Lecture 1

September 9, 2014 9:46 PM

The animal kingdom embraces
- Mammals
- Birds
- Fish
- Reptiles
- Insects

animal
Reptiles - herpetologist
Mammals - mammologist
Plants - botanist
Insects -entomologist
Flies - Dipterists
Lepidopterist- butterfly
Coleopterist - beetles
Ornithologist - birds

Start of lecture 1
Component 1: Staying Alive

Defenses
All living things face a challenge of not becoming food for something else

1) Appearance
    a. Camouflage = concealment
        i. Most camouflage is on smaller animals (bigger animals don't have a need for it)
        ii. background matching - Bearing the coloration of the living environment, patterns and colors that match the environment
        iii. Animals need to be cryptic (still)
        iv. Gray Tree Frogs
            1) Mimic for different environments
        v. Snow Shoe hair
            1) Seasonal color change
        vi. Disruptive patterns
            1) Birds use streaks/strips that make light/dark colorations that make it seem inanimate when cryptic

Hello test

Lecture 2

September 11, 2014 6:21 PM

Coincident disruptive coloration- when disruptive patterns match when body parts come together to make a larger disruptive pattern

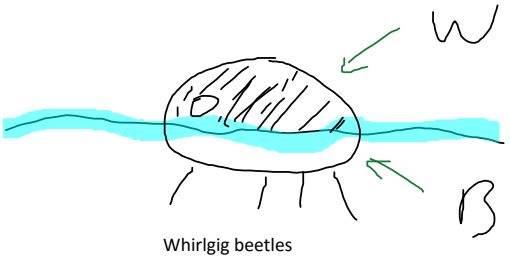
The angle winged butterfly is a good example of an animal that uses shapes as its camoflage (which gives it a appearance of a leaf)

Mimicry (masquerade) is when animals resembles a another object

- Dead leaf mimic (Angle wing butterfly)
- Live leaf mimic (katydid)
- Twig mimic (walking sticks)
- Thorn mimic (tree hopper)
- Bird dropping mimic (Giant swallow tail)
- Camouflaged looper
  - They add camouflage to their own bodies but sticking things to itself
- Scarlet lily leaf beetle
  - As a larvae forms a mucous sac around it and attaches itself to leaves, and it poops inside the sac and provides camouflage
- Spittlebugs
  - Suck in stem juices and excretes it in a foamy state and surrounds itself in it for defense
- Wolly aphids
  - Produce strange wool like materials that make it camouflage with plants

Bicoloration

- Is when an animal offers background matching from two directions
  - The whirlgig beetle provides an excellent example as the part of the beetle is black and part of it is white(above)
    - It swims on its back (back swimmer), the bottom is black therefore it blends in with the water, and white on top to blend into the sun seeping through the water



Whirlgig beetles

Why are large animals bicolored? (deer)

- Countershading (self-shadow concealment)
  - The upper body shades the lower body to make it seem 1 directional(1 color)

Example of countershading

- You can see that the white underbody is blending in with the upper body

When camouflage fails then animals use plan "b"

- Example underwings moth
  - This moth has camouflage but if that fails it opens its wings and a bright color full color appears and hopefully startles the predator
  - 
  - Startle patterns
    - Eyespots- when color patterns resembles eyes (silk moths)
    - 
    - Because they distract a predator they are also called distraction patterns, animals might go after the prey after they recover and will likely try to get the distraction patterns, but they are not necessary for the survival of the prey. It can be damaged
      - Aka 2nd function where some animals have expendable distraction pattern
      - They can deflect a predator's attack(to a non-vital body part)
  - Startle structure
    - Apparatus that is apart of the animal
    - Giant swallow tail when touched shoots out a snake like tongue from its head (osmetarium)
  - Startle Sound
    - The beaver slaps its tail on the water to scare off predators
    - Ruffed grouse makes a startle sound when taking flight
  - Eyes spots (makes an animal look a lot larger and offering it protection
    - Eyed elater
    - Eastern tiger swallow tail
    - Eyed butterflies
      - They can deflect a predator's attack(to a non-vital body part) tails,eyespots
      - Canadian swallow tail
    - Five lined skink
      - Has a bright tail that attracts predators, and they break off when are attacked
      - The tail continues to squirm and flip
      - Autotomy
        - When parts of body can fall off and regrow

Lecture 3

September 20, 2014 7:53 PM

Physical Defenses

- Body armor
    - Hard shell that protects vital parts of the body
        - Nacreous millipede
        - Blanding's turtles
        - Snapping turtle cannot fully withdraw into their shell
    - Physical defences can be soft structures
        - Eastern tent caterpillar silk tent
        - Fall webworm silk tent
        - Physical defence can be soft hairs
        - Physical defence can be stiff hairs
            - Woolly caterpillar
            - Mammals can also use stiff hairs as defences
                - Porcupines
                    - The porcupine has quills that have antibiotics on the end of their quills
                        One. If they impale themselves
                        Two. A theory is that predators will teach the young not to attack a porcupine
            - Some stiff hairs are poisonous
                - Poison spines
                - Io moth caterpillar
                    - Has tree like spines which stings when impaled

Chemical defenses

- These animals advertise that they are poisonous with bright colors
- Warning coloration = aposematic coloration
- Milkweed tussock moth caterpillars
- Giant leopard moth caterpillars
- Wasps
- Red eft
- Milkweed beetle
- Skunks (striped skunk)
- Animals don't poison themselves by
    - Compartmentalize the poison
    - They have antibodies
- How animals get poison
    - They produce them selves
    - They eat it (sequestering)
        - Milkweed tussock moth
        - Monarch caterpillars
            - Heart poison cardiac glycoside (terpenoid)
        - Black swallowtail caterpillar
        - Fireflies
            - They use a steroidal toxin
            - Photuris fireflies sequesters
                - The female fireflies get poison by eating male photuris fireflies
                    - aggressive mimicry
                        - Usually done for a meal
                        - But the female fireflies do it for poison

- Poison released from body parts
  - Swafly larvae
    - Chemical defences can be released from different parts of the body
      - They create bubbles (terpenoids)
  - Blister beetle
    - Releases toxins from leg joints
    - Toxins are aphrodisiac
  - Yellow jacket wasps
    - Injector = stinger
  - Skunks
    - Shoots out sulfur alcohol
  - Bombardier beetle
    - Shoots out 100 degree gas and burns the attacker

Lecture 4

September 25, 2014 7:55 PM

Aposematic coloration
- When animals displays bright colors to warn predators of chemical defences
  - Bumble bee
  - Wasp or hornet
  - mimics
    - Mullerian mimicry
      - When animals bear similar appearances and all bear chemical defenses
      - Milkweed
        - Feeds on milkweed(poisonous)
      - Milkweed bug
        - Feeds on milkweed using a sucker
        - Bugs use a sucker to get food
    - Batesian mimicry
      - Monarch butterfly (model 1)
        - As a caterpillar it has posion but after transformation it is still poisonous
        - The "model" that is not safe to eat
      - Viceroy (mimic 1)
        - The "mimic" that is safe to eat
        - Viceroy is not poisonous
      - Bumble bee(model 2)
        - The model where it has chemical defenses(stings)
      - Hover fly(mimic 2)
        - The mimic where the hover fly is harmless
      - Bald-faced hornet(model 2)
        - Also a model for the mimic, the hornet stings
    - Number of models > mimics
    - Both mimics and models have to appear at the same time

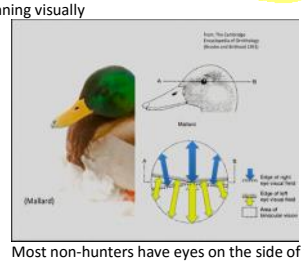
American Toads
- Bufotalin
  - Is a toxin in the skin glands
- Another defense is that they inflate to make themselves look bigger
  - Behavior defense

Behavior defense
- Hog nosed snakes
  - If they are threaten they inflate their head area to back off prey
  - If inflating fails, then they play dead
    - Preys don't always want to eat it
    - Thanatosis
      - Insects like the blister beetles also play dead
      - Possums also play dead
- Behavioral group defense
  - Deer groups are called yard
    - Safety in numbers
  - Bird groups are called flocks
    i. Visually confuse preys
    ii. Safety in numbers
  - Group defense can be aggressive
    - Yellow jacket wasps colony
      - They give out attack pheromones
    - Birds can also be very aggressive
      - Black bird attack larger birds
        - Mobbing
          - Tries to drive away larger birds from their territory
          - A pre-emptive attack
        - One bird attacks a bird then calls for more birds
        - They harass owls at during the day to clear the area
        - Mobbing allows birds to clear the area of preys, making it safer for the birds at night
    - Some animals guard other animals
      - Carpenter ants guarding aphids
        - The ants love the aphids because they love the sugar the aphids produce
    - Behavioural defenses can be weird
      - When cotton tails rabbits run away they left up their white tails and shows the white mark on the back end
      - Also white tailed deer lift their tails
        - To tell the attacker that they know something is chasing it, and it not worth the preys time to chase
    - Vigilence
      - Being aware of their surroundings
      - Example squirrels eating pauses
      - Being alert and scanning for danger
        - Noses, ears, eye
        - Smells, hearing, eyesight,
        - Having larger ears (large external pinnae) which can pivot
          - Mammals are not the only animals with ears, tiger moths also have "ears"

Lecture 5

October 13, 2014 7:15 AM

- Olfactory sense
  - Sense of smell
  - Some animals have long elongated nose (Jacobson's organ)
    - Moose
      - The moose can you their tongue to look for addition airborne scents
    - The red fox can also look for scents with opening their mouths
      - Flemen is the term for the posture of revealing the Jacobson's organ
- Scanning visually



  - Most non-hunters have eyes on the side of the head, increasing field of vison but sacrificing depth perception
  - Hunters have eyes on the front of the head, increasing depth perception
    - Owls are hunters therefore no need for field of vision
  - A beaver has all the sensory organs on the top of its head
  - Birds that feed pointing their beaks down benefit from having eyes on the side of the head
- Large eyes
  - The larger the eyes the better the vision is at night
  - Tapetum lucidum is the reflective layer of cells in a night time animal
- Group behavior allows for more complete vigilance
  - Some deers can feed while some deers can stay lookout
  -
- Flocks depends on the food resource type
  - If they are berry eaters, trees have a lot of them
  - If they eat insects, then multi species flocks exist because there are different types of way to look for insect

