BIOL 1902 – Natural History
Lecture 1: Intro
Monday, September 11th , 2017

Important:
Midterm Exam is on Sunday, October 15th from 2:00pm – 3:30pm

Natural History – is nature, living breathing dynamic animals and dynamic plants

Animals include: mammals, birds, reptiles & amphibians (Herps), insects and sponges

Natural history is the observation of living plants and animals (flora & fauna) and their interactions. It is an observational science.

High-Contrast Patterns in **Background Matching**:
- Sparrow: Stripped, vertical lines allow it to blend in with Grasslands
- American Bittern: vertical lines to blend in with Cattail Marshes
- **Female** Ruffed Grouse: Dappled Pattern, blend into forest well, have light matches resembling sunlight
- Spruce Grouse: light and dark spots
- White tailed deer: white spots help them blend in
- All depends on the background area (whether animal will blend in or not)

Mimicry:
- Matching with tree trunks ex. Brown Creeper, **Gray Tree Frog**
- Gray Tree Frog: pattern on legs matches the bark, called Bark Mimic
- Gray Tree frog can also change its colour to match gray, brown and green
- Eastern Screech Owl – bark mimicry, suns itself at entrance of tree hole
- Forest floor:
    - Background matching doesn't work in winter unless animal is able to change their appearance
    - Snowshoe Hares (or Varying Hare) can change their colour – from brown to white – Seasonal Colour Change

Complex Camouflage:
Disruptive Patterns
- Facial and head markings on songbirds: for concealment
    - When bird is on its nest, markings break off the outline of the birds head; as long as bird doesn't move it becomes near invisible: **Disruptive Patterns**
    - Killdeer – breast bands serve same purpose and again are especially useful when bird is on its nest
- Canada Goose: Chin Strap – when it is frightened it will put its head down low and the chin strap breaks up the outline of it
- Loon – Necklace markings, also bends head down when frightened
- Leopard Frog – leg markings: **Coincident Disruptive Pattern** (means they match up)

BIOL 1902 – Natural History
Lecture 2: Staying Alive – Animal appearances
Wednesday, September 13th , 2017

Masquerade

- Using shape for camouflage
- Angle-winged Butterfly: resemble dead leaves (**dead leaf mimic**)
- Use of colour and shape to create rolled up or hollow effect – ex in moths
- **Live leaf mimic** by Katydid, Luna moth, Praying Mantises
- **Twig Mimicry** by caterpillars, inchworms, walking stick
- **Thorn Mimic** by tree hopper
- **Bird Droppings Mimic** by moths, caterpillars (prickly ash)
- **Pine cone Mimic** – imperial caterpillar
- **Animals that add nature to themselves to blend in**:
    - Camouflage Looper Caterpillar – adds bits of plant to its body
    - Spittlebug: feeds on plant sap, hide in spittle
    - Woolly Aphids: look like wool
- **Bi-colouration**
    - Whirligig beetles: hide by having a two-toned body, black above and white below
    - Backswimmer have opposite colouration of whirligig, works because it swims upside down
    - **Countershading/Self-shadow Concealment**:
        - White-tailed deer: dark above and light below, shadow effect makes them one-dimensional and uniform

Camouflage is not foolproof so many animals have a plan B:

Startle Patterns

- **Underwing moths** with **bright pattern** that startle the other animal
- **Eyespots** are fake eyes on Polyphemus and other moths to scare animals
- **Gray Tree Frog** has a bright yellow pattern on legs to startle animals
- Ring necked snake has brilliant yellow underside to startle

Startle Structures

- Giant swallowtail caterpillar can pop out a structure that looks like a snakes tongue called an Insectarium, it also smells bad

Startle Behaviour

- Tail-slap by beavers, beavers have the most multi-functional tail
- Ruffled Grouse – take off with an explosion of wing sound

Startle Patterns Cont.

