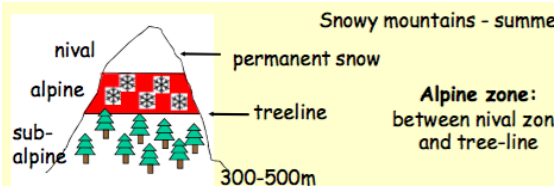
Lecture 13: Animal adaptations to extreme environments: Alpine zone

The Himalayas, European Alps all have a permanent ice/snow cover, so it generally has a degree of snow cover whether its summer or winter. The Alpine Zone is between the nival zone and the tree-line.



The Australian alpine zone

- 0.15% of Australian landmass. (Alpine areas are found at high altitudes, excl. Tasmania which is further south, so
- The alpine areas occur at a lower altitude.
- Mean temp. of warmest month $<10^{o}C$ (trees don't thrive)
- Snow 2-3 months per year, Strong winds (bad for small animals), make up 25% of Australia's rainfall
- Significant area for: water supply, recreation, nature conservation (contains unique group of native species)
- Many of the species are endemic.

Special features of the Alpine environment: Predictable and strongly seasonal

- Extreme temperature differences (Different during the day, night and in micro habitats, e.g. under rocks = cold)
- Prolonged cold - winter, night and cloud. (Animals live under the snow, like a blanket)
- Abundant moisture - condensation, snow melt
- Flora mostly herbs and lichens - very low biological productivity
- Snow gums (sub-alpine woodlands)
- Energy input through flying insects, wind-blown detritus, pollen and seeds
- B/c plant growth is slow; it takes a long time to recover from environmental damage. Thus if you trample on the flora, they may never recover again.
- The alpine zone flora includes small plants and summer flowering. These include Alpine grasses, peat bog & streams which are a source of permanent water, and alpine daisies.

Snow gums: Sub-Alpine

- Leaves can withstand freezing (waxy)
- Do not occur on mountaintops (not in alpine zone)
- Highly susceptible to fire, and rarely recover from it. They just turn silver.
- Sheltered woodland helps you minimize your heat loss.

Flora of the Alpine zone

e.g. Mountain log skink (lizard looking thing), flame robin (bird)

- Low species diversity
- Fewer species present as altitude increases. No truly alpine birds - migrate seasonally e.g. flame robin
- Low diversity of reptiles (only 1 species found in 2000m in altitude). Very few mammals, largest herbivores absent.
- Invertebrates most diverse and abundant group!
- Experience highly seasonal food availability

Ectotherms in the alpine

- Ectotherms don't main T_b via metabolism).
- Lower energy requirements – useful in an energy poor environment
- However T_b declines with environmental temperatures, thus can't maintain activity.
- Strategies to avoid freezing?? (Dormant life stage, seek refuge, migrate?)

Invertebrates: Adaptations to low biological productivity.

e.g. Tasmanian scorpionfly

- In spring and summer, it gathers around edges of snow drifts and feeds on detritus as it is released during the snow melt (this is blown up from the sub-alpine areas)

Invertebrate adaptations for coping with temperature fluctuations

- Small size (hypolithy - occupy sheltered micro- climates e.g. under rocks)
- Stenothermy (physiology geared to operate at low temps thus sensitive to heat)
- Reduced wings (flying difficult in high winds if body mass is very low)

Invertebrates: Behavioural thermoregulation

e.g. Chameleon grasshopper

- Remain active all day (can cope with temperature extremes)
- Movement in & out of sun
- Thermal melanism: In cold conditions (higher altitude) they become darker and absorb more heat. In warmer conditions (lower altitude) they are a pale blue/green. Thus, they are Ectotherms, but use behaviour & melanism to raise body temp via the sun.

- Found in Mt Kosciuszko

Ectotherms: vertebrates

Frogs in the alpine zone

e.g. Corroboree frog and Baw Baw frog

- Become totally inactive during the winter, or have very low mobility.
- They must find microhabitats that don't freeze.
- There is a frog in the USA that freezes solid during the winter, so it shatters like glass.

Carroboree frogs

- Occurs mainly over 1800 m in elevation
- Females make no sound; males have mating calls.
- Males dig burrows in sphagnum moss bogs. The females lay their eggs in this nest. The eggs hatch, but development is delayed until winter, then slow. When burrows fill with water in spring, they mature. They don't lay a lot of eggs.
- They are rare, and declining. There are conservation programs for these frogs. Breeding program in Healsville.
- They don't jump or hop b/c they live in sphagnum moss, so there is no launch platform.

Endothermic animals in the alpine

Endotherms: Generate their own body het via metabolism, thus maintain their temp b/w strict limits. This is very energy expensive, and mostly occurs in mammals and birds.