Plants

Face all the same challenges as animals

Physical defences

- Trees have external armor (Bark)
- Seeds are protected by hard coats
  - Acorns
- Thistles
  - Spines are modified leaves
  - Prickles are epidermal outgrowths (stems)
    - Rose
    - New rose buds resembles prickles
      - Auto mimicry
        - Mimics danger parts of itself
    - prickly ash
  - Hawthorn
    - Thorns are from modified branches
- Trichomes are hairs that make it uncomfortable to eat
  - Ragweed
  - Leaves have trichomes
    - Mullein
  - Some trichomes have chemicals in them so that when they are broken they form toxins or glue
    - Stinging nettles
    - Called glandular trichomes (Physical + chemical)
    - Water smartweed
      - No trichomes in water
      - Trichomes in mud
      - Called inducible
        - Means created defense on demand based on attackers and environment change
- Structural elements such as cellulose, hemicellulose, pectin makes plant tissues hard to digest
  - Lignin gives leaves stiffness, nuts and cherry pits their hardness
  - Digestibility reducers
    - Silica
      - Horsetails
      - Silica is hard like chemical to make things hard

Lecture 6

October 18, 2014 6:19 PM

Tannins are not structural and just there to make the plan hard to eat
- Astringent
  - A drying agent, bind and shrink proteins

Plant secondary metabolites (Chemical defense)
- Calcium
  - Arum plants have calcium oxalate crystals, the tongue and lips burn and choke
    - Skunk cabbage
    - Jack in the pulpit is an arum plant
- Tannins
- Terpenoids
  - Cardiac glycoside
  - Taste bitter, do not contain nitrogen and tend to repel preys
  - Resin(oleoresins) contain terpenoids
    - Poison ivy
    - Ursuhiol
- Alkaloids
  - Contains nitrogen
  - Astors
  - Buttercups
  - Alkaloids interfere with digestion by binding to digestive enzymes: some are sugar mimics
  - Proteinase inhibitors
    - Bind proteins

Chemical defense that is produced on demand
- Hydrogen cyanide(HCN)
  - Is inducible
  - Plants stores chemicals in separate containers and when eaten the chemicals mix and turn into HCN
  - Black cherry
  - Bracken

Wound signals
- When leaves are wounded they send signals to the other leaves
- Wound hormones
- Potato plant

Constitutive defenses(they are always there)
- Terpenoids
- Alkaloids

Some plants produce growth hormones
- MH = moulting hormone = ecdysone = phytoexdysones
- JH = juvenile hormone

- Some plants produce MH/JH
- MH
  - Rock polybody gives bugs an overdose of MH and causes predators to mature too quickly
  - Bracken Fern is loaded with phytoecdysone
- JH
  - Balsam fir contains Phytojuvenile hormone and causes predators to never grow up/mature

More geared towards insects

Phyto suffix means plant produced

Reproductive hormones
- More geared towards mammals
- Phytoestrogens
  - Mess up an animal's reproductive system
  - Red clover

Photo toxins
- St.johns - wort
- Makes the affected area very sensitive to the sunlight
- Exoskeleton - insects
- Skin - mammals

When a plant is under attack, an alarm is sent to the other parts to prepare themselves
- Chemical messenger = phytohormones
- Initiating biochemical responses
- Plants send through the plant
- Send it airborne

Some plants pay ants for protection
- Plants produce extrafloral nectaries for ants to proctect them from other predators

Some plants send out a "911" airborne chemical
- Calls wasps in to kill caterpillars or lay eggs on them to eat them

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Temperature

Problems that are caused by sub-zero temperature
- Water turns to ice and expands

How animals deal with these problems
- Ectothermic
  - Heat comes from the outside
  - Turtles and snakes
  - Robber flies
- Endothermic
  - Wolf

How animals deal with extreme cold
- Active animals
  - Grow more feathers/fur
    - Mammals grow more hair
      - Outer hair is called guard hairs
      - Underfur is a dense amount of hair that traps bodyheat
    - Birds grow more feathers
      - Outer feather is called contour feathers
      - Down feathers underneath
  - Fat

        - Mammals have 2 types of fat
            - Subcutaneous fat for insulation = warmth
            - Internal brown fat for burning for warmth
        - Birds
            - Add subcutaneous fat for fuel
            - Shivering is an important means of thermogenesis
                - Shivering causes flight muscle to produce heat
    - Colour can provide warmth
        - The warmest color is white
            - Pale colors retain body heat better
            - Pale colors have air pockets to trap heat
        - Gloger's rule
            - The further north the more white animals
            - The equator contained more darker colors
    - Short extremities are better
        - Allen's rule
        - Ear, legs, tails
    - Low surface area:volume ratio
        - Bergmann's rule

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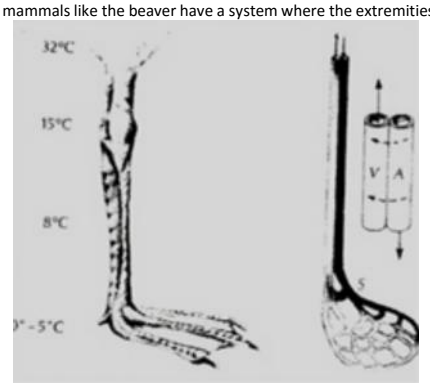
Lecture7

October 18, 2014 9:02 PM

Keeping warm

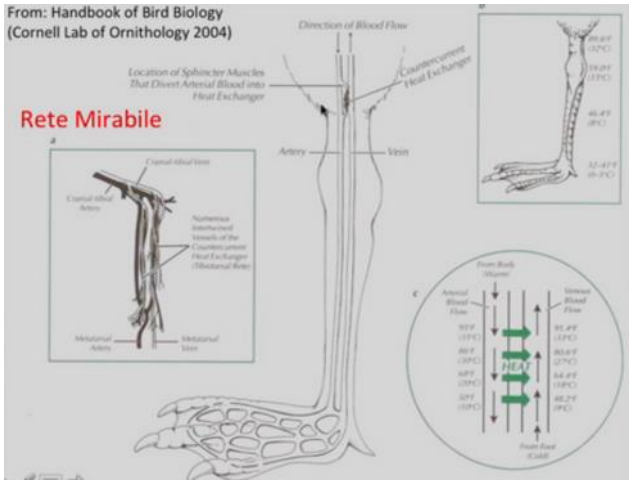
1) Short extremities
   a. Allen's rule
2) Pale coloration
   a. Gloger's rule
3) Low sa:volume
   a. Bergmann's rule

Birds, and mammals like the beaver have a system where the extremities are at a lower temperature



Countercurrent heat, exchanger

- Rete mirabile = wonderful net



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Birds also sometimes tuck their legs into their feathers, resulting in standing on 1 foot

- ducks

How an animal breathers in the winter also conserves heat and energy

- Mouth closed, breathers through nostrils
- Instead of panting, releasing warm air
- foxes

Birds can find warmth in the branches of snow covered coniferous trees

- The branches traps the warm air
- Holes in the tree
- Black-capped chickadees
- Owls

Huddung animals that cuddle up to share body warmth

- Muskrats
- Muskrat den is called a voles and shelters called lodges
- Beavers also make dens and lodges
- Has a vent or chimney to allow fresh air to flow
- Body heat melts the snow at the top

Some small animals burrow under the snow for warmth

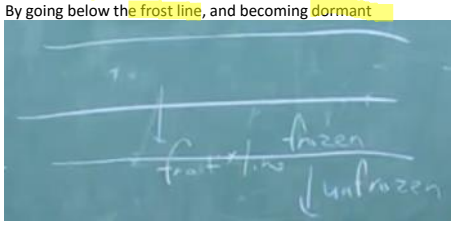
- The snow on the ground melts and freezes to create a space called subnivean
- The small mammals go under
- Why the leave the subnivean
  1) Can't find seeds or food on the ground anymore
  2) Increased population causes lower oxygen levels
- Squirrels
- Some birds also find warmth in the snow
  - Ruffed grouse snow bed

Some animals can bask/tan in the sun

- Absorbing the solar energy
- Can be done during the day sleeping
  - Owl
  - Risk, small birds mob them
- On cold night chickadees drop their temperature by 12 degrees
  - They end up entering a deep sleep called torpor
  - Once they reach a certain temperature, they start shivering
    - Shivering is thermogenesis

How do ectothermic survive in freezing temperature

- By going below the frost line, and becoming dormant



- Dormancy = behavioural freeze avoidance
- Hibernaculum = dormant home
- Turtles goes to the body of the lake which is 4 degrees
  - So do frogs
- Praying mantis
  - Adults die every winter
    - They lay eggs before the winter called ootheca
      - Has anti-freeze in the eggs - glyceral or sorbitol
        - Cryoprotectants
          - Wooly bear caterpillars
      - When no ice forms in the body its called supercooling

Lecture 8

October 18, 2014 10:33 PM

Silk moths stay over winter as pupae in cocoons
- The cocoon and pupil cases protects it from water and ice

Some insects overwinter in special sites
- Golden rods
  - Golden rods gall
    - Contains fly grubs
    - The fly grub is able to survive being frozen
      - Puts antifreeze into the cells, called freeze tolerance
      - Ice nuleating sites
      - Woodpeckers can break the gall and eat the grub

4 great frogs
- Gray tree frog
- Wood frog
- Spring peeper
- Chorus frog
- All of them are freeze tolerant

Some hatchling painted turtles are freeze tolerant but only as hatchlings
- Some painted turtles go into the water and some stay in the ground

Ectothermic survive by supercooling or freezing

Another sub-zero problem
- Mobility
- Ways to solve mobility
  - Physical adaptation
    - Long legs(moose)
    - Big feet(snow shoe hare)
      - Marten
      - Rough grouse
        - They grow scales on each toe and give it more surface area
        - Gone by the next may, they wear off
  - Behavioural adaptations for mobility
    - Subnivean space
      - Small mammals
    - White tailed deer move to a yard, sheltered areas under trees with less snow
    - Wolf packs, they will walk in single file, and put their foots where some wolf ahead did
    - Otters, will run and slide in the snow