- **Visible Eyespots**:
    - Eyed Elater has visible eye pattern that are not hidden, as do Tiger Swallowtail caterpillars
    - **Make animal look larger than life**
    - These are never hidden

    - Sphinx caterpillar – very convincing fake eye
    - Dragonflies also have fake eyes, as do butterflies
- **Deflective/Distraction Pattern:**
    - Startle Patterns have more than one purpose: serve to startle animal but also serve to **distract** it. The startle pattern is usually located on non-vital body part.
    - Some fake eyes are accompanied by fake antennas to replicate a head – this can cause the attacker to go for the tail end of the moth or butterfly etc. instead of their actual head
    - Five-lined Skink (Lizard) has a bright blue tail so that animal will attack tail: at the slightest touch the tail will fall off and jump around (nerves) to distract the animal attacking. Then the Skink will grow a new tail. **Autotomy**

Body Armour

Not all animals have camouflage to protect themselves.

- Millipede will curl up to protect its soft body parts, its outside is harder
- Turtles, snails, clams all have body armour
- Snails: will withdraw inside shell and can pull a little door shut. Shells can be made of calcium.
- Click Beetles have a chamber for their legs
- **Turtles**
    - Have been around for millions of years and have changed very little because their shells are an amazing defence
    - Can pull inside their shell generally
    - Blanding's Turtle: lower part of shell can be partly closed up
    - Box Turtles can fully close their shell
    - Snapping Turtles: do not have a bottom shell, they bite to defend themselves
- **Soft-Structure Defence**
    - Tent caterpillar creates a silk tent to live inside, birds do not like eating the webbing, leave tent to feed
    - Fall Webworm also make tents; they enclose leaves inside to feed on
- **Soft-Hair Defence**
    - Hairy caterpillars – most birds don't like to eat the hair –
- **Stiff-Hair Defence**
    - **Porcupine** – Quills are modified *Guard Hairs*, tail is the dispenser. They cannot shoot their quills, they have to make contact with the attacker, slaps animal with its tail and the quills come out
        - Quills are designed to go in farther after entrance
        - Quills contain antibiotic in case porcupine impales itself, also possibly for teaching lessons: adult gets hit but survives and teaches its young not to go near porcupine

Chemical Defence

- **Poison-Spines**
    - Common in caterpillars - Poisonous caterpillars are normally brightly coloured and not camouflaged
    - Animals that are poisonous tend to be brightly coloured like Yellow Jacket Wasps

    - Red Eft Salamander – bright red and poisonous
    - Milkweed Beetle has bright red spots
    - The bright colours are warning signs – bright reds and yellows
    - **Warning colouration = Aposematic Colouration**
        - Allows a predator to learn and avoid that colour pattern
- **Stinky Spray (Sulfur Alcohol)**
    - **Skunks** – active at night, their black and white colouration is a warning sign (**Aposematic** at night)
- **Toxins:**
    - Some animals manufacture it themselves like Ladybugs
    - Others get it from the plants they eat like Milkweed caterpillars and Tussock moth caterpillars – this process is called **Sequestering**
    - Female Photuris Fireflies (a type of beetle) sequester toxins by eating male Photinus Fireflies (male firefly of another species). Mimics the blink pattern of the Photinus species to catch the male. This is called **Aggressive Mimicry**.
- **Released Chemicals**
    - Some animals will release toxins from mouth and legs, called Tripenoids
    - Yellow-jackets inject with a stinger
    - Skunks spray, some will give a warning with a **defensive behaviour**al handstand making their white pattern stand out
    - Bombardier Beetle with hot Quinone gas that burns the face of the attacker

Müllerian Mimicry = when a group of unrelated animals are all heavily defended in some way and bear similar appearances

- Helps predators learn to avoid all these different animals

Batesian Mimicry

- Group of unrelated animals that match each other in colouration but not all are defended
    - Monarch (poisonous) is the model, Viceroy (not poisonous) is the mimic
    - Bumble Bee (stings) is model, Hover Fly (harmless) is the mimic
    - Bold-faced Hornet (stings) is model, Hover Fly (harmless) is the mimic
    - Raspberry Crown Borer Moth: mimic of wasps
- There must be more models that mimics
- They must occur at the same time of year

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Lecture 3: Staying Alive – Animal Defences
Monday, September 18th , 2017

Behavioural Defence:

- American Bufo Toads have camouflage, and toxin in their skin but also have a third defence – they inflate themselves with air, puff up to make themselves look like a bigger animal than they are
- Hog-nosed snakes are harmless, they swell up in defence (plan A), but will also roll over and play dead – called **Thanatosis** (plan B)
    - Some predators look for movement
    - Some animals kill snakes not for food but out of defence
- Blister Beetles also play dead
- Opossums play dead as well

