

This article first appeared in the Isle of May Bird Observatory and Field Station newsletter.

## OTHER STUDIES - HOUSE MOUSE

### The early history of Isle of May mouse research

Whilst readers are no doubt aware of the wealth and variety of the Isle of May bird populations, the island is also home to a lively and well documented population of *Mus musculus domesticus*, more commonly known as the house mouse.

How and when mice were introduced to the Isle of May is not known, though they were likely accidentally introduced by people who have been living on the Isle of May since the middle of the twelfth century. The earliest recorded sighting of mice on the island is in an undated letter written by the 19th century lighthouse keeper, James Agnew, "We have no rats, but legions of mice, and most impudent mice they are, for they sit and look in your face, and even gnaw at the legs of your trousers with a composure that is quite amusing." Unfortunately, I can confirm that the trouser gnawing is still a current trait.

Mouse research on the Isle of May began in 1963 with R. J. Berry collecting 96 mice for an inter-island comparison of mice across the United Kingdom. Berry found the Isle of May mice to have a comparatively large size and multiple unique skeletal features, which is likely to be due to selective pressure from their exposed outdoor environment and lack of mammalian predators. In a later follow-up study during 1970-1973, G. S. Triggs detailed how the size of the mouse population can change sevenfold year to year, largely dependent on the severity of the winters, and how the mice are physiologically and behaviourally well-adapted to the cold conditions. This includes atypical behaviour such as huddling together in their nesting sites (up to 15 mice at a time), rather than forming multiple nesting sites as smaller family groups.



Releasing a mouse caught during fieldwork

### The introduction of Orkney mice

In 1982, 77 mice sourced from the island of Eday, in Orkney were released at South Horn (at the southern end of the island) on the Isle of May to investigate their impact on genetic hybridisation and mouse social structures. The expectation was that the advantageous adaptations and engrained social structures of the Isle of May mice would limit the expansion and intermixing with the new Orkney population. In complete contrast, within six months, offspring with a combined Isle of May and Orkney heritage were found at every location on the island including Rona and North Ness (at the northern tip of the island). Within three years the entire Isle of May mouse population was derived from these hybrid mice. These new hybrid mice are physically larger and their rapid expansion across the island would imply that they are even better adapted to the environmental conditions on the Isle of May.

### Who are we?

Our team is made up of immunologists and ecologists from the University of Manchester and the University of Nottingham. Immunology is the study of the immune system (in all organisms), describing its components, understanding how it functions and delineating its role in health and disease. The immune system is typically thought of as a defence against infection, but it also has roles in cancer, autoimmune disease, metabolism, and reproduction. Ecology is the study of the relationships between organisms (including humans) and between organisms and their environment. By mapping these relationships, ecology provides an understanding of the impacts of organisms and their environment in health, disease, evolution, economics, and sustainability. By combining our disciplines as a team, we are hoping to contribute to the relatively new field of Ecoimmunology.

Ecoimmunology is about exploring the natural variation in immune function and establishing relationships between the environment and immune function. As an example, it is well established that both air pollution and cold-dry weather conditions (environment) can exacerbate inflammatory lung diseases (immune system) such as asthma.

Our Isle of May Ecoimmunology project was pioneered nine years ago by Professor Jan Bradley (University of Nottingham) and we have been helped along the way by various helpers from our universities, the NatureScot wardens and the Biotechnology and Biological Sciences Research Council, who have funded our research.



The 'Mouse People' (as, apparently, we are known!) with the Wardens at Kirkhaven, November 2019



Break-time on the Isle of May; the bottle of wine was just for decoration

### Why study wild mice?

Our goal, as a mixed team of immunologists and ecologists, is to understand how ecological conditions on the Isle of May impacts the functioning of the wild mouse immune system and what this means for their health and susceptibility to disease. Mice have been used as a research model in both immunology and ecology for several centuries, hence there's a wealth of research describing the norms and intricacies of their behaviour and physiology. The wild mice on the Isle of May represents a novel opportunity, as an isolated island population with limited human interaction, we can measure and monitor many of the conditions that could affect the health of the mice. The research by Berry and Triggs also gives us a vital historical baseline to work from. By combining our expertise and the unique environment of the Isle of May, we are hoping to uncover novel mechanisms that shape the immune system which can later be translated to benefit not only human health, but also wildlife management and conservation efforts.



The high-tech research laboratory in Fluke Street, after I'd tidied it for the photo

### What do we do?

Much of our work involves capture, individual tagging, and release of mice. We measure the mice to assess their condition and collect samples such as blood (to measure immune markers such as antibodies) and faecal matter (to assess diet and microbiome composition) and then release them back into the wild to be re-captured at a later date. The data we collect can be used to look at aspects such as how the mice are faring in different parts of the island, whether the changing of seasons or diet alters immune function and whether any of these things relates to their susceptibility to disease, infection, or their long-term survival. We have also conducted studies using a vaccination programme (against an innocuous protein) to investigate what factors determine the strength and type of immune responses to specific immune challenges in a wild environment.



Now that all the traps are washed, it's time to put them all out again!



Another house mouse returns to the outdoor laboratory that is the Isle of May!

### What have we found so far?

We have confirmed some of the previous research, that the size and health of the mouse population is highly dependent on seasonal and weather extremes, but we have also documented many physiological changes that are tied to this phenomenon. As seasons change, the mouse gut undergoes sex-specific changes which creates an alternative environment for the various microbial species and parasites that live in the gut, as well as potentially altering nutrient absorption. In the winter, immune cells alter their activity and accumulate in the bone marrow, potentially as a mechanism to keep immune cells in reserve, reducing resource expenditure to a minimum.

We've also investigated the incidence and impacts of parasitism on the Isle of May mice. The mice are naturally exposed to a variety of ecto (meaning parasites attached to the skin of the mice) and endo (internal) parasites such as whipworm. Specifically, we've found that the burden of whipworm varies heavily across the different areas of the island, and that we can correlate this parasite burden with specific immune signatures, indicative of alternative immune responses to infection.

For the future we are interested in the interplay of genetics and ageing with the immunological and environmental variation. Ultimately, we still have much work to do, but our experiences on the Isle of May have been a source of enjoyment for all of us and a vital contribution to the scientific record.

Andrew Muir



Halloween on the Isle of May. The pumpkin was enjoyed by both researchers and hungry mice!