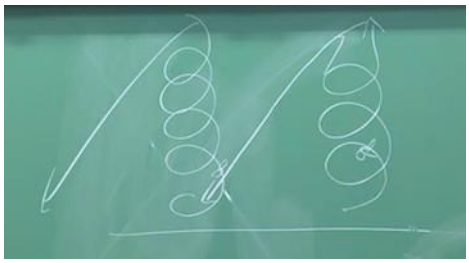
Endotermics cannot freeze but some can become dormant
- (Racoons)Lethargy when animals are dormant but can wake up
  - Racoons undergo periods of lethargy
  - Porcupines also go into periods of lethargy(less than racoons)
- (chipmunks)Torpor, lowered heart rate, low temperature, awakens every few days
  - Chipmunks
- (bats)Light hibernation(torpor)
  - Bats have a high heart rate (24-36bpm), low body temp(5degree)
  - Easily awaken
- (black bear)light Hibernation
  - Low heart rate (8bpm)
  - High body temperature >30degrees
  - Easily awoken
  - They don't defecate during the winter
    - Tappen is a rectal plug that prevents the bear from defecating
- (groundhogs).True hibernation
  - Low heartbeat
  - Low body temperature
  - Biggest large hibernator
  - Only wakes up when temperature goes dangerously low
  - Sleeps in a ball form for more heat conservation
- Other true hibernators
  - Jumping mice

Hibernaculum - the hibernation area

Lecture 9

October 19, 2014 12:21 AM

Many animals escape sub-zero temperatures by leaving
- Migration
  - Monarch butterflies
    - Migrate to Emillio's motherland(Mexico)
  - Most birds
    - Geese
    - Insect eating songbirds
      - There's no available insects during the winter
    - Scarlet tanagers fly to brazil every year
    - Artic tern (artic-africa-antartica) 20k kilometers
    - Red knot 27k kilometers
    - Fat powers flights
      - They eat bugs in the bay of thundie, 10 days to double weight (Sand pipers)
    - Most song birds only migrate at night, 300-500km a night
      - Fly-eat-fly
      - Why do song birds fly at night?
        - Avoid winds, to save energy
        - Getting food during the day
        - Fewer predators
        - Temperatures are cooler
      - Some song birds migrate during the day(glide)
        - Eagle
        - Turkey vulture
        - Hawks
          - These birds soar up on thermal
            - During the day heat rises, and lifts the bird (hot air balloon)
            - Soar up - glide - soar up - glide
            - Thermal hopping
      - Some song birds feed while migrating during the day
        - Swallows
          - They are fast flier and burn up a lot of fuel when they move
            - Flying insects
        - Humming birds
      - Sandpipers fly at night and day
      - Red knot has the long distance to fly
        - Endurance: non for 8 days (8000km)
    - How do birds find their way?
      - Built in navigation systems
        - Day time migrants navigate by the sun, landforms, other visual cues
          - Sun from where it rises and they keep track of direction
          - Landforms ie. coastlines, sounds of coasts
        - Night time migrants navigate by visual cues
          - The moon, stars, constellations used as compasses
        - Both night and day use earth's magnetic field
          - Rhodopsin is a retinal photo pigment that is likely involved with electromagnetic inter action
          - A new theory involves cytochrome also found in the eye
    - Bird migration patterns
      - Birds, in v patterns gain lift from following the first bird FREE LIFT
    - How do we learn about bird migration
      - Banding, adds a tag to a bird
      - Small birds are caught in very fine nets called Mist nets
    - Only about half of the birds that migrate each year return the next year
  - Green darner Dragonflies



Birds have a wing shape of cambered airfoil ^

Some birds have wings that provide extra lift

slots

The slotted feathers resemble mini wings at the end of wing

Sub-zero temperatures for plants
- Many plants go dormant in the soil under the snow
- Plants can become cold hardy
  - Cold hardy means that the plant itself can be exposed to sub-zero temperatures and it would not be killed
  - They lose excess water from twigs and leaves
  - Plants have cells, but they also have their cell wall
    - When water leaves, the freezing point decreases
    - Adds protective sugars to increase solute concentration
    - The cell walls become more flexible, allows water to exit easier
    - Antifreeze proteins that prevents ice in cells
    - Allows ice to be between cells

  - Plants become cold hardy acclimation
  - The shorter days, triggers the first steps of cold hardy transformation
  - The colder temperature, triggers the second stage(0-10c)
  - Some trees can survive till -80c

Fan's dream girl

Lecture 10

October 19, 2014 2:40 AM

Cold hardiness

Controls where the ice forms, penetrates the cell membrane but not cell wall
Walls become more flexible

The process to cold hardness is called acclimation
1) Daylight available
2) Temperature change

The remaining needles in pine, uses the chlorophyll to produce heat, instead of food (Photosynthesis)
- A problem is caused by this, damage by solar radiation
- The solution is xanthophyll pigment

- Desiccation is another problem
  - Drying out, calm sunny days are the worst
- The solution is small leaf surface area
  - Also little pores that can be closed off (Stomatas)
  - Cuticle
    - A protective clear coat on the leaves
  - Hairs on the underside of leaves, on northern plants
    - Traps water
  - Some plants have behavior
    - Evergreen ferns
      - They curl up to reduce surface area
  - Deciduous maple, oak
    - Really big leaves, lose the most water
    - The solution is to shed the leaves
    - Red maple has different sex tree, male = red, female = yellow

- Another problem is the weight of snow
- The solution is the shape of the plant
  - Cones makes snow slide off
  - Balsam fir has a spire shape
  - Black spruce has spindly
  - No solution is perfect
    - Freezing rain damages trees

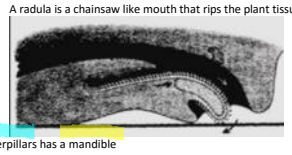
Too much heat for plants

Desiccation
- Leaves start curling
- Close stomata

Too much heat for animals
- Seek shady place
- Go to water or where it is cool
- When the ground is hot
  - Tiger beetles live in hot sandy places
    - They elevate themselves away from the sand
    - Called stilting
- Direct sunlight
  - Dragonflies
    - They raise up their abdomen called obelisk
    - Minimize the amount of their body in direct sunlight
    - They also pump hotter fluids to the external extremities for a greater temperature gradient
- Rete mirabelle
  - Birds can do the opposite of the function of the wonderful net by bypassing the wonderful net and pumping hot blood into their legs. Increasing the gradient temperature
  - Beavers also pump hotter blood into the tail bypassing the wonderful net, increasing the temperature gradient
- Honeybees work together to create air circulation to bring hot air from the hive to the outside
- Foxes uses evaporative cooling to cool off by panting
  - There is water lining the mouth and throat, and when panting causes the water to evaporate.
- Birds also pant like the fox
- Bees also use evaporative cooling, they smear a liquid all over themselves and when the liquid evaporates it take some heat away
- The turkey vulture pees on their legs and the liquid helps them cool off when the liquid evaporate
- The morning dove employs a dangerous strategy of raising it internal temp to 45degrees(as long as it is cooler than outside)
  - Called hyperthermic
  - Hyperthermia

Nutrition

Plants can make their own foods (autotrophic)
- They need their raw ingredients

Animals cannot make their own food
-solutions
- Eat plants
  - Herbivory
    - Leaves are eaten by insects, mammals,
      - Maple spindle gall mites
    - Seeds
      - Birds, squirrels
      - butterflies
    - Sap
      - Yellow bellied sap sucker
    - Bark and twigs
      - Beavers
    - Dead plant material
      - Millipede eat pine pollen
      - This animals are called detritivore
      - Dead plants are called detritus
      - Food that is brought to them
        - Clams, have a entry point in one end, water flows through and takes in the nutrients (filter feeders)
        - Black fly pupil, water flows through and the black flies have modified feeders like an umbrella that brings in nutrients
          - Called the labral brushes
          - 
        - Ducks also filter feed
          - Mallards bend down in the water and filter feed
          - Dabblers or puddle feeders
          - Also swans
          - They have built in filters in their beaks
            - Called lamellae
    - All plant foods require feeding adaptations
      - Nectar
        - You would need a proboscis(straw like)
          - It can be coiled and tucked in when not in use
            - Swallow tail
        - Humming birds has a long bill, which has a really long tong that extends when needed, the tongue does not coil the Hyoid appa ratus extends the tongue
          - A muscle that retracts and extends the tongue for the hummingbird
          - 
      - Sap
        - Needs a mouth part that needs to tap into the vessels, xylem, phloen
          - Stylets
            - Are used to tap into the tree
            - Aphids
              - Sap eaters
            - Pokes it into the phloem, the pressure of the flow of the liquid forces it into the insects
            - Woodpeckers
              - Filament that they put in the tap to drink the sap
    - Why are plants hard to eat
      - Cellulose, hemicellulose, pectin
      - Getting the plant material into the body (Ingestion)
      - Slugs and snails break of plant tissues with a radula
        - A radula is a chainsaw like mouth that rips the plant tissue
        - 
      - Caterpillars has a mandible
        - Pincer like mouth that clips away leaves
        - Some caterpillars are inside the leaves
          - Leaf blotch miner

MIDTERM SAMPLE QUESTIONS

1	C
2	d
3	d
4	A
5	e
6	A
7	D
8	a
9	D
10	b
11	A
12	d
13	D
14	B
15	D
16	b
17	B
18	B
19	E
20	C

17	B
18	B
19	E
20	C

- Caterpillars has a mandible
  - Pincer like mouth that clips away leaves
  - Some caterpillars are inside the leaves
    - Leaf blotch miner
      - The adult moth lays the egg in the leaves
- Beavers have modified teeth
  - incisors

  - They self sharpen, the outside is hard enamel and the inside is a softer Dentyne, they replace themselves after use
  - They have an orange color because of iron in the enamel
  - Never stop growing and self sharpen
- Moose has incisor on the bottom and a palate on the top to break things off
  - They also have large cheek teeth to grind up food and process it
    - Are powered by masseters
- Spruce grouse contains a gizzard that can break down plant material
  - Beak that swallows large pieces to bring to the gizard