Behavioural Group Defence

- Safety in numbers
- Chances of being captured are less when in a group
- White-tailed Deer group defence: YARDING
- Bird group defence: FLOCKING
    - Visually confuses predators
    - Odds of being captured are lowered
    - This is a passive defence
- Group defense can also be aggressive
    - Attack pheromones in Yellow-jacket Wasps summon the troops to defence
    - Alarm calls given out by birds summon other birds, this is called **Mobbing**
        - Mobbing is a pre-emptive defence: driving predators away so they're safe at nighttime and to prevent future attacks

Unusual Defences

- Some animals have bodyguards
    - Aphids are guarded by carpenter Ants because Aphids feed the Ants with their excrement
- Eastern Cottontail Rabbit lift their tail up – a very obvious mark
    - Confuses the predator, distracts the predator
    - Telling the predator that it knows the predator is there and has lost the element of surprise

Vigilance: Being alert and scanning for danger

Auditory = ears

- Large ears (external pinnae) capture more sound and magnify it, they can also pivot their ears to scan in all directions
    - Moose can use their antlers to help them capture sound, especially during mating season
- Large ears are common on animals active at night

    - Beavers are active at night but do not have large ears because it would inhibit their swimming, causing resistance and burn more energy
- Some insects have hearing membranes that detect sound vibrations ex. Tiger Moths
    - Mantids have one ear in front of hind legs on underside of abdomen
- Snakes cannot hear but can detect danger coming towards them by feeling vibrations in the earth
    - Snake tongues can smell by picking up molecules of scent and using their **Jacobson's Organ** to analyse the molecules
        - Many large animals, like Moose, have the Jacobson's Organ to analyze scents

Olfactory = nose

- Moose have an enlarged snout that houses more sensory smells, as well as the Jacobson's Organ
    - Moose and white-tailed deer will lick the air to pick up scents
- Animals like foxes will open their mouths to create an airflow that will bring more scents in to the Jacobson's Organ, called **Flemen**

Visually = Eyes

- Many animals, like the Snowshoe Hare, have their eyes located on the sides of their heads to provide a larger view of their surroundings
    - Many animals have no blind-spot, like Mallard Ducks which have a 360-degree view
- Owls and Foxes have eyes located on the front of their faces to give them more depth perspective
- Beavers: nose, eyes and ears are all lined up near the top of its head to benefit their vigilance when swimming
- Eyes on the back of the head, near the top, on certain birds like the American Woodcock gives them binocular vision above and behind them
- American Bittern eyes are located low, at the base of the bill so that they can still see in front of them when they point their bill upwards
    - No adaptation is perfect – because of the location of the eyes on the American Bittern, it cannot see behind it
- Big eyes, like on Deer, gather more light
- Nocturnal animals display **eye shine**
    - Result of an adaptation for seeing at night
    - Night-active animals have lots of rods in the back of their eyes
    - Also have a reflective layer to give light a second chance of hitting cells. This layer is called Tapetum Lucidum.
- Group defence: the more animals together in one area, the more eyes to scan for danger
- Single-species flock (one type of bird in the flock) vs. Mixed-species flock (more than one kind of bird in the flock)
    - Mixed-species flock has diversity
    - Differences lie in food resource type
    - Both flocks have more eyes for danger

Single-species flocks can be in the area they eat and not compete for food

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Lecture 4: Staying Alive – Plant Defenses
Wednesday, September 20th , 2017

Plants are under attack constantly because they are food sources, yet they flourish because they have their own defences.

