Don't Feed the Squirrels! The Impact of Supplementary Feeding on Morphology

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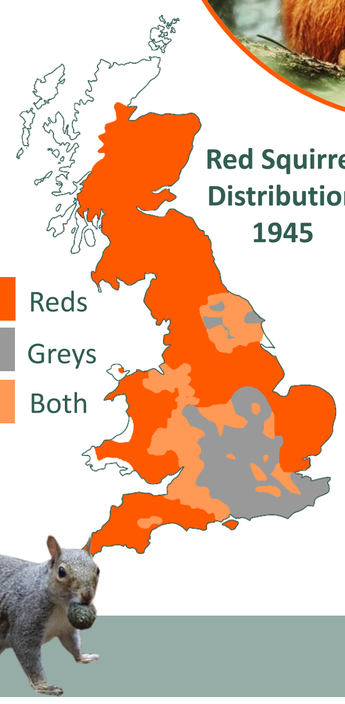
British red squirrels (*Sciurus vulgaris*) have declined greatly in number and distribution since the introduction of invasive grey squirrels (*Sciurus carolinensis*) in the 1800's.

Populations in Britain today are disparate and little genetic exchange occurs between them. Each population can be considered an "Evolutionary Island" with different genetic histories, diets, climates and habitats.

Populations have access to different food sources, with one population, a National Trust site at Formby, Merseyside, eating a high proportion of peanuts.

Understanding how these populations differ is key in informing conservation practices, such as provision of supplementary food, and translocation projects.



Research Question:

Are populations morphologically distinct from each other, as they adapt to different diets?

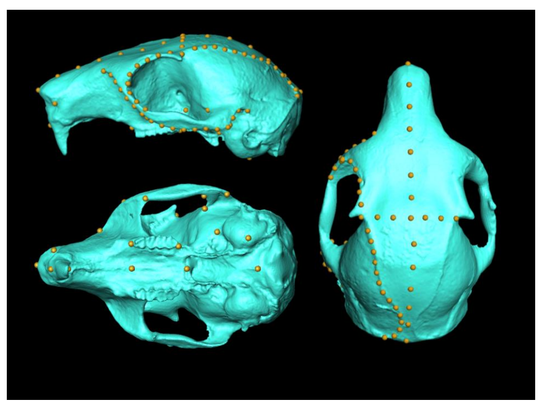
Red Squirrel Distribution across Britain Today

Map of Great Britain - Populations of red squirrels today. Specimens from each population were included in the dataset - the best represented were North Scotland, North England and Formby. Specimens from a population in Thetford, East Anglia, that went extinct in the 1990s, were also included. The diet of each population varies, made up of a range of foods such a pine cones, hazelnuts, acorns, beechnuts and 'human' food such as peanuts.

Study 1:

