IcemiRs)

By research visitor Dr Thomas Desvignes

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In February-March 2018, three scientists from two American universities, Prof. John H Postlethwait and Dr Thomas Desvignes from the University of Oregon (UO), and Prof. H. William Detrich from Northeastern University (NEU), came to Stanley to study the capacities of temperate Notothenioid fish to cope with acute temperature changes. While Profs. Postlethwait and Detrich stayed for 1 and 2 weeks respectively, Dr Desvignes stayed for four weeks.

Prof. H. William Detrich (NEU), Dr. Thomas Desvignes (UO), and John H. Postlethwait (UO)

Notothenioid fish form a large family of fish composed of about 130 species. Most of these species are found exclusively in the Southern Ocean around the Antarctic continent. There, over millions of years, they evolved unique characters enabling them to survive and thrive in this frigid environment. Among these adaptation is the evolution of an anti-freeze protein that prevents ice-crystals to damage the cells by bursting them open, and therefore gives these fish the rare ability to survive where any other fish would die. As a drawback, however, Antarctic Notothenioid fish lost the capacity to activate a genetic response to environmental temperature change because the Southern Ocean has remained stably cold for millions of years, without annual temperature fluctuations. This inability to produce a response to temperature changes is likely to make Antarctic fish extremely susceptible to climate change and they could be some of the first casualties of the predicted dramatic effect of global warming on the Southern Ocean.

The team of researchers came to SEARI for help because two extremely interesting groups of Notothenioids species can be found in the Falklands.

The first group represents "ancestral" notothenioids. Before Antarctica and South America split apart, some Notothenioid fish were swimming in the soon-to-become Falkland waters and stayed around as continents separated. Nowadays, some of their descendants can still be found around the archipelago. Studying these species allow us to understand how sensitive to temperature changes Notothenioids were before some of them adapted

to the cold waters of Antarctica. It also allows us to study the modalities of the genetic response ancestral fish could likely initiate when facing temperature changes. Among the "ancestral" Notothenioid species found in the Falklands, the group was able to study temperature effects on one well known Falkland species: the Falkland mullet, *Eleginops maclovinus*, which we captured using a seine net at Moody Brook.

In addition to the "ancestral" species, the Falklands host several species of Notothenioids that managed to escape the frigid cold Antarctic waters and returned into more temperate waters, at some point over the last 15 million years. These species are of important interest for our study of the effects of climate change and global warming. Indeed, if some fish managed to escape Antarctica and come back to warmer water, how did that impact the ability of these 'escapees' to cope with cold waters or the predicted warmer water in the future? What is the minimal temperature they can handle? Are they able to protect their body with an anti-freeze protein similarly to their Antarctic ancestors or have they lost this capacity? On the other hand, while their ancestors lost the capacity to express a genetic response to temperature warming, have the escapees evolved a new way to generate a response to temperature elevation? To answer these questions, we studied two species of escapees: the humped notothen *Patagonotothen sima* that we caught with the seine net at the same time as the Falkland mullet, and the tessellated notothen *Patagonotothen tessellata*, that was kept alive for us by the members of the Falkland Island Fisheries Department (FIFD) during their February Ground Survey cruise. We are extremely grateful to SAERI intern Amy Guest and the FIFD team for helping us to obtain these live specimens and many other specimens of other species.

During the month of field work in Stanley, with the critically important technical help of employees of the Falklands Fish Farming Ltd, the team managed to study the effect of temperature decrease and increase on three species (the 'ancestral' Falkland mullet and the two escapees, tessellated and humped notothens) and collect DNA, RNA (for gene expression), and morphological data from many more temperate Notothenioid species. All the samples have now been safely received at the University of Oregon and their molecular analysis will start soon, now that the same team members have returned from field work at Palmer Station, in Antarctica, where similar parameters were studied but this time on the cold adapted sister Notothenioid fish species.