Science for Saving Species

Research findings factsheet

Project 4.4.4

Threatened Species Recovery Hub

National Environmental Science Programme

Mountaintop refuges and causes of distribution limits for threatened antechinuses in Queensland

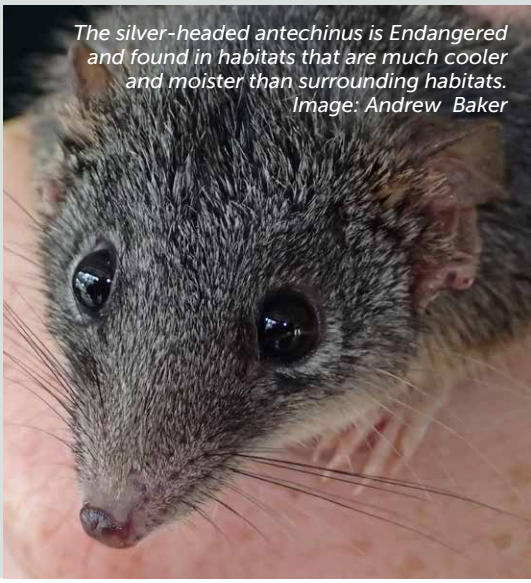
In brief

Antechinuses are carnivorous marsupials that are unique to Australia. There are several antechinus species restricted to mountaintops in eastern Queensland, including two species listed as Endangered.

Using camera and pitfall trapping surveys designed in 2017, we conducted a field study of several species of antechinus that are of conservation concern, across four Queensland national parks. We wanted to find out whether these species' distributions are limited to these montane habitats because of recent environmental change or their evolutionary histories. We also investigated whether mountaintops could be refuges from predation or competition with other antechinuses; and if rainfall was a likely driver of their limited distributions and population densities.

We found that antechinus population densities were directly linked to climate – particularly rainfall patterns – and each species' evolutionary history. Each species has become specialised on their habitat types over the last 1.5 million years. Winter rainfall increases the abundance of insect prey, which means that antechinuses are in better condition for breeding in late winter and early spring.

The most important conservation action for these species is therefore to maintain the condition of their current habitats to prevent any further restriction of their current ranges and abundance. However, predicted lifting of the cloud base under climate change, increases in frequency and intensity of droughts, heatwaves and severe fires are likely to severely impact food supply at critical times of year, and habitat suitability. Effects of climate change on the habitat of the black-tailed dusky antechinus in particular will be especially difficult to counteract.



The silver-headed antechinus is Endangered and found in habitats that are much cooler and moister than surrounding habitats. Image: Andrew Baker

Background

Antechinuses are small, carnivorous marsupial predators that are only found in Australia. There are 15 species of antechinus, and they are primarily restricted to woodlands, forests and rainforests in eastern Australia. They predominantly eat insects and other invertebrates.

Two antechinus species only occur in tiny areas at the summits of a few mountains in eastern Queensland. They inhabit cool, high-elevation cloud forests and rainforests with very high rainfall. These species are threatened, or at potential risk because of their small ranges and specialised habitat needs. These vegetation types and climates were once much more widespread in Australia but became rarer and more isolated when Australia's climate became drier and warmer, around 1.5 million years ago. The antechinus species that rely on these conditions may now be restricted due to the disappearance of their preferred habitat types and climate refuges. A third species also occurs at altitude but inhabits a broader range of habitats such as grassy forests, woodlands, wet eucalypt forests and rainforests.

The University Of Queensland AUSTRALIA

QUT Queensland University of Technology

LEFT: The black-tailed dusky antechinus was ranked among the top 20 Australian mammals most likely to go extinct. Image: Gary Cranitch, Qld. Museum

Background (continued)

Synchronised breeding events occur in winter and early spring. As is the case for all antechinus species, males of the range-restricted, mountaintop-dwelling black-tailed dusky antechinus, silver-headed antechinus and Atherton antechinus only live for 11.5 months and die soon after their first mating season. Females typically die after weaning one litter of 6-8 young at around 18 months old. Breeding is a very energetically costly activity, and weaning success depends on adequate food for mothers. This means that the food requirements for antechinuses is greatly increased over these few weeks every year.

High population density is essential for antechinuses because many species nest communally in winter for warmth. Also, because the population halves each year when the males die after reproduction, the small population of females are at high risk of chance disasters (e.g., fires) and local small population processes.

Antechinuses are prone to local extinctions, and droughts have been associated with range reductions and declines in some populations. Due to the very short life span, one year of failed population recruitment can jeopardise the persistence of an entire population. They are also at risk of extinction in environments with unpredictable rainfall and food availability.

In 2017, researchers from The University of Queensland developed field research methods that made it possible to test very fine-scale changes in the timing and abundance of food for insect-eating predators. The methods involve using white-flash camera traps on time-lapse settings and with close-focus to record insect type, size and number. Cameras were set up across different elevations to look at variation in insect abundance. This range of elevations is important because of the large variability in climate that exists across the altitudinal gradient. Temperature and rainfall – and therefore, habitat type – change substantially with increases in elevation above sea level over only a few hundreds of metres on mountains in eastern Queensland.

Research aims

Our goal was to test candidate causes behind the limited distribution of threatened and range-restricted species of antechinus that only occur on mountaintops in Queensland. We aimed to understand if the rarity and extinction threat of these montane antechinus species is a legacy of their evolutionary history or if it is influenced by recent environmental change. We also investigated whether mountain summits could be refuges from competition or predation; and if mechanisms of climate and food restriction at critical times of year limit antechinus distribution and population density.

What we did

We surveyed antechinuses and their prey over a range of elevations, latitudes and times of year.

To survey antechinus species we used Elliott traps, pitfall traps and camera traps.

