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To the Rockies and back

Studying marmots in Colorado

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Yellow-bellied marmots are cat-sized ground squirrels that hibernate for about 8 months of the year. Since they typically live in social groups and at high elevation, they are a popular study system for researchers interested in sociality, behaviour and climate change. However, my interests as a PhD student diverged from those subjects and I took advantage of the long lifespan in these burrow-dwelling rodents to study a most intriguing aspect of life: ageing or 'senescence'. As part of my project I spent two summers in the Rocky Mountains, Colorado, where I observed and trapped marmots over several months. Whilst challenging, my time in the field was fun and enriching, and I am always delighted when fellow 'marmoteers' report news that study animals including 'Dandelion', 'Bird' and 'Stitches' have survived yet another hibernation.

The marmot study at the Rocky Mountain Biological Laboratory (RMBL) was started in 1962, and has been running every year since. The ongoing continuation of the project has led to the accumulation of a



Fig.1. Marmot trap, shaded and camouflaged with vegetation and cowpat.

wealth of data. Whilst the elusive nature of mammals often prohibits successful observation and collection of large data sets, a lot of these challenges can be overcome in the marmots. The reason for this is that they live in permanent underground burrows which, once located, permit repeated capture of individuals. Also, marmots are active during daytime and tend to stay in the vicinity of their burrows, allowing near-daily observation of individuals.

Marmot trapping and cowpats

During the summer months, fieldwork at the RMBL marmot project starts early in the morning with trap setting. Marmots are baited with horse food, although some individuals can only be enticed when peanut butter and salt are added to the 'trap menu'. While mornings in the Rockies are freezing, it heats up quickly once the sun rises over the mountain tops. Consequently, traps need to be checked only a few hours after being set. To provide some shade to any captured animals, we cover traps with vegetation, rocks and dried cowpats, kindly left by passing cattle (**Fig.1**).

Once an animal is captured, we can identify it based on its numbered ear tags (**Fig.2**). We then collect blood, faeces and hair samples, and measure marmot weight and hind-foot length. We also record any alarm calls, which to an outsider might suspiciously look like the marmot is being interviewed (**Fig.3**). One aspect of data collection that is most crucial to the work of my PhD is that marmot pups are captured and tagged as soon as they emerge from their burrow in spring (**Fig.4**). This means that we know their exact year of birth, and thus can follow known-aged animals throughout their lives.



Fig.2. Marmot with ear tag.



Fig.3. Recording of alarm calls.



Fig.4. Capture of newly emerged marmot pup.



Fig.5. Marmot with fur mark 'Forbidden Sign'.

Observing marmots, 'potato marks' and 'marmot hands'

We spend many hours observing marmots from a distance through binoculars and scopes, which allows us to confirm that animals are still alive and record their behaviours. Individuals can be identified from afar based on unique fur marks which we give them at capture using an old toothbrush and cattle dye (Fig.5 shows 'Forbidden Sign'). During my training as a marmoteer, I soon appreciated the challenge of performing this task on a live animal, and despite my greatest efforts, I produced a number of 'potato marks' in my time. The marmots do their best to ensure that the dyed fashion is not reserved for them alone, indeed, among scientists at RMBL 'marmot hands' is a well-established term that describes

the consistently dye-blackened hands of marmoteers. However, it is a small price to pay for being able to identify almost every single individual from a distance.

If during our observations we do not see an adult for a full year, it likely has died. This may be due to unsuccessful hibernation or predation early in the season. Predators include foxes, coyotes, badgers, bobcats, weasels, martens and various birds of prey such as the golden eagle. Later in the season, adults are unlikely to be killed by predators, however pups are commonly targeted. Marmots protect themselves by using a sophisticated system of alarm calls, warning their offspring and other marmots of predators. In fact, the whistling sound of these calls has resulted in the marmot also being known by the rather endearing nickname 'the whistle pig'.



Fig.6. Body mass (left) before and (right) after hibernation.

Ageing in marmots?

Based on data that has been collected over the last 55 years, we know that females and males can live up to 14 and 11 years respectively. However, most marmots have an average lifespan of about 5-6 years. I investigated three topics in the context of ageing: how female body mass changes as a consequence of ageing, how reproductive history affects female reproductive success at older ages, and how ageing in the mother affects the reproductive success of her daughters.

First, I found a decrease in body mass in females beyond the age of 8. Like other fat-storing hibernators, marmots rely on fat reserves to survive hibernation and reproduce in the following year. In fact, the difference in body mass before and after hibernation in a fully-grown marmot can be up to 40% (Fig.6). As animals age, they may become less efficient at storing fat, or use more energy to maintain bodily function, which would explain the decrease in mass with advancing age.

Second, females which had reproduced more frequently and weaned larger litters in previous years were less likely to reproduce again in the current year. This suggests that frequent reproduction and having large numbers of offspring lead to faster rates of bodily deterioration.

Finally, my results showed that daughters that were born to older mothers were more successful at reproducing than daughters that were born to younger mothers. This was surprising because the expectation is that due to ageing, reproduction is particularly costly in old mothers, and that some of these costs are passed on to their offspring. However, my findings indicate that adult daughters benefit from being born to mothers with greater life experience.

Dandelion

Although my PhD is reaching its conclusion, as is so often the case in science, many questions remain. However, a couple of things are indisputable. First, I am incredibly grateful to all the people that made my PhD possible and contributed to making it an enjoyable experience. Second, marmots will always have a special place in my heart. If you ever make it to RMBL, keep an eye out for 'Dandelion' (Fig.7), who was the first marmot I ever named and is unmistakable in his appearance: handsome and full of character.



Fig.7. Marmot 'Dandelion' carrying a dandelion.