Physical Defences

- Armour – like the bark on trees
- Hard Coats – on acorns
- Spines on plants = modified leaves
- Prickles = hair-like epidermal outgrowths
    - **Auto-mimicry** = new rose buds resemble prickles
- Thorns = modified branches
- Spines, prickles and thorns are designed to defend themselves from large predatory animals
- **Trichrome** – plant hairs that fend off small animals like caterpillars
    - Glue like substance is released when they are broken that makes it sticky for the animal to walk through and can also form a dense barrier that blocks the animal completely
    - Stinging mettles – some trichrome sting, called **Glandular Trichrome** (physical + chemical)
    - Water Smartweed are safe in water, do not have trichrome when in water. If water goes away, trichrome develop on their leaves. **Inducible Defence** = not present all the time, it produces when it is needed.
- **Structure Elements** such as **Cellulose**, **Hemicellulose** and **Pectin** make plant tissues **hard to digest**
    - **Lignin** gives leaves stiffness, nuts and cherry pits their hardness
    - Structural elements are **digestibility reducers**
    - **Silica** is found in Horsetails (Equisetum), also called scouring rushes and were used to clean dishes in pioneer times
        - Grasses are high in silica
- Other digestibility reducers are not structural components
    - **Tannins** are astringent – it has a drying effect
    - **Calcium** is also used as a deterrent
        - Arum plants have **calcium oxalate crystals** in their leaves
        - Hard and not nice to eat
        - Jack-in-the-Pulpit is also an Arum plant

Chemical Defences cont.

- Monarch butterfly: feeds on milkweed that has cardiac glycosides – **Terpenoids**
- **Terpenoids** are a major group of plant chemical **toxins**
    - Tastes very bitter, goal is to repel animal
    - Terpenoids do not contain Nitrogen
    - **Resin** contains terpenoids
    - **Poison Ivy** contains resin, which contains terpenoids
- **Alkaloids contain Nitrogen**

    - Asters – their uneaten leaves show that they are chemically defended
    - Black Cherry and Bracken Fern – contain Hydrogen cyanide (which is inducible by the plant)
    - **Alkaloids disrupt the digestive system**

Insect Growth Hormones:

- **Moulting Hormone**: process of changing their outer skin or skeleton is called moulting
    - **Ecdysone**
- **Juvenile Hormone:** only there in early stages
    - As insect grows larger and nears the time to become an adult, juvenile hormone stops producing

Some **plants produce these hormones**, like the Rock Polyploidy fern and the Bracken fern

- **Phytoecdysones –** causes insects to mature too quickly and die
- **Phytojuvenile hormones –** like in Balsam Fir trees, causes insect to not mature and **stay young forever**
- **Reproductive hormones** – meant to act on bigger animal like deer and moose
    - Interferes with animals' reproductive system – can cause sterility, deformities in babies, etc.
    - **Phytoestrogens**
- **Phototoxins** – migrate under the skin, making those areas susceptible to damage by sunlight (phytophotodermatitis)
- Some plants advertise these hormonal defences by smell and colour
- Plants have early warning symptoms
    - When a plant is under attack, an alarm is sent to other parts to prepare themselves
    - **Phytohormones** = chemical messengers travel through the plant, initiating biochemical responses
- Some plants have bodyguards (like aphids do)
    - Produce nectar – carpenter ants with protect the plants because they are protecting their food source
    - **Extrafloral nectaries** provide food
- Some plants call animals to help them out – **Wound Hormones**
    - Release chemicals into the air, telling certain animals that there is food there for them (the food is the animal eating the plant)
    - Predatory wasps can be summoned

Parasitoids can also be attracted – kill the animal they are living in or on

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Lecture 5: Staying Alive – Environmental Stress
Monday, September 25th , 2017

Temperature extremes

- Sub-zero temperatures
    - Water freezes at below zero degrees Celsius, turns to ice and expands
    - Certain animals' bodies temperature is controlled by the temperatures around them, whereas others are controlled on their own
    - **Endothermic** (temperature of animal is controlled internally) vs **Ectothermic** (temperature of animal is controlled by temperature outside of it)
    - **Mammals and birds are endo-thermic**
    - **Reptiles, amphibians and insects are ectothermic**

How animals deal with extreme cold

- Animals that stay active
    - Mammals, like Moose, put on layers – grow more hair
        - Guard hairs: grow longer and thicker
        - Dense Underfur traps body hear
    - Mammals have fat layers
        - **Subcutaneous fat** for insulation = warmth, located under the skin
        - **Internal Brown fat** around the internal organs for burning to create heat/warmth
    - Birds grow bulkier feathers
        - Contour feathers on the outside
        - Grow Down feathers underneath
    - Birds add subcutaneous fat for fuel
        - Burn it overnight through shivering – an important means of thermogenesis
    - Colour can create warmth
        - Pale colours retain body heat better
        - Snowy owl, arctic fox, snowshoe hares