To assess prey abundance, such as insects and spiders we used pitfall traps and white-flash camera traps with a modified focal length of 250 mm. These camera traps sampled ground-dwelling arthropods over the long-term at the same sites that we trapped antechinuses. We placed a camera trap at each site along the elevational gradients and used the time lapse function to take a photograph once every 15 minutes between 4pm and 6am at each location for two years.

From these surveys, we estimated the abundance, elevational distribution, and prey abundance and seasonal distribution of eight *Antechinus* species at four montane regions in Queensland, Australia:

- Springbrook National Park (28°S, maximum elevation 1010m)
- Conondale National Park (26°S, maximum elevation 870m)
- Kroombit Tops National Park (24°S, maximum elevation 950m)
- Danbulla National Park (17°S, elevation 1100+m)

The species we surveyed included both threatened and non-threatened species. The threatened and restricted species were:

- black-tailed dusky antechinus, *Antechinus arktos* (Endangered)
- silver-headed antechinus, *Antechinus argentus* (Endangered)
- Atherton antechinus, *Antechinus godmani* (restricted)
- rusty antechinus, *Antechinus adustus* (restricted)

RIGHT: Camera traps are activated by motion sensors and are helping to provide further information about antechinus populations. Image: Nicolas Rakotopare

Key findings

We found that in subtropical and tropical regions, the population density of antechinuses is highest at higher latitudes and at high elevations. Competition between antechinus species does not explain their rarity. Rather, our data suggest that the abundance of antechinuses, including threatened mountaintop species, is limited by the availability of food in winter.

Winter is the dry season in the tropics, and there is typically less rainfall at lower elevations. Mountaintop antechinus species occur above the cloud layer, where conditions are continually moist. Damp leaf-litter and soil are both important for maintaining abundant insect prey in winter. Insect abundance at this drier time of year is critical for antechinus survival, and their successful reproduction therefore depends on having enough winter rainfall. Having a wider variety and greater availability of food means that the antechinuses can direct a larger portion of energy towards reproduction.

In Queensland, the oldest antechinus species in evolutionary terms are restricted to high elevations and have smaller ranges than more recently evolved species. The timing of births among antechinus populations differs according to elevation and is tightly synchronised with the timing of annual peaks in availability of insects at each elevation. This is consistent with the rarity and extinction threat of mountaintop antechinus species being largely a legacy of their evolutionary history.

Ancient antechinus species may be unable to extend their ranges into lower elevations because they cannot adapt to different seasonal patterns of prey availability or because they have highly specific climatic and habitat requirements. Because of their evolutionary history, these species are very specialised and therefore have limited ability to adapt to changing environments.

Research implications

The evolutionary history of the ancient, Endangered black-tailed dusky antechinus and the Endangered silver-headed antechinus has led to them becoming very specialised. They live in habitats that are much cooler and moister than surrounding habitats, and that have a specific pattern of seasonal prey abundance. This is particularly the case for the black-tailed dusky antechinus, which is dependent on precipitation from the cloud layer (e.g., fog and mist condensing on foliage) as well as rainfall. Silver-headed antechinus can occur in rainforest and adjacent eucalypt forest at relatively cool, high elevations. This evolutionary history is the most important factor keeping their ranges small, thus limiting their populations.

The most important conservation action for these species is to maintain the condition of their current habitats. Most antechinus habitats are already in national parks, so deforestation and habitat fragmentation are unlikely to occur, although damage to vegetation from feral animals and weeds can still be problematic.

The main threats to these species are droughts and severe fires and destruction of vegetation communities by feral animals and weeds, which can all expose the understorey and leaf litter layer to high levels of forest drying and heating. Additionally, climate change is raising the cloud layer to higher elevations, leading to reduced winter rainfall. These processes will cause a reduction in habitable environments for these specialised antechinus species. Further, without adequate winter rainfall, insect abundance is

Camera trap image of silver-headed antechinus taken at Kroombit Tops National Park in 2019. Image: Stephane Batista/QUT

LEFT: Elliott traps have a spring-loaded door that snaps shut when an animal steps on the trigger inside the trap. Image: Nicolas Rakotopare

Research implications

lower, meaning that mountaintop antechinus species may not have access to enough food. Antechinuses require a high food availability for keeping warm in the cold months and for nutrition during their brief – and only – breeding season.

Our results suggest that management should focus on protecting existing habitat and addressing threats in species current ranges on summits. It is unlikely that expanding forest protection to lower elevations, feral cat control or limiting competition from other species that prey on insects can expand these ancient species' small ranges downslope. Instead, habitat management should focus on preventing or minimising the antechinus's distributions from shrinking further upslope.

Our results also suggest that monitoring of the status and distribution of the high-elevation, restricted Atherton antechinus would be advisable. Although it is not currently classified as threatened, this species shares features with the silver-headed and black-tailed dusky antechinuses, which indicate it is susceptible to decline. The Atherton antechinus also has lower population densities because of its restricted distribution within the tropics.

We recommend that current Department of Environment and Science and Queensland Parks and Wildlife Service fire control measures to prevent fire incursions into wet forest should continue. We recommend artificial watering of the leaf-litter layer at key sites during severe droughts, which should benefit these species, especially in the dry season.

Although populations are unlikely to establish downslope of current species ranges, males may travel long distances through suboptimal habitat during dispersal. Maintaining opportunities for antechinuses to disperse between local populations is also essential, for example, by conserving habitat corridors between refuge areas where these currently occur. Dispersal between local mountain peaks can mix individuals exposed to slightly different environments and minimises the chance of breeding patterns on each peak becoming even more specialised. If populations become too highly specialised to the environmental conditions on each peak, then populations will become gradually smaller and more isolated.

Ex-situ management and future translocation to locations with similar climates may also be an option for these species.

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Further Information

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