□ Analogous structures
- Same function but different origin on the function/structure

○ Eat other animals

Lecture 11

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Ingestion
Digestion(Plant material)

- Plants
  - **Slugs** and **snails** produce digestive enzymes
    - **Caterpillars** don't produce the enzymes
      - **Caterpillars** only take a small percentage of all the incoming food, they waste a lot
      - This works because the caterpillars are constantly eating
      - They can afford to waste a lot because of the amount of incoming food
    - **Moose's** do not have enzymes
      - Moose gets help from bacteria and gets broken down by bacteria called the rumen
      - cellulose, hemicellulose, pectin are very hard to digest, so moose's bring back up the food and processes the food twice, it is called rumination and an animal is called a ruminate
      - Symbiotic relationship the moose and the bacteria both share the same food
    - **Hares**, **rabbits**, **beavers**
      - Lack rumen
      - They have Caeca or caecum
      - They eat their own droppings/waste, it's called coprophagy to act like a ruminate
      - Some birds have these as well to help digest plant material
      - However **porcupines** don't eat their droppings
        - Their digestive tract is about 26% of their body weight
        - Really large digestive system
- Fruits (Animals are called obligate if they eat fruiit)
  - Birds are fruit eaters and also eats bugs
  - They are some birds that specialize in eating fruits
    - **Bohemian waxwings**/**cedar waxwings**
      - If birds need to digest fruit at a face pace then birds need to swallow a berry whole, seed dispersers
        - mouth needs to be fairly larger, a large gape
        - Short intestines to increase digestion with a small gizzard
        - Some birds can swallow a fruit and poop out a seed in 12 minutes
        - **Black Bears** also do the same thing, they only eat the fruit part and poop out seeds
          - These animals are called seed dispersers
      - Seed Predators
        - Some animals don't want the flesh of the fruits, they want seeds
          - Chipmunks, finches , evening grosbeak
          - Birds break open seeds with bills
            - They have a "can opener" system in their bills
          - Crossbill can eat seeds in cone shapes
            - They pry open the seeds and the tongue picks up the seed
- When eating plants with chemical defenses
  - Vein drain they find the canal that conducts the poison to the leaves and cuts off the flow of the chemicals
    - Therefore reducing the amount of toxins they ingest
  - Some animals use enzymes
    - MFO mixed function oxidases
  - Some animals only eat one sort of food
    - Specialist
    - **Monarch butterfly** eats only milkweed
  - Some animals eat a assorted amount of food
    - Generalists
    - Beavers eat an assorted amount of food
  - Some animals switch foods for a balanced diet
    - **Moose**

        - Fresh leaves and twigs
            - High in carbohydrates and low on sodium
            - **Balsam fir**
            - Hard dense droppings
        - Aquatic plants
            - High sodium
            - **Water shield**
            - Liquid droppings
            - Stores the sodium in the rumen
- Another solution is to eat the plant eaters
    - Advantages
        - Much more return for the effort (proteins already packaged)
        - Easier to digest
    - Disadvantages
        - Can be hard to find
        - Often the prey is well protected
        - They fight back
    - These animals are called predators
    - Some animals eat from the inside while the animal is alive
        - Parasitoid
            - Kills after eating from the inside
        - Parasites
            - Eats from the inside
    - Some animals eat dead animals, scavengers
    - A predator must
        - Find it
            - Daytime, cones
                - Birds have large eyes to see prey
                - A hawk magnifies images 2-3x
                - Binocular vision
                - Eyes in the front are called
                    - Pursuit folia
                - Central folia
                    - Search folia
            - Night time, rods
                - **Owls**
                - Owls have a large blind spot because of their pursuit folia
                - Owls turn their head around to increase vison, they have 270 degrees FOV
        - Capture
        - Immobilize

Lecture 12

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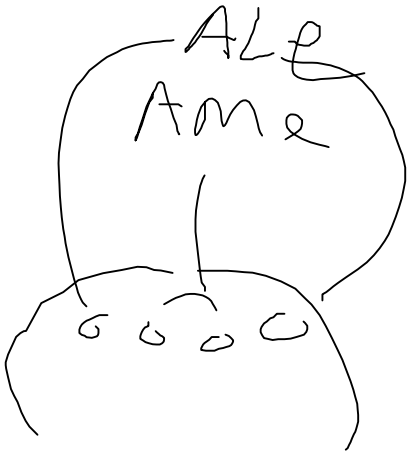

Hunting

Visuals

- **Tiger beetles** hunt visually and have compound eyes
- **Dragonflies** are visual hunters
  - 280,00 ommatidia each with 6 or 7 sensory cells
- Whirligigs can both see in the water and the air
  - Their eyes are very large and half of the eye is in the water
- Spiders have 8 simple eyes
  - **Jumping spiders** have exceptional eyesight
  - Anterior median eyes, AME
  - Anterior lateral eyes, ALE
  - **Jumping spiders** can move AME retinas with muscles
  - **Crab spiders** are visual hunters
    - **Golden rod crab spider**
      - Can change their colours from white to yellow
    - Sends in a chemical to mush up the insides of preys then squeezes out the mush

Auditory

- Large ears
  - Large pinnae
  - Predatory mammals tend to have large ears
  - **Owls** hear very well but have no external pinnae
    - **Owls** hear with their faces
    - Facial disks capture sound
    - Ear openings in their face
    - Face can be modified to increase sound
    - **Owls** have asymmetrical ear openings and wide heads
      - They have a higher right ear canal and a lower left ear canal
      - Very wide heads
      - Both these traits allows for pinpointing sound
        - They can detect whether sound is coming from up,down,left,right
        - They can detect 30 millionths seconds of the differences in sound
  - Some animals produce sounds to help in hunting
    - **Bats**
      - Echolocation
        - They can emit different frequencies to increase pinpoint accuracy
    - **Shrew** also use echolocation to find preys

Smell, olfactory

- Elongated snout
- Vomeronasal organ
  - Large amount of sensory on the top of the mouth
- The best time of day is dusk because the temperature is going down while the ground retains some heat
  - The animals scent is trapped is in between
- Snakes uses the jacobson's organ
  - Snake's tongue is forked because it can tell the direction of the prey

tactile

- Raccoons have touch sensitive front paws
  - Tactile paws
- A lot of mammals have stiff hairs around the mouth
  - Whiskers
  - Vibrissae
  - Ex. **River otter, fox, cats**
  - Birds have sensory feather like whiskers called rictal bristles
  - **Moles** have star nose called nose protuberances
    - Have a lot of sensory nerves
  - **Sand pipers** have herbst corpuscles in the bill's tip
    - Tactile nerves so they know when they catch a worm
    - **Ducks** also have tactile senses at the end of their bills
  - **Woodpeckers** has tactile senses at the end of their tongue tip herbst corpuscles

Special ways of hunting

- Rattlesnakes have infrared heat sensors
  - Located in the heat pit lies between the eyes and nostril and can detect changes as small as 0.001c

How are all these tools used?

- Active searching

- They move around to see if they can find the scent or the sight or sound of a prey
- **Nursery spiders/Wolf spiders/tiger beetles** also perform active searching

- Sit and wait / wait and ambush
  - **Preying mantis / Crab Spiders /**
- Traps
  - Flight intercept traps
    - Spiders create webs to stop the flight of insects
    - Types of spider webs
      - Orb weaver spiders builds spectacular orb shaped webs
      - Funnel weavers usually builds webs on the ground
        - They are parallel to the group
      - Sheet-web spider webs
        - Knockdown stands
        - Capture "sheet"
        - Preys knock down the strands and preys get caught
      - Webs have to absorb water to maintain elasticity, which is why dew is on the webs in the morning
        - Hygroscopic - meaning attracts water
      - Web facts
        - Webs can contain 6 or more types of silk
        - Spiders recycle silk from broken webs
        - To build a complex orb web it takes 20 minutes
        - Argiope
          - They are an orb weaver and in the middle of the web is a strange zig zag structure
            - Called the stabilimentum
            - Used to let birds see it so that they don't have to rebuild it
            - It reflects ultraviolet light, and so does the spider
            - The ultraviolet light attracts insects to the webs

Lecture 13

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Traps

- **Moles** also have traps
  - They make tunnels to trap preys
- **Ant lions** make holes in the sand and waits for prey to fall in
  - They pop out from under the hole
  - This is called pitfall traps
  - Only the larvae do that
- Aggressive mimicry
  - **Angular fish** mimics a lure
  - **Alligator snapping turtle** wiggles a worm like tongue to lure fish

Capturing prey

- Most predators use their feet
  - Birds are equipped with talons to catch and hold onto prey
  - **Osprey** have special feet for catching fish
    - They dive down into the water and grab the fish
    - While flying they turn the fish to make it more aerodynamic
    - In their feet they have scales that help holding slippery fish
    - One of their toes are reversible to help turn and grab things
      - Owls also have reversible toes
- Animals also use their mouth for catching prey
  - Ducks use their bills to catch fish
    - Hooded **merganser**
      - Fish specialist
      - Duck's bills have saw like bills that help grab fish
  - **Otter** have modified teeth called canines
    - Foxes also have canines
  - **Tiger beetle**s uses modified mandibles
    - Strong serrations
  - **Frogs** use their modified tongue
    - The tongue is flicked out
    - **Lizards, and woodpeckers**
- Some animals uses legs to catch prey
  - **Crab spider**s uses legs
  - **Praying mantis** uses legs with spines on them
  - Called raptorial legs

Killing the prey

- Canines are powered by the temporalis
  - The larger the temporalis the more powerful the bite
  - All the carnivores have large temporalis
  - **Foxes** uses a "shake and break" technique to break prey's neck
  - **Wolves** kill larger prey by "slash and shock" technique to weaken larger preys
  - **Weasels** bite into the brain case (cranium)
  - **Cats** bite into the neck vertebrae
- Larger birds kill prey with their raptorial bill
  - Some birds have meat hook tips on the bill
    - **Shrikes** also kill a meat hook
  - Bird hawks (accipiter) kill with their talons