Gloger's Rule: the idea that animals are white for heat in the winter (snowshoe hares gain 27% in the coat's insulation heat for being white)

Allan's Rule: Shorter extremities are better to survive the cold

Bergmann's Rule: To have a low $Surface\ Area : Volume$ ratio (a more rotund shape)

Shape:

- Most Northern deer in the world: Caribou
    - Small ears, short tail, shorter legs (compare with Deer) – Allen's Rule: short extremities are better for cold temps
    - Low surface area: volume ratio
- Artic Fox

    - Tail: dense with fur, has longer tail: curls tail around its face to keep warm
- Countercurrent Heat Exchanger: Deliberately making legs/feet colder
    - Rete Mirabile or Wonderful Net: balances heat
    - Ducks, otters, beavers
- Northern Gull
    - Rotund shape (Bergman's Rule), White (Glover's Rule), short legs (Allan's Rule)

Rete Mirabile/Wonderful Net

- Animals with bare feet (like birds and beavers) have a special circulation system so that their feet don't freeze
- The have a counter-current heat exchange, which keeps the blood by the body warm and the blood closer to the ground colder
    - Less heat is lost when the feet are kept cold
    - this by-pass system can be turned on and off based on external temperature

Behaviour:

- Tucking in extremities helps them keep warm
- Under really cold conditions mammals keep their mouths closed and breath through their nose – saves energy by warming up the air as it comes through their snout (counter-current blood vessels in the snout)
- **Sleeping habitat**: choice of roost site for birds is important
    - Coniferous trees offer more warmth – needles of tree form house around bird and help trap body heat, block the wind. Even better if the coniferous is covered in snow, helps trap heat and buffer wind even better.
    - Holes in trees: chamber provides shelter from wind, helps retain body heat
        - Woodpeckers, small owls, Black-capped chickadee
    - Huddling: group of animals than all sleep in the same area to improve the surface area: volume ration – sharing more body heat
    - Built shelters: some animals manufacture their own
        - Muskrat lodge, softer plant material like cattails. When covered in snow – muskrat's body heat rises and creates a chimney
        - Beaver lodge: use sticks unlike muskrats. Prepare for winter by adding material to their lodge: mud = insulation – holds body heat inside the lodge better. Chimney carries scent of beaver out to wolves but the lodge is very good at keeping predators out.
- **Subnivean Space (Below the Snow)**: Small animals create tunnels deep in the snow where it meets the earth
    - Much warmer down there because it's right next to the earth, few degrees below 0
    - Crystalline area: easy to tunnel through
- Warmth in the snow
    - Ruffed Grouse snow bed (bird finding warmth inside the snow)
- Basking in the sun
- Black-capped chickadees can lower their body core temperature by 12 degrees Celsius
    - **Enter deep sleep = Torpor**
    - Revive themselves by shivering their breast muscles which brings up their temp
- Most animals need to have a core body temp above 0 degrees Celsius

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Lecture 6: Staying Alive – Environmental Stress
Wednesday, September 27th , 2017

Ectotherms in winter:

- Snakes survive by going down in cracks in the ground below the **frost line** and becoming **dormant**
    - **Dormancy = behavioural freeze avoidance**
    - **Hibernaculum**
- All adult turtles and most hatchings escape subzero temps by going to the bottom of ponds and lakes, as do many frogs (always exceptions)
- American toads dig down beneath the frost line, as do salamanders
- Many insects survive winter above the frost line
    - Go dormant and use an antifreeze called **Glyerol = Cryoprotectant** (keeps them alive), protects caterpillars for up to – 50 degrees Celsius
    - Insects usually overwinter in sheltered sites, but some not as adults
    - Ootheca (praying mantid egg case) – no water in eggs, or anti-freeze is added = cryoprotectants
        - Walking sticks overwinter as eggs as well
    - Some insects overwinter as Larvae – Antifreeze = Glycerol (Cryoprotectant) ex. Woolly bear caterpillar
    - When no ice forms inside the body = **Supercooling**
    - Some insects stay as adults, like female mosquitoes, wasps and bumble bees which survive the winter as adults
        - Angle-winged butterflies survive the winter as adults by using anti-freeze
    - Gall on Goldenrod flower, contains white grub (baby fly)