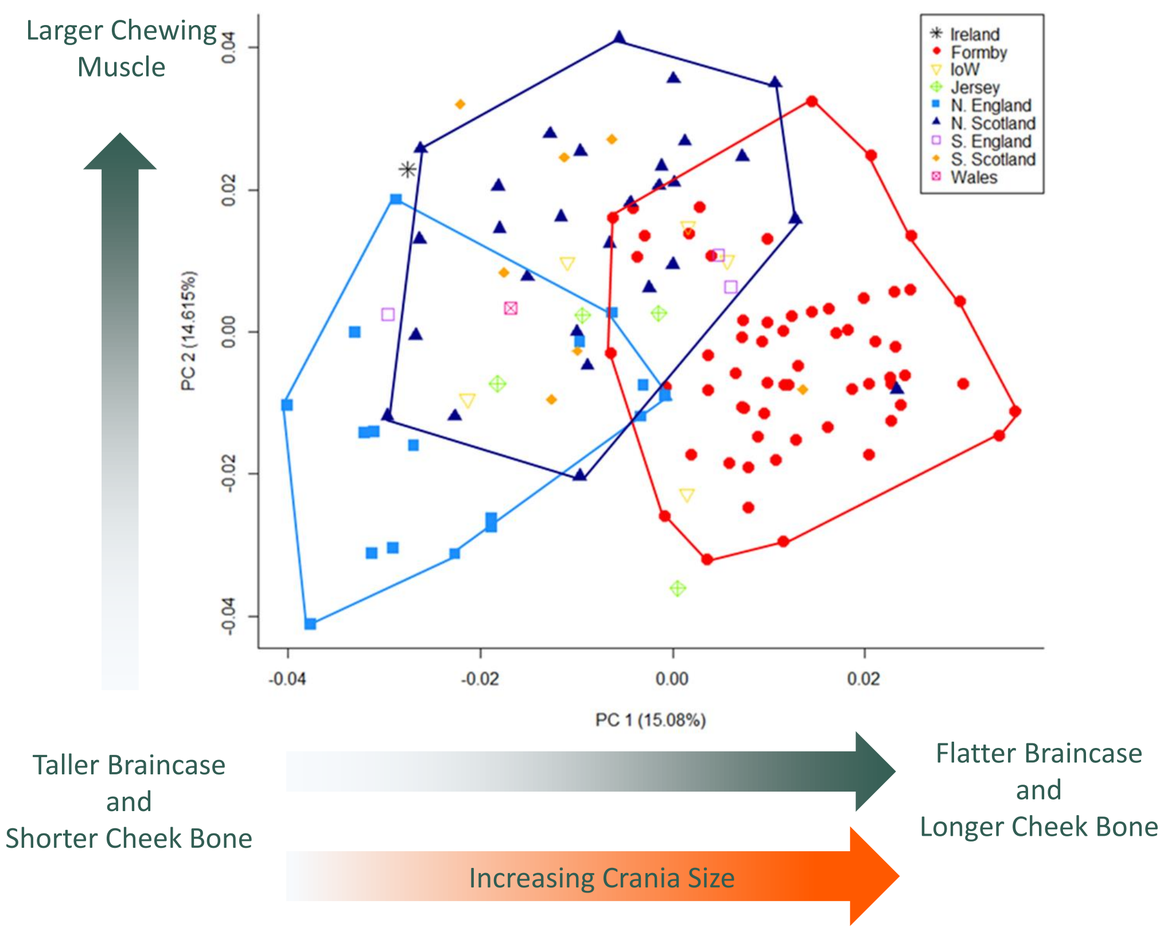
Shape Analysis through Geometric Morphometrics

1. Red Squirrel jaws and skulls from the National Museum of Scotland were photographed and scanned with a 3D surface scanner.
2. These photos and 3D models had their shapes captured through land-marking.
3. Shape data were analysed using Geometric Morphometrics and compared through statistical analysis such as Analysis of Variance.



3D Models of Squirrel Crania with landmarks placed in the software Avizo

Results



Above graph shows shape variables on a Principal Component plot. Each data point represents a single squirrel and the axes represent shape changes.

Populations of British red squirrels do show statistically significant morphological variation between different populations in both the skull and jaw.

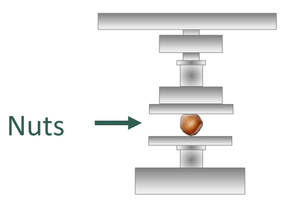
Squirrels in Formby are the largest, and are possibly becoming more morphologically distinct from other populations over time.

Conclusions of Study 1

Morphological differences in the mastication (chewing) apparatus exist between populations of Red Squirrels in the UK. These differences may be linked to the availability of **different food types**. **Formby squirrels may be most different due to the provision of non-natural food type** – peanuts. Although staff at the reserve no longer provide peanuts to the squirrels, visitors continuing to feed squirrels with peanuts may be contributing to this morphological change.

Further Research – Interdisciplinary Techniques

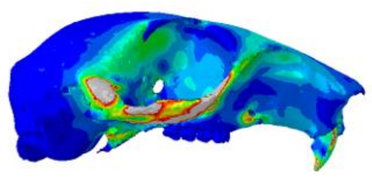
Study 2: Mechanical Properties of Nuts



Mechanical properties of the different food types will be tested through **physical testing** methods used in materials design.

Study 3: Biomechanics and Engineering

Finite Element Analysis, an **engineering** method for predicting how a product reacts to real-world forces, will be used in biomechanical studies of mastication



Stress distribution map of a squirrel skull

All specimens included in this study were deceased prior to collection by the National Museum of Scotland. No culling was performed for this study.
Stress distribution map image taken from Cox et al. 2012. All other photos, graphs and maps on this poster were created by the author or downloaded from https://pixabay.com/