        - They sit on top and squeeze until the talons strike a vital organ
- Snakes swallow preys while its alive
    - They have to be able to open its mouth large, due to detachable jaw bones
- **Gray rat snake**s and **milk snakes** are constrictors
    - Every time the prey exhales the snake gets tighter
- Venom
    - Poisons, toxins, digestive enzymes
    - **Massasuage rattlesnake**
    - **Crab spider and assassin bugs**
    - **Robber flies**
        - They chase prey down then injects digestive enzymes
    - **Fisher**
        - Porcupine specialist
        - They run around a porcupine and slash at their faces until is weak enough to be flipped
        - They then skin it
    - **Wolves**
        - Sometimes eat small bones and hairs (indigestible pieces)
        - Hair is wrapped around the bones
    - **Owls** swallow animals whole
        - They digest it then 12 hours later they cough up a pellet

Lecture 14

December 11, 2014 6:14 PM

Predators face many hazards

- Preys fight back
- Accidents can happen during the hunt
- Ingestion of toxins
  - Bioaccumulation
  - Botulisms
  - **Peregrine falcons** were driven to near extinction by ddt through accumulation
- Human bias, they kill larger predators
  - Human persecution
- starvation
- Predators are a major force in natural selection and evolution
  - Predators drive the evolution of different prey defenses

Other animals eat their prey from the inside

- The host can either be killed or left alive in the process
- A parasite does not kill the host
  - Ectoparasites are parasites outside of the animals
    - **Leaches**
      - Young and mature leaches are all ectoparasites
    - **Ticks**
      - **Moose ticks** don't affect the moose, but when the moose gets irritated they will rub their skin causing hair loss, which leads to hypothermia in the winter
      - All life stages are ectoparasites
    - **Mites**
      - **Arrenurus** live in the water, and hang on to dragonfly nymphs, and when the dragonfly transform they attach to the dragonfly and detach when it lays eggs
- A parasitoid kills the host
  - **Braconid wasps** are parasitoids in the larval stage
    - Adult female lays eggs into caterpillars and the larvae eat the caterpillar and eventually pop out
  - **Tachinid flies** are parasitoids as larvae
  - **Flesh flies** are parasitoids as larvae
  - **Thread waisted wasp** paralyze prey and then digs a hole and shoves the paralyzed prey into it and the larvae eat the prey
  - **Digger wasps**
    - **Cerceris** dig a hole and burrow in it, then they capture a jewel beetle and paralyze it and put it into the hole
  - Some parasitoids finds host visually,
    - They have to be big enough
    - They have a ovipositor (egg laying tool)
  - **Ichneumon** wasps are a huge group of parasitoids
    - **Megarhyssa ichneumon** have really long ovipositors
      - They walk along the bark and the ovipositor burns through the bark using chemicals and insert into the grubs in the bark

Lecture 15

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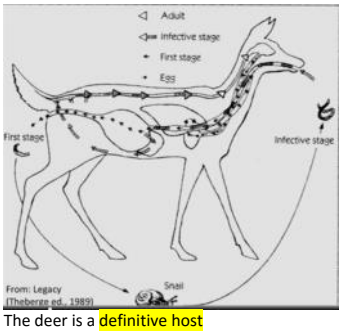
ectoParasites

- Ectoparasitic flies on birds
  - **Flat fly**
- Baby clams are parasitic
  - **Glochidia** is an ectoparasite on fish gills and fins
    - Adult clams have a fish like lure that attracts fish and when fish pass by they shoot up glochidias
- Through the haller's organ parasites can detect a host
- Leaches
  - Has a mouth part with saw like blades that cut into the skin
- Ticks
  - Have a hypostome which are barbs on the mouth part to attack to the skin
- anticoagulants is a chemical that increases blood flow
- Body shapes flatted to climb through feathers, and hair
- **Horse flies, mosquitos** are not ectoparasites
  - They are only getting blood for the development of eggs
- Obligate parasites
  - No other options but to feed on hosts'
- Problems with ectoparasites
  - The death of a host
  - Hosts don't like ectoparasites, removal by the hosts
    - Grooming and preening
    - Some animals have special tools for ectoparasites
      - **Great blue heroin** have a special comb, grooming claw, pectinate toe
      - **Beavers** have huge hind foot, they have a grooming claw, a double or split toenail

Placed here for no reason

Endoparasites

- Some parasites live inside the host
- **Cuterebra** (a **robust bot fly**)
  - Is only endoparasitic in the larval stage
    - The adult fly lays eggs on the ground and the body heat of a small mammal makes the eggs explode and the larvae grabs onto the mammal and crawls in through holes in the mammal
      - It cuts a hole in the mammal and lives there until its matured and pops out
- Deer have a parasitic brainworm
  - The larvae leave its deer host in waste/droppings
    - A slug is an intermediate host, the snail once it becomes a host it becomes day active and deers eat the parasites and the parasite



    - The deer is a definitive host
    - But if the **brain worm** attaches itself to the moose, then **brain worm** starts eating the brain and kills them
      - And changes the behaviour of the moose called the blind staggers
      - The brainworm and deer evolved together and mooses didn't resulting in danger for the moose
- **Flatworms or flukes**
  - **Robins** are the definitive host for the parasitic **fluke**
  - **Slugs or snails** are the intermediate hosts
    - The parasite makes it way to the tentacle of the **slug or snail** and makes it swollen to make it look attractive to birds
    - The bird eats the tentacle and the **fluke** lives in the bird
- Endoparasites adpatations
  - Small size
  - Parasitic castration
    - Lowers the hosts urge to mate
- Endoparasites problems
  - Host may not be found
  - Wrong host might be entered
  - Host can die

scavengers

- Some animals eat animals that are already dead
- Most scavengers also eat other foods including live animals
  - facultative scavengers
    - **Blue jays**
    - **Marten**
    - **Bald Eagles**
  - **Gulls** scavenge extensively but not exclusively
    - Same with **ravens**
      - In the winter ravens are primarily scavenger in the winter
  - **Turkey vultures** are full time scavengers, they are obligate scavengers
    - Featherless heads to put their head in dead carcasses

        - raptorial bill for tearing flesh
        - Power sense of smell, by the smell of death
            - Enlarge nasal chamber
            - Large olfactory bulb in the brain
            - Huge nares(nostrils not separated)
        - Teetering flight maximizes stability and lift at the low altitudes necessary to detect carrion smell
            - Carrion smell = dead things
    - Small insects also scavenge
        - **Blow flies** lay their eggs on dead animals
        - **Carrion beetles** bury the dead animals in holes
            - **Burying beetles**
            - Necrophagous- eats only dead things

Problems as an animal

- There are time where food becomes really scarce
- Predictable food shortages solutions
    - Dormancy/hibernation
    - Migration
- Certain foods are less predictable
    - Seeds and nuts
    - Berries and other fruits
    - Small mammals
    - Unpredictable food supply
    - Solutions are:
        - Moving from areas of low food supply to areas of high food supply
            - Not always south
            - **Bohemian waxwings** move in larger number to find food
                - Nomadic and irruptive
                - They are fruit specialists
                - When a sudden arrival of a large amount of animals due to food is called irruption
                - **Crossbills**
                    - Seed specialist
                - Great gray owls are not really nomadic but when food is scarce in the boreal forest they move in large numbers
                    - Grey owls are irruptive

Lecture 16

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Predators are geared to kill when they can kill

- They will store food if they can kill more
  - They stash them away
  - **Shrike** stores food by impaling small mammals on branches, this is called larder
    - A ladar is a collection of food
    - In the winter the larder are frozen
      - So the shrike will sit on the larder to heat it up
    - **Owls** also do this
      - **Northern saw-whet owl**
  - Unpredictable food shortages

Some animals prepare for this in advance for preparation

- **Gray squirrels**
  - They cache 100s of acorns individually in an area
    - This is called scatter hoarding
- **Gray jay**s do not migrate
  - They scatter hoard for the winter
    - Cache food all summer
    - They roll the food inside their mouths and form a coat of saliva on the food and store the food
      - Enlarged salivary glands
      - Sticky saliva
      - Nest early
      - A large hippocampus provides excellent spatial memory
- **Red squirrels** create a number of larger stashes in middens
  - They also store mushrooms, the squirrels hang the mushrooms on branches to dry them before storing them
  - Middens are usually hole in the ground

Dormancy

- **Chipmunks** are dormant but also store food underground
  - They wake up to eat
  - They store large caches of food underground
  - Cheeks can expand to allow them to carry more food
- **Beavers** create a central cache of branches called a food pile
  - In the autumn there have trailers where they bring the branches, called the drag trail
  - Beavers like the poplar tree
  - Beavers leave eaten and undesirable food at the top of the pile to freeze

How plants deal with nutrition

- Are plants different from animals
  - Plants can make their own food
    - Photosynthesis
      - Sunlight
      - Water
      - Nutrients
        - Nitrogen
        - Phosphorus
        - Calcium
      - Plants may have trouble getting the required nutrients
      - Bogs are a formed by mosses and very low on nutrients and the mosses are very acidic
        - The plants in a bog are the heath plants
          - Bog laurel
          - Sheep laurel
          - Labrador tea
          - These plants survive because the plants have fungus partners
            - These fungus gathers the required nutrients and returns it to the plants
              - Associated with their roots
              - The fungus is called mycorrhizae which are in the roots (mycorrhizal association)
                - Endomycorrhizae are inside the cells of the root (ericoid mycorrhizae)
                - Orchids are endomycorrhizae
                - Ectomycorrhizae are outside the roots, fungus around the root
              - mycorrhizae increase the uptake of nutrients such as nitrogen and phosphorus
              - Also prevent uptake of toxic compounds
          - **Alders** have a different solution for the collection of nitrogen
            - They have root nodules
              - The root nodules are part of the root and inside the nodules are bacteria
              - The bacteria fix nitrogen from the air for the plant
              - The bacteria benefit because of the sugars from the plant
          - Some plants eat animals
            - These plants are called, carnivorous plants
              - **sundews** are carnivorous
                - They have hairs with glue that glistens
                - When an insect land on it, it gets stuck
                - Then the leaf folds over
                - Longer hair has glue, short hair has digestive enzymes
                - **Sundews** are adhesive traps
              - **Pitcher plants** are carnivorous
                - They are closed at the bottom and open at the top
                - They have hairs on the inside of the leaf that are pointed, the insect cannot crawl back up
                  - Called downward pointing hairs
                - Eventually slides down the leaf and drowns in the water
                - **Pitcher plants** are pitfall traps
              - **Bladderworts** are carnivorous
                - A little round sac under the water
                  - These sacs have little doors with hairs
                    - When a animal touches on of those hairs the sac opens up and the vacuum sucks it in
                    - Enzymes as released to dissolves the animal
                    - And then pumps out the water to create suction
                    - Sacs are called utricles
                - **Bladderworts** are suction traps
      - A lack of sunlight might also be a problem
        - Shade
          - Plants tend to have larger leaves
            - Larger surface area = more sunlight collected
            - **Round leaved orchid**
          - Some plants save energy by having the leaves flat on the ground
            - Not having to support it on the stem
            - Parallel to the ground
            - Supresses other plants competing for sunlight
          - Thin leaves allows faster sunlight hitting the cell
          - **Hobblebush**
          - Chlorophyll b > chlorophyll a
            - B collects more sunlight therefore shade plants have more b
          - Some plants grow bigger leaves but some grow MORE leaves
            - Lots of leaves
              - **Bunchberry** has a ton of leaves
                - Grow a lot of leave is called colonial growth
          - Some plants are covered by other plants
            - Some grow away from other plants that block sunlight
              - Is called, positive phototropism
            - Another way is to grow on top of the other plants
              - Climbs atop the competition
                - Wild cucumbers
                - Thigmotrophic, tendrils
                - Once it feels something it grows all around it