Goldenrod Gall Fly Grub

- Is frozen but alive
- **Cryoprotectants** inside the cells
- **Ice Nuleating Sites** between the cells, not inside them – **freeze tolerance**
- Certain birds can find the grubs like chickadee's and woodpeckers

Not all "HERPS" avoid freezing temperatures
- Gray Tree Frogs stay near the soil's surface and freeze, as do Wood Frogs, Spring Peeper Frogs and Chorus Frogs – **Freeze Tolerance**

Snapping turtles are not freeze tolerant, go to the bottom of lakes where a stream comes in

- Has more current and provides more oxygen
- Goes into a motionless state, drop down heartrate and can breathe through their skin
- **Dormancy**
- Babies hatch in the fall: head for the water where they spend the winter in dormant stage
- Some hatchling Painted Turtles stay in the ground all winter
    - **Painted Turtles are freeze tolerant but only as hatchlings**

Endotherms in winter:

Endotherms cannot freeze but some do become **dormant**

- Raccoons do not hibernate; they get active on warm days – undergo periods of **Lethargy**
    - Become lethargic in a sheltered den
- Chipmunks undergo longer periods of **Torpor** - they wake up every few days in the winter
    - Store their dry goods in underground chambers, they wake up every few days to eat
- Bats have high heartbeat and low body temp – easily awoken in their sleep
- Black Bears: low heartrate with high body temp – also easily awoken in their sleep and are therefore not hibernators
    - Bear dens are often not elaborate and can consist only of an overturned tree or leaves
    - Bears depend largely on their fat to keep them warm in winter
    - Feed on fat rich foods before winter like beechnuts, create "bear nests" on beechtrees
    - Bears are still fat in spring, they depend on it
    - the first thing they eat in spring is grass, dandelions etc.
    - bears don't urinate or defecate during dormancy, tappen is a rectal plug keeping them from fouling their den
- only 3 true hibernating mammals in Ontario – low heartbeat and low body temp
    - Groundhogs – largest true hibernator
    - Jumping mice
    - Chipmunks

Mobility is a big challenge for winter-active animals

Physical Adaptations

- Moose have very long legs for going through deep snow and large feet
- Snowshoe hares (Large surface area of feet)
    - Hind feet are biggest
- Ruffed Grouse have snowshoe feet – grow little scales on side of toes in winter

Behavioural Adaptations

- Squirrels travel through subnivean space
- White-tailed deer and wolves create paths
- River Otter will run and slide, using their body as a toboggan – called tobogganing
- Mink will also toboggan

Many animals leave the area and go down to warmer climates – **Migration**

- Not a one-way route, it is a return trip
- Leaves area that causes big challenges
- Big food source for birds (insects) are not available in winter
- Ground freezing causes food in the ground like worms to be unavailable as well

BIOL 1902 – Natural History
Lecture 7: Staying Alive – Environmental Stress

Monday, October 2nd , 2017

Migration

- Canada geese, Songbirds (and other birds that eat insects), Monarch butterflies, some dragonflies (common green darner), some bats (red bats),
- Scarlet Tangers migrate to Brazil
- Arctic Terns migrate from the arctic to Antarctica
- Red Knot make the longest migration trip
- Driven primarily by food supply
- Fat powers their flight
    - Sandpipers can double their body weight in 10 days
    - **Hyperphagia** – eat a lot more food, eat constantly
    - **Hyperlipogenisis** – convert the food into fats much quickly
- Most songbirds migrate only at night – flying 300 – 500 km each night
    - Fewer predators
    - Less wind
    - Their flight muscles give off heat – air is cooler at night
    - **Calmer, Cooler, Safer**
- Some birds fly in the daytime
    - Bluejays migrate during the day time
    - Is more economical for them – they use less energy
        - Hawks, Vultures
        - They **soar** (without flapping their wings which uses energy) using **free-lift** on a **thermal** → they soar up on a thermal and then glide down to the next thermal and then soar up on it → this is called **Thermal Hopping**
        - **Slotted** wing feathers for extra lift
    - **Swallows** migrate in the daytime because they feed on flying insects while they fly – they are fast fliers and burn up a lot of flat while they move
    - **Hummingbirds** migrate in the daytime – they eat as they move
- Some birds fly by day and night
    - Sandpipers, geese
- How do birds find their way?
    - Daytime migrants navigate by the sun, landforms, and other visual cues
    - At night, the moon and constellations are used as compasses
    - Can navigate by the **Earth's Magnetic Field**
        - **Rhodopsin** is a retinal photo-pigment
- Formation
    - Canada Geese fly in a V
        - Provides free-lift for the bird behind – conserves energy
- **Banding** helps us learn about migration
    - Songbirds are caught in very fine nets called **mist nets**
    - **Geo-locators** provided even better migration data – little computers sending info via satellite
    - **Motus** – radio antenna's that pick up signals from tiny **nano-tags** glued on birds' backs – very small, pick up location
        - Coordinated hemispheric tracking system

- Migration is a complex adaptation to solve environmental stresses but still has **problems**
    - Half the birds that migrate each year do not come back, they die
        - Big buildings, habitat loss, feral and house cats

Sub-zero temperatures and Plants

- Ice is a problem for plants
    - Many plants go dormant in the soil under the snow
    - Plants become **Cold Hardy** – have evolved to be able to survive cold temps
        - Excess water is withdrawn and evaporated from leaves
        - Water is drawn out of the cells, which increases solute concentration
        - Protective sugars added to cells increasing solute concentration
        - **Increase flexibility of cell membranes**
        - **Ice forms between the cells but not inside**
    - Plants become cold hardy through **acclimation**
        - First stage of acclimation is triggered by a change in the **photoperiod**
        - **Phytochromes** = light-sensitive photopigments
        - Cause cells to go dormant
        - Makes plant more responsive to low temperatures
        - Second stage is triggered by **cold temperatures**

BIOL 1902 – Natural History
Lecture 8: Staying Alive – Environmental Stress
Wednesday, October 4th , 2017

- Retaining needles creates new problem = damage by solar radiation
  - Enable chlorophyll to use sun's energy to create **heat**, not photosynthesize
  - Skunk cabbage can generate its own heat – very unusual
- **Dessication** (drying out) is another problem
  - Calm, sunny days are the worst for it
  - Conifers retain their leaves so size and shape is very important – leaf surface area is small, close stomata to hold water inside the needles, thick cuticles to retain inner moisture
  - Hairs on underside of leave can be a way of conserving water
  - Curling up leaves reduces surface area to lose water from
  - Deciduous trees have big leaves with a large surface area – they drop their leaves
  - Green colours vanishes because chlorophyll is breaking down
- Leaf loss helps solve a second problem associated with sub-zero temps
- Snow builds up and adds weight which can break them
  - Loosing leaves takes away surface area for snow to build up on, loosing leaves reduces breakage
  - Conifers retain their leaves so size and shape are very important
  - Some shapes shed snow – triangle shape of fir trees
  - Black spruce are spindly

Too much heat can be a problem

- Dessecation (drying out) is an issue – curling leaves to reduce surface area can reduce the heat they take in
- Some animals go into water to cool down
- Dragonflies – heat can be shunted to body parts with a greater surface area, such as the abdomen
  - Can reduce their surface area by body posture: using back end like an umbrella – called **Obelisk**
- Tiger Beetles on hot sand: raise themselves up with their legs and stand on the tips of their feet – called **Stilting**
- The Rete Mirabile in ducks is shut down on hot days – put more hot blood into their feet
- Beavers: have a Rete Mirabile in their tail, they pump their hot blood into their tail
  - By diverting more blood through the tail, 90% more eat is lost than when the rete mirabile is in operation
- Honey bees: create air flow to cool their hive
- Foxes: pant, helps them lose body heat by exposing the respiratory tract to air – moisture is evaporated – evaporating water cools down the body
  - **Panting = evaporative cooling**
  - Some birds pant as well
  - Bees also use evaporative cooling by creating drops of liquid from their mouths and putting them on their body

    - Vultures use their legs for cooling by defecating on their legs – the excretion evaporates which helps cool them off
    - Mourning Doves employ the dangerous strategy of allowing their internal body temp to rise to 40 degrees Celsius – raising body temp to match more closely the temp around you