Alpine endotherm strategies:

• Migratory: many sp. avoid cold by migrating - e.g. birds, large mammals (wallabies)
• Permanent residents
- some spp. stay active
- some use torpor – (e.g. small mammals.)

(Side note: Cold causes our fingers to become stiff b/c enzymes aren't working properly)

The wombats!

- They stay active during the winter.
- Have a medium body size.
- They're mammals, so high metabolic rate, so they can keep warm and active.
- They are the only species living permanently in the alpine zone.
- Under the ground/snow, the temperature is quite stable, and is fairly warm.
- Not alpine specialists, but have some adaptations to help it survive there.
- They use burrowing, and this is energy expensive, but they're usually quite permanent homes. They can burrow VERY quick if necessary!

Torpor: Daily adaptive hypothermia:

- Can be short term or long term.
- Energy-saving strategy where the body temperature drops dramatically, metabolic rate, respiratory rate, heart rate, body temp is all reduced. (They can change their temperature set points)
- They curl up (minimise surface area)
- Often a response to low food availability
- Very important in seasonal and low productivity habitats
- Small endotherms – never more than a few hours from starvation, so they must keep eating.
- Occurs in species where adults <10kg, common among small marsupials.
- Small mammals go into torpor regularly to sustain life. During the night, their body temperatures and ambient temperature drop from 37ish to 10-15 at lowest, then go up again during the day time. Rapid entry is when the metabolic rate drops and the body temp drops by passive cooling.
- Metabolic rate at 1/20-1/100 normal, thus saves large amounts of energy, reduce food reqs.
- Animals exit torpor by turning MR up, body temp follows.
- Some small marsupials are active at night, and go into torpor during the daytime. They may do a few test drops in temp before going into full torpor.

Hibernation (Seasonal-induced deep torpor, longer bouts)

- Only 2 AU mammals do this, including the Mountain pygmy possum and the echidna.
- They fatten up prior to winter (so they have energy stored to come out of it later), and go into torpor for longer periods, and at lower temp.
- Hibernaculum (safe place), they also do test drops, and have periodic arousals.

Breeding patterns in the alpine zone animals

- Short period of warmer weather, thus short growing season & short breeding season, but very predictable
- Some species exhibit dormancy at other times of year (i.e. during non breeding season)
- Invertebrates: speed of development often not as crucial as in arid areas. Life-cycle usually completed in a season.
- Larger animals, e.g. Mountain pygmy-possum - synchronised breeding season, fast growth etc.

Breeding pattern: mountain pygmy possum *(Burramys parvus)* - highly seasonal

- Entirely limited to alpine regions,
- Thought extinct until 1966, endangered
- 30 – 80g & lives 5 – 12 (?) years
- Habitat: boulder fields and rock screes
- Hibernates up to 7 months/yr
- Diet: arthropods, fruit, seeds & caches food
- Mating occurs when snow melts and Bogong moths arrive (store body fat)
- "Tunnel of love" - sexes occupy different habitats

Link to activity on alpine zone in your workbook

Live in alpine to sub-alpine areas.

They cache foods, keep food in places where they sleep.

Can be found in Mt. Kosciuszko, Mt Bawbaw and Mt. Hotham

Distribution was sex-biased. Males lived in the lower areas, Females higher up in slope.

Mt Hotham ski resort was in the way of their habitat, separating the males and females. So, they dug a tunnel under it, so the M and F could mate/see each other.

Breeding patterns: Bogong moths (In enormous density)

Small grey-brown moth (wingspan approx 4cm), alpine seasonal migrant

- Larvae winter in pastures in Sth QLD, NSW & SE Vic, but food plants dry over summer
- Intolerant of summer heat. Adults migrate to alpine areas, shelter in caves & crevices >1500m during spring/summer up to 17 000 individuals/m^2
- Aestivate when in alpine zone - survive on fat stores.
- Pygmy possums rely on Bogong moths for food. They NEED them to survive.

*Aborigines harvested Bogong moths for food. They are nice and sweet, walnut flavoured. Locals moved to alpine regions for a few months in the warmer periods, and reported going up thin, and coming back healthy.

Climate change in alpine zone

- Alpine plants and animals are very restricted to the zone b/w the tree-line and summit. If continent warms, they need to keep going up, and they may run out of places to go. (Alpine specialists can't leave). Mt Hotham in VIC is showing the tree-line moving up, and 18-66% snow cover reduction etc.

Effect on the pygmy possums

- Less than 500 left in Kosciuszko, need 1cm of snow to keep warm, even 1^oC increase can cause them to lose their entire environment. This could also impact the Bogong moths, which would affect them also.

Conservation issues include ↑recreational use, ↑ human infrastructure which results in loss of habitat, erosion, pollution, ↑ fire frequency, ↑ cattle and sheep (grazing and trampling), ↑ feral animals (rabbits, cats, brumbies)