- **Trilliums** have another solution to the shade problem
  - The flowers blooms before the tree leaves open
  - So that the trees don't cover them
  - These species are called spring ephemerals
  - A problem is that there may still be cold, like snow and frost
- Some habitats have no sunlight what so ever
  - Some plants lost the need for sunlight
    - **Coralroots**
      - They have fungal partners that go to living plants and steal nutrients or rotting plant and soil
      - Mycorrhizae
- Autotroph means plants feed themselves
- Mychoheterotrpohs means plants feed with mycorrhizae
- **Indian pipe** have mycorrhizae, it lives like a parasite

Lecture 17

December 12, 2014 12:38 AM

Some plants make their own food and use mycorrhizae

- This is called mixotrophs

The cancerroot has no leaves and has no mychorrhizae

- The seed of the cancerroot detects the chemical signal of plants attracting mychorrhizae
- Houstria is how the cancerroot send a branch over to the plant to steal the nutrients
- Holoparasite
- The dwarf mistletoe is a holoparasite but with trees

Some habitats can have too much sun

- Solutions
    - Smaller leaves, smaller surface area
        - Buttercup
            - Has tiny leaves
            - The leaves are on a 45 degree angle
    - There are some extremely sunny and hot places (sand dunes)
        - Plants often have leaves that are highly dissected
            - Dissected leaves have a lower surface area

The most important thing for both plants and animals are reproduction

- Some animals reproduce asexually and sexual
    - Sexual reproduction
        - Internal fertilization
            - the sperm enters the egg inside the body
            - Better guarantee
            - Sponges are hermaphrodites
                - They release sperm into the water
                - Clam are also hermaphrodites
                - They can both give sperm and receive
                - Slugs, snails, earthworms
                    - Have love darts
                - They all are sedentary or slow moving
                    - So they send of their sperm for a better chance
            - Snow fleas are internal fertilizers
                - They are spermatophores, the leave spermatophores on the ground and when females walk over they pick them up
            - Any tool the transfer sperms are called intermittent organs
                - Slugs have love darts
                - Spiders are internal fertilizers
                    - They have palps or pedipalps
                        - Male spider insert their sperm with special mouthparts
                - Males snakes have two intermittent organs called hemipenes
                    - Only one is function at one time
                - Mammals have penises which are intermittent organ

- Can also serve to stimulate
- When needed, a penis is usually inflated
- Some animals have another type of support
  - Penis bone, baculum
    - Walruses
- A penis is stored away when not needed because it can get damaged or cause drag in the water
  - Most birds do not have a penis, drag in air
    - They press their cloacas together
      - Cloacal kiss
    - Birds have common openings (cloacas)

- External fertilization
  - The egg is outside
  - Fish, frogs
  - Amplexus
    - A special hold where the male has its arms around the female

- How do animals choose a mate
  - Some meet by chance
    - Whales
      - Has barnacles are hermaphrodites
        - Barnacles has a penis
          - The penis travels until it finds a barnacle and enters it
  - By advertising
    - Auditory advertisements
      - Woodpeckers use their bills to drum
        - Non-vocal advertisement
          - A series of taps that are species specific
        - Ruffed grouse also drum with their wings
        - Snipes make non-vocal sounds with their tails
          - Winnowing
          - They fly up and let their tails vibrate in the air
        - Grasshoppers and crickets make courtship sounds by rubbing wings and legs together
          - Called stridulation
          - cricket
            - Tree crickets uses leaves as amplifier
            - Crickets has 2 wings one as a scraper and one as file
          - Grasshoppers
            - Crepitate
              - The wings opening and snapping close causing a sound
          - cicadas
            - Zzzzzzz sound
            - Uses tymbals, a membrane that is plucked back and forth to make a sound
            - Spend most of their life underground as nymphs
              - 17 years
      - Frogs produce vocal sound
        - Vocal advertisements
          - Male toads and frogs have extensible throat sacs
            - That act as resonating chambers
            - Leopard frogs has 2 resonating chambers
            - Frogs use an amplexus hold

- Male bullfrogs have a large tympanum
  - To hear the frog calls
  - Males have larger tympanum
- Birds also advertise with vocalizations
  - No voice box
    - What they have is an air sac
      - There is a syrinx that makes different sounds from the air sac
      - The syrinx is why birds can sing two songs at the same time, they have two tracheas
    - Song has main two functions
      - Advertising ownership of territory
      - Advertising to attract a mate
    - Some birds have two different song for each function
      - Warblers
- female choice is major part of sexual selection and a driving force in evolution
  - Sexual selection is only affected by traits that are involved with reproduction
- Some mammals use vocalization for mate attraction
  - The breeding season for moose is called RUT
  - Cow moose call to attract bull moose
  - The moose's antlers help the moose hear the mating calls better
  - Bull moose also vocalize and make non-vocal sounds by thrashing with their antlers
- Advantages are long rang
- Disadvantage is that
  - predators or parasitoids can hear you
  - Satellite males
    - Sneak around a male singing, and take his place

- By visual
  - Female choice is a powerful component of sexual selection
  - Only a handful of birds have more colourful females
    - Wilson's phalarope are polyandrous
      - The female courts the male
      - The male takes care of the egg and raising young
      - polygamy
        - Polyandrous
          - Is when a female has multiple male partners
        - Polygyny
          - Is when a male has multiple female partners
    - Female mallards choose males with the greenest head
      - The green can reveal age and health
    - Female house finches choose the mostly brightly coloured males
    - Brightly coloured males are better at finding food
    - Some birds have ornaments
      - Atlantic puffin
        - The bill is huge and brightly coloured
        - Badges or maturity or status
        - Two years per grove
        - Males with two or more grooves are chosen (4 years old)

- Male deer, a buck
  - Antlers are ornaments
  - Moose also have ornaments
  - Antler's tips are called tines
  - The flat part of the antler are called palm
  - As moose get older the tines are shorter
  - Antlers shed every winter and grow back the next year
  - As they are growing the antlers are covered in velvet with blood vessels
  - The moose thrash until the velvet comes off
  - Antlers indicate age of the moose and health
  - Males spar with their antlers to see who is stronger
  - Males also sometimes playfully spar after the rut
    - Sparring bulls learn that they should not mess with larger antlers

Lecture 18

December 12, 2014 8:33 PM

Ornaments
- Dobsonfly

Ritualized displays
- Many ducks use head displays
  - Hooded mergansers
- Male ruffed grouse use neck ruff and tail displays
- Some animals do ritualized displays in the air
  - Male flies are in swarms and females fly up and get a male
    - Called midges
    - Aerial displays
  - Ebony jewelwing(damselfly)
    - Females indicate interest by the movement of the wings
  - Fireflys
    - Each species have different flash patterns
    - And different colours
  - Swans
    - Have choreographed mutual displays
    - They copy each other's motion
  - Sandhill cranes perform ritualized dances
    - Bow then jump into the air
  - Wild turkeys
    - A bunch of males display
    - The females walk around
    - These communal display grounds are called leks
    - Male sharp tailed grouse also dance at leks

Olfactory advertisements
- Sex pheromones
- Female mooses will release pheromones
- Bull moose dig shallow rut pits and pee in the pits
  - They then roll in it
  - The males pheromones
  - Called wallow pits or rut pits
- Female snakes leave pheromone trails
  - Multiple males follow the pheromones
  - And compete with other males
- Pheromones are commonly used by insects
  - Usually the females produce them
  - Moths depend heavily on pheromones
    - Males have very large antenna
    - Males only live a week after leaving the cocoon
    - Male antennas have 4milllion sensory nerves
    - Males do not eat, cause their only purpose is to mate
    - Like garter snakes the moths push each other around to mate
    - Males can detect pheromones up to 2-3km away
- Pheromones can have a second role
  - Snow shoe hare

        - The males also produce pheromones, the white shoe hare will pee on the females
        - The pheromones in the pee help stimulate
    - Porcupines
        - Males stands up and pees on her
        - And if the female likes it, then they mate

Gift giving

- Cedar waxwings
    - Food, berries
    - A male offers a female a berry and the female takes it and offers it back and hopes away < this is a cycle
- Tern
    - A male goes and catches a fish and offers it to the female
    - After the male goes back and gets another fish
    - They prove to the female that they are good fisherman
- Edible courtship gifts also given by some male spiders, scorpion flies, and dance flies
    - All are predatory
    - Males go off and find a prey and offer it to the female
    - This is so that the female doesn't eat them
    - This is called "safe sex" coined by prof
    - Scorpion flies wrap the gift in saliva and give it to the female
        - And sometimes tricks the female with an empty gift
    - Some are like satellite males that steal other male's gifts
- Male marsh wrens also offer gifts (they are polygamist)
    - Male marsh wrens make dummy nests
    - The males that make the most dummy nests attract more females
    - Males that have more nests, that means the male spent less time finding food which means its bountiful
- Male bass and bluegill sunfish offer nests too
    - The fish use their tails to dig up holes
    - And they guard them
    - Sometimes bluegill sunfish stay in juvenile state
        - And the juvenile fish lets sperm go
        - Another is a male fish that looks like a female and lets sperm go
        - Male bluegill sunfish come in 3 forms, 1 regular, and 2 cheater forms (satellite males)