Plants advantage over animals:
Most can manufacture their own food

Animals cannot manufacture their own food:

Eat plants – Herbivory (animal is called Herbivore)

- Leaves – some animals eat from outside, some eat from inside
- Fruits, Seeds, Nectar, Sap, Bark and twigs
- Dead plant material – **detritivore**

1. Strategies:

- Some animals have food delivered to them through moving water – animals that extract their food from moving water are **Filter Feeders**
    - Clams are filter feeders, ack fly larvae filter feed
    - Large animals filter feed like certain Ducks with big broad bills – Dabblers or Puddle Ducks (ex. Mallards, Northern Shoveler)
    - Water and mud pass through filtering screen in beak called **lamellae**
    - Tongues also help filter the food from water (Northern Shoveler, a Paddle Duck)

2. All plants foods require feeding Adaptations:
    - Nectar requires a long **Proboscis** (tongue)
    - **The Hyoid Horns** (Hyoid apparatus) extend the tongue – **extensible tongue** – on hummingbirds, wood peckers
    - **Stylets** are used to get sap – is a narrow injection tool
    - Aphids are sucking bugs

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3. Eating harder parts of plants can be challenging because of **Tough Structural Components** – animals face problems:

a. Ingestion:
- slugs and snails break off plant tissues with a **radula**
- caterpillars have modified **Mandibles**
  - some caterpillars eat leaves from the inside
- mammals use modified teeth (**incisors**) – never stop growing and self-sharpen
- moose have only lower incisors, instead of upper incisors they have a hard plate, they rip off plant tissues
- large **cheek teeth** grind up the food (molars and pre-molars), powered by large **Massaters** (muscles)
- mandibles, radula and check teeth all perform the same function but arise from different origins – **Analogous Structures**
- some birds don't have teeth, like Ruffed Grouse, they break down material with their **Gizzard**

b. Digestion
- Slugs and Snails produce digestive enzymes
- Caterpillars do not have enzymes – they waste a lot: their waste has lots of nutrients in it, some small animals eat it. Many caterpillars eat 10x their body weight a day
- Moose do not have enzymes so they employ the help of smaller organisms: they get help from **bacteria** in their stomach (in the **rumen**) – symbiotic relationship
  - Plant materials are very difficult to break down so moose will bring their food back up and chews/swallows it again – **rumination**
- **Caecum** (plural: caeca) – sacs full of bacteria on intestines in Hares. Beavers have something similar. Too far down to bring back up and re-eat, so they eat the food again after it's passed through the first time. **Coprophagy** – when animals eat their droppings.
- Grouse also have Caeca.
- Porcupines do not eat their droppings – they have extremely long intestines
- Most animals that eat fruit do not eat it as a full time diet, they also eat other items
  - Robins eat fruit and worms
- there are a few birds that do eat fruit primarily – called fruit-eating specialists
  - ex. Bohemian and Cedar **Waxwing** – can open their mouth very wide and swallow berries whole (a large gape) – ingestion
  - they have short intestines for fast processing – digestion – they only want the berries and pass the seeds. **Seed Dispersers** – eat the fruit and excrete the seeds.
- some animals only want the seeds that are inside the berries, like chipmunks, chipping sparrow, evening grosbeak – **Seed Predators** – leave the fruit and eat the seeds.

- Seeds have a hard coating on them that needs to be removed first – certain birds have specialized beaks like a can-opener to remove the coating. Ex. Red **Crossbill** – eat the seeds that most birds cannot get at because they're hidden in pinecones
- Squirrels also eat the seeds inside pinecones, they bite the scales off to get to the seeds

Other birds remove the seed coat:

- Crack open nuts/seeds with beaks, ex. Bluejays

<u>Plants have chemical defences that some animals can sequester.</u>

Vein Drain: Milkweed Beetle eat milkweed – do not want to overdoes on terpenoids so they sever off the canals that transfer the terpenoids – so that they get some toxins but not too much.

MFO's (mixed function oxidases): enzymes to neutralize the toxins – beavers

Specialists:

- Red-headed Pine Sawflies eat only pine needles
- Monarch caterpillars eat only milkweeds
- Disadvantages to specialising:
    - Scarce food
    - Plant going extinct

Generalists:

- Beavers eat plant material, wide variety, highly diverse diet