GENETICS OF NORTH AMERICAN ARCTIC FOX POPULATIONS: SUMMARY

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Genetics of North American Arctic Fox Populations

A DNA Study by: L.E. Carmichael, J. Krizan, J.A. Nagy, E. Fuglei, M. Dumond, D. Johnson, A. Veitch, D. Berteaux, G Szor, M-A Giroux, and C. Strobeck

Introduction

Arctic foxes have lived in Canada's mainland barren-ground tundra and the arctic islands for thousands of years. Foxes have many characteristics that allow them to survive cold northern temperatures; for example, they are the only member of the dog family (including dogs, wolves, foxes, and coyotes) that changes colour in winter and has fur on the pads of its feet. Arctic foxes also have special behaviors for dealing with variations in their food supplies. They prey on birds and their eggs, and scavenge from polar bear kills, but prefer to eat lemmings whenever possible. When lemming populations crash and foxes can't find enough prey nearby, they travel thousands of kilometers over land and sea ice to look for more food. The number of arctic foxes living together is also affected by the abundance of their prey.

Objectives

Arctic fox furs are a valuable source of income for many northern residents, and arctic foxes sometimes carry diseases like rabies and canine distemper. Genetic analysis using arctic fox DNA can help us understand how foxes live and how they move between populations, so we can develop better management plans. The major goals of this project were to find out 1) how island fox populations are related to mainland populations, 2) how prey influences the way arctic foxes move, and 3) how arctic foxes mate and den. We did this by comparing the DNA of foxes from different areas.

Methods

We asked hunters from communities in the Northwest Territories and Nunavut to give us small pieces of fur from foxes they had harvested. Extra samples were collected from museums, fur auctions, and other research projects. Certain pieces of DNA have different sizes in different individuals; we compared the sizes of twelve different pieces for each fox collected. Then we combined the results for all foxes in each area, and checked whether different areas had different DNA. On Bylot Island in Nunavut, we also knew which den foxes were living in, and combined this information with the DNA to study fox mating patterns.

Results

On arctic islands which are not surrounded by winter sea ice (for example, St. Paul Island in Alaska and Mednyi Island in Russia), arctic foxes often live in groups with one male and many females. On Bylot Island, most male foxes had only a single female mate. However, we found one den with two males, two females, and two litters of cubs. We also found a den where one female was living with two mates, and her litter of cubs therefore had two fathers. Complex families of arctic foxes are thought to form when lots

of food is available, and all family members have plenty to eat. We now know this is true on Bylot Island, where arctic foxes eat birds and eggs as well as lemmings.

Arctic foxes had the same amount of DNA variation (number of sizes per DNA piece) in all populations, on both islands and the mainland. Furthermore, there were no differences in the DNA of any fox population in our study; all foxes were genetically similar. This result tells us several things. First, it shows that Canadian arctic foxes have existed in one continuous population for thousands of years, with no large declines in numbers, and nothing to prevent movement of foxes from one area to another. Second, when lemming populations crash and foxes travel long distances looking for food, they do not return home to breed, but find mates in new places. When they do so, they carry their DNA with them, mixing fox DNA across populations that may be thousands of kilometers apart. Third, when hungry foxes follow polar bears over sea ice, they also carry their DNA with them, making island populations the same as mainland populations. Since results like this have never been found in other dog-like species, arctic foxes are very unique.

Implications and Future Research

Our DNA results tell us that all arctic fox populations in Canada are currently healthy and should be able to survive for a long time. However, changes in arctic climates may have negative impacts on this species. If sea ice is lost, fox populations on islands may become isolated from foxes on the mainland. When lemming populations decline on the islands, foxes may not be able to escape in order to find more food. This might not be a problem as long as birds nest on the islands, and carrion from polar bear kills is available. A bigger concern is that arctic foxes can't live where red foxes do, because red foxes are bigger and stronger. Red foxes are currently restricted to warmer southern environments, but will continue to expand northward as the arctic climate changes. Over time, red foxes will continue to push arctic foxes further and further north. Like the loss of sea ice, this could result in isolation of arctic fox populations, which may damage their genetic health in the long term. The results of this study therefore provide a good starting point for monitoring future changes in the DNA of arctic foxes.

Because the DNA of arctic foxes in all areas is so similar, we can't tell whether foxes move in some directions more than others. That means we can't yet predict how fox-borne diseases like rabies will spread through space. A different way to learn about this would be with ear tags or radio-collars, to track individual foxes as they move through the landscape. These kinds of studies could add a great deal to our understanding of the arctic fox.