Males try to ensure paternity

- Bull moose will contact guard the females to ensure that their sperm make contact with the egg
    - These bulls only chase short distances, bluff charging
- Dragonflies
    - Have claspers that connect to the back of the female head
    - Every species is different
    - The mating position for dragonflies is the wheel
    - Sometimes the male will keep connected until the female lays the eggs
        - Contact guarding

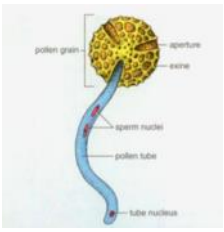
Lecture 19

December 12, 2014 9:52 PM

Contact guarding

- Walking sticks
  - Long confulations
    - Male walking sticks use bondage
    - Male walking sticks have claspers that couple to female walking sticks for a couple days
- copulatory plugs
  - Beetles
    - Many male beetles produce extra headless sperm that ends up blocking the female, and form a plug
    - Feathering beetles
      - Use giant sperm to plug the female
    - These plugs are called copulatory plugs
  - Mosquitos
    - ejaculate hardens making a cement plug in the female
    - Some add anti-aphrodisiac
      - Male garter snakes also do this
- Honeybees use a different kind of plug
  - Their body explodes during sex
    - And the make dies
    - And the genitalia is left in the female

Plants



- Are flowers like animals when it comes to sex
  - Animals are hermaphrodites
- Flower sex organs
  - Stamens (male) produce sperm
  - Pistil (female) produces eggs
    - Stigma, top part of the pistil
    - Style, the long tube or stem
    - Ovary, where the eggs are
- Do plants have a penis or an intromittent organ
  - They have intromittent organs
  - Pollen is the intromittent organs
  - Pollen grain contains two sperms
    - One goes into the embryo
    - One becomes food for the embryo
    - Called a double fertilization event
  - Problem how do plants get the pollen grains near the eggs?
    - Some plants harness the power of the wind
      - Grass pollen is carried by the wind
      - Sedges are wind-pollinated
      - Ragweed is wind-pollinated
      - Pollen has to be small and lightweight
      - Coniferous tree is also wind-carried (conifer)
      - Wind pollination is called anemophily
      - Benefits of anemophily?
        - less energy
        - Powerful winds
      - Disadvantages
        - May not always reach destination
        - Solution?
          - Produce more pollen
    - Some plants harness the power of water
      - Hydrophily
    - Some plants use animals
      - Couriers
        - Pollinators = "surrogate lovers"
          - Wasps
          - Butterflies
          - Moths
          - Flies
          - Beetles
          - Hummingbirds
          - Bees <- most important
      - Pollination by insects is entomophily
      - Why do pollinators help flowers have sex?
        - Because they are bribed
        - In return they get food
          - pollen attracts some insects, such as hoverflies
            - Some flower only offer pollen as food
              - Bees have to latch on to it and vibrate it to get the pollen
                - Poricidal pore
              - Anther cone, has porcidal pores
              - This kind of pollination is called buzz pollination
          - Nectar, sugar water
            - Nectar is held in nectaries
            - Buttercup nectaries are small sleeves at the base of each petal
            - Milkweed has cups for nectaries, which means multiple species can eat the nectar
            - Columbine has special nectar with long spurs (needs long tongues because it's a really long tube)
            - Dutchmen breeches also have spurs, which means it requires a long tongue
            - Bumblebees have really long tongues that can reach spurs
            - Cardinal-flowers have long spurs but bees ignore them
              - Who do they attract?
                - Hummingbirds
  - Flowers advertise
    - Different combinations of color and form attract different pollinators
      - Shape and colour are long range visual attractants
      - different kinds of insects prefer different colours
      - The colors we perceive they don't
      - All insects see colours differently
    - Scents often help attract and guide insects near flowers
      - Scents are close range attractants
      - Flowers will release scents when certain insects fly
        - The evening primrose releases scents at dusk when their flower opens up, to attract moths
          - Primrose moths
      - Not all flowers smell beautiful
        - Wild ginger smells like decaying fungus
          - It is pollinated by fungus gnats
          - This type of pollination is called
            - Brood site deception
              - Makes the insect believe it's a good place to lay their eggs
        - Red trilliums smell like rotting flesh
          - The flies lay their eggs on dead animals
            - Brood site deception
    - Flowers uses close range guidance aids
      - Flowers want to immediately pollinate
      - They have patterns to guide insects
        - Nectar guides
          - Can be landing targets
        - Guides the insect to the nectar and pollen
    - Does marsh merigold have nectar guides?

□ Yes, because some flowers have ultraviolet landing guides

Lecture 20

December 13, 2014 1:13 AM

Plants advertise

- Nectar guides
  - Some plants has uv reflector that shows uv patterns for insects
    - Some birds also have this

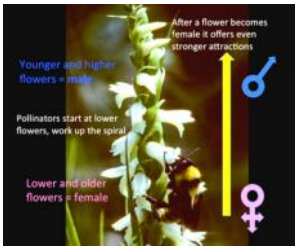
When plants pollinate itself

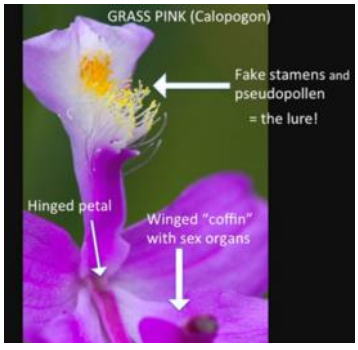
- Self-pollination
  - It is better to crosspollination = out breeding
  - Solutions
    - If the pollen grain lands on the wrong stigma, then the pollen tube does not grow
      - Called self-sterility = self-incompatibility
    - Another is spatial separation of the sexes
      - The male parts and female parts are separated
      - Females are usually on the top while male parts are lower in the plant
      - Coniferous trees
    - Some plants like the white campions bear only male or female flowers on one plant
    - Spatial placement in the same flower
      - Bottle gentian
    - Temporal separation
      - Male and female parts don't work at the same time
      - Jewelweed flowers start off as males
      - After a few days the male part falls off and becomes a female, revealing the stigma
      - Temporal sex change = dichogamy
    - Plants with spiral arrangements display dichogamy with a twist
      - Lower flowers open first and are functionally male with pollen block the way inside the flower
      - After pollen is taken out the flower becomes female, it offer stronger attractions
      - Pollinator work up the spiral
    - In pink lady slippers
      - The pouch petal has a slit opening
      - Once the bee is inside the bee is guided to the top
      - The two exit riutes are blocked
      - There is pollen and a staminode at the top
        - As the bees exit at the top the bees stick to the pollen
        - The bees are not rewarded but tricked
    - Purple loosestrife has a complex way of avoiding self-pollination
      - The flowers come in 3 forms
        - Short style form
        - Long style form
        - Medium style form
        - Has 2 sets of stamens and 1 pistil
        - All plants have the same style form
        - The pollen only works on another form of the style
        - This is called heterostyly
          - 2 forms = distyly
          - 3 forms = tristyly
            - Pickerel weed
    - Pseudopollen
      - Fake pollen that tricks pollinators
      - Does not reward pollinators
    - Pseudonectaries
      - Grass of parnasus
        - Has fake nectar
    - Some flowers take an active role in the pollination process
      - Milkweed flowers
        - There is a slit that is beside the cups of nectar and sacs of pollen attaches to the pollinator legs
      - White Water lily
        - When they first open up they are females
        - Insects are attracted to the nectar at the bottom where the stigma is
        - Insects are trapped when the flower closes the petals and keeps them overnight
        - And when they open again the flower is now a male and when the insects escape they get pollen on themselves
      - Grass pink has a "slam dunk" trick
        - Has pseudopollen
        - A petal on a hinge falls
        - As the bee crawls out it first touches the female part then touches the male part
        - There is no self-pollination because female -> male
      - Laurels have bashing stamens
        - They have stamens that are hitched to a grove and when insects walk over it the anther pops off and attaches to the insect
      - Bunchberry
        - When an insect walks over the flowers, the stamens explode opens
        - The fastest moving floral parts
        - Also called pop flowers
      - Twayblades also have explosive sex
        - Open as males with a "canon" with pollen ready to fire
        - When an insect walks by the landing pad and canon appears and shoots out glue with pollen
          - After the canon fires, the plant becomes a female
      - helleborine
        - They releases odours of a plant under attack (wound hormones)
        - These attract predatory wasps
        - Provides nectar
      - Bee and fly orchids
        - They mimic females and release hormones
          - This is called psuedocopulation
        - Insects try to have sex with it

Cross pollination is the general rule

- What happens if it is too cold for pollinators to fly?
- "plan b"
  - Next to the ground will produce seeds through self-pollination
  - If they can't cross pollinate then they self-pollinate
    - Cleistogamous flowers are an insurance policy
  - There are exceptions to everyrule
    - Dandelions primarily self-pollinate
      - Which allows them to quickly take over a new habitat without competition
      - Just an exception

Bottle gentian



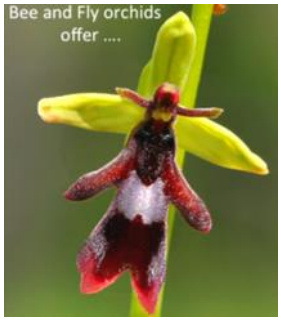


After successful reproduction, plants and animals face one more challenge

- Getting their progeny off to a good start in life
  - In plants this is called seed dispersal
    - They have to be protected
      - Hard structures
        - Acorns
      - Chemically
        - Unripe berries are protected with bitter terpenoids
        - 
        - Milkweed seeds are well protected by the pod fill of terpenoids
          - Once mature, the pods open and the seeds are ready
  - How are these seeds sent of?
    - Plants in open habitats such as fields use wind

- Milkweed seeds are well protected by the pod fill of terpenoids
  - Once mature, the pods open and the seeds are ready

- How are these seeds sent of?
  - Plants in open habitats such as fields use wind
    - Wind dispersal = anemochory
      - Inorder to fly
        - Seeds have to be small and light
          - Dandelion
        - Silk parachute
          - That will catch the wind
          - 
          - But no solution is perfect



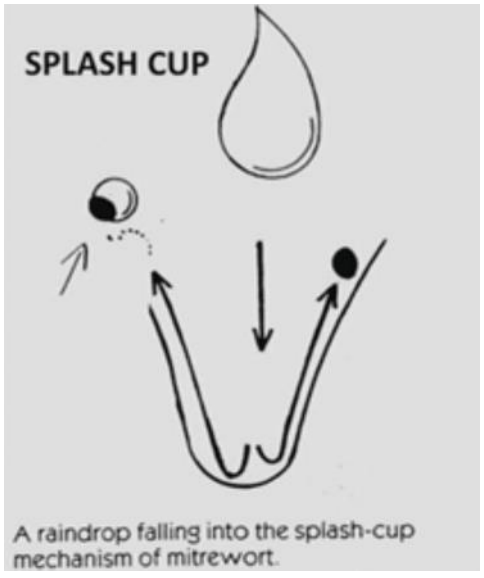
Lecture 21

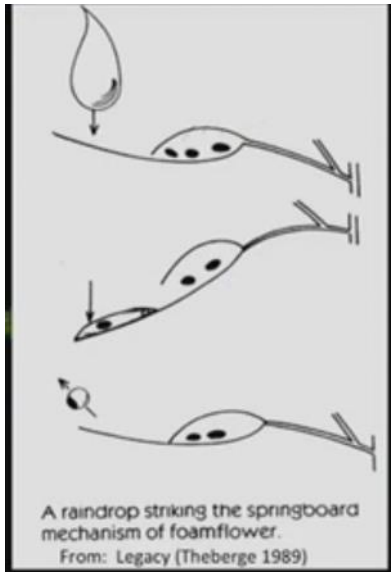
December 14, 2014 2:06 AM

Seed dispersal

- Seeds might fail to reach the destination
  - Solutions
    - Have more seeds
      - Firewood flies flowers produce 70k-100k seeds
    - Animals can carry them
      - Hooks and bards to catch hair or feathers
        - Burdock seeds also hitch hike
      - Queen anne's lace also uses animal powers
        - But not everyday
        - On a Sunday they have hooks
        - On a cloudy day they close up
          - This is possible because in the stalk there are 2 cells, 1 cell absorbs water and closes up and when it dries it opens up
      - Dispersal via animals = zoochory
    - Other sun loving plants exploit animals in a very different way
      - The plants bribe the animals with fruits
        - The seeds are consumed and are pooped out
          - The seeds have to survive the animals digestive system
      - These animals are called seed dispersers
        - Bear
        - Waxwings
        - There also seed predators
          - Chipmunks
    - Seed dispersal also takes place in very different habitats
      - In the forest wind dispersal is not viable
      - Animal dispersal is viable but not regular ways
        - Spring ephemerals use this strategy
          - They pay off ants, ants help them with seed dispersal
          - Ants transport the seeds underground
          - theses seeds has food on them, elaiosomes
          - 

          - Violet seeds have elaiosomes
            - The leaves tense up and they pop off
              - Ballistic ejection
            - Then the ants take them
      - Larger animals disperse seeds in forests
        - Animals like squirrels scatter hoard
          - They bury the seeds all over the place
          - The squirrel may forget where it was buried
          - The squirrel may die
          - Then the seeds will grow
      - Mitreworts don't use animals
        - They neither use animals or wind
          - They use little cups with seeds
          - The cups are the perfect size for raindrops to pop/splash them out
            - Called splash cups
            - 
          - Foamflowers uses raindrops differently
            - Leaves are pushed down by rain drops and the leaves spring back up
            - A seed are shot up
      - In the fall and winter, there are winds in the forest
        - Some tree seeds have sails to help them fly
          - Basswood
            - Are like hanggliders
          - maples
            - Samara
        - Yellow birch seeds
          - Has tiny windblown seeds that land on stumps or logs
          - If a tree is standing by the roots that means that it was grown on a decaying log or stumps
        - Indian pipe
          - After its pollinated the flower points up wards
            - Very lightweight seeds are kept inside until the pod opens
      - Adaptation of seeds dispersal by water
        - Most of these seeds have floatation chambers
        - When the chamber leaks, the seed sinks down
        - Water dispersal = hydrochory
      - Orange jewelweed grows in wet places
        - When the seeds are mature it creates tension
        - Exploded when touched, the straps acting as catapults
          - Ballistic ejection
        - Jewelweeds are also called touch-me-not
      - Reasons why offspring venture off
        - Avoids crowding and competition
        - Diseases and parasites
        - Prevents in breeding
        - Might save some offspring from being eaten
      - Boom or bust strategy
        - Abort seeds if conditions become poor





The animal equivalent of seed dispersal is parental care

- Getting progeny off to a good start in life

- Some just leave the eggs
  - Like frogs and toads
  - But females choose the right habitat
    - Dragonflies and damselflies
  - Temporary or ephemeral ponds are egg laying habitats for great tree frogs
    - There are no fish in these ponds
    - These tadpoles will have to have fast development
    - The pond might freeze but great tree frogs are freeze tolerant
  - Snakes
    - Some snakes lay eggs
    - But some hold the eggs inside them like garter snakes
    - Smooth green snake lay their eggs
      - Under a rotting log
        - Rotting logs have some humidity and heat to it
  - Choosing the right plant to lay a herbivorous plant
    - Monarch butterflies lay eggs on plants that can be eaten by the larvae
    - Host plant
  - Choosing the right host for parasitoid
  - Parental care is stopped after laying the eggs for turtles
    - The soil temperature during egg incubation determines the sex of hatchling turtles
    - Cold and hot = female
    - Can eventually wipe them out
    - Turtles do not guard their eggs or young
  - Walking sticks end up underground but are not placed there by the female
    - Eggs contain a cap, the capitulum, which ants find irresistible
    - First the eggs are carried over by ants underground
  - Northern water and garter snakes hold eggs internally until they hatch
    - Called ovoviviparity

Lecture 22

December 14, 2014 4:08 AM

Parental care in animals

- Other females guard their eggs
  - Five lined skank
  - Red backed salamanders
    - Most salamanders lay eggs in water
    - But the red back lays eggs and hangs them from the moist rotting logs
    - And guards them till they hatch
  - Female spiders carry their eggs around
    - Wolf spiders
      - They weave a ball over their eggs
        - The egg sac is held by spinnerets
          - Several 100-1000 eggs
        - The babies are carried on the mother's back
    - Nursery web spiders carry their egg sacs in their jaws
      - When the eggs almost hatch
      - They create a nursery web and guard the sac
- Do males guard their eggs?
  - Male bass
  - Male giant water bugs
- Mammals spend a lot more time caring for the young
  - Moose calves take 8 months to develop in a cow moose
  - Advance born young are called precocial
    - They can run, swim,defend
    - Females still have to feed and guard them
    - Cow moose teats (utter) to feed the calf
    - Cow moose protect their young for one year
    - Total investment is 20 months
  - 95% of mammals, females provide all parental care
    - But there are exceptions
      - When both parents care for the young it is called
        - Biparental care
          - Wolves and Foxes take care of the young together
          - Wolves are social animals
            - Wolf packs
              - Cooperatively raises the pups
              - In mid-summer pups are taken to open places called rendezvous sites
      - Not all female mammals invest a lot internally
        - Black bears
          - The cubs are altricial, they are very non developped
          - Can't see, can't walk
          - Females stay with the cubs for 1.5 years
          - Female black bears protect the cubs
          - Bears mate in june and give birth in January
            - Their gestation is 2 months
            - There is a 6 month gap
            - Delayed implantation allows bears to mate and give birth

when the time is right

- Fishers
  - Mate late march and get born mid march
  - The delayed implantation is 11 months

- Opossum babies are even more altricial
  - aPlacental
  - They are born 13 days after mating/gestation
  - They climb out and go into the pouch
    - They are marsupials, so the pouch is a marsupium

Lecture 23

December 14, 2014 5:49 AM

Atricial young

- Bats mate in summer, and give birth the next spring
  - Gestation = 40 days
  - Bats do not have delayed implantation
    - But they delay the fertilization and store sperm
    - Wasps and paper wasps
      - Also store sperm
      - The queen takes the sperm and fertilizes the eggs in waves
        - Slave generations
        - Paper wasps, ants, and other social insects display group care for the young
      - Ants have castes with individuals working as caregivers for the eggs and young
      - Over 90% of all bird species provide biparental care
        - Eggs are a huge investment
        - Shells require lots of calcium and yolk
        - Sucks, grouse, sandpipers = large eggs, 40% yolk
          - Very little effort in nest building
          - Precocial chicks, More developped chicks
        - Songbirds = small eggs, 25% yolk
          - Elaborate nests
          - Altricial nestlings (chicks)
        - Near the hatching time, the chicks start communicating to each other to hatch at the same time
          - Precocial birds

Incubation is also part of parental investment

- Birds have special parts of the body that acts as heat pads
  - The patch of skins is full of blood vessels
  - Incubation pots = brood patches
    - Birds turn the eggs and keeps the eggs at 37c
  - female ducks and grouse do all the incubation
    - Males do not develop brood patches, the makes desert them
  - Male species that incubate
    - Phalonopes(females are more colourful)
      - Males have brood patches

Nest sanitation is also a part of parental care

- Faecal sac that carries waste
- Hawks add green conifer sprigs to nests
  - Keeps the nest clear of parasitoids and insects
- Chemical sanitation
  - Take beetles and wipe the chemicals around the nest

Feeding the young

- The chicks that beg the most and loudest are feed the most

Defending the young/eggs

- Nest defence
- Number of ways
  - Aggressive responses
    - Gulls puke and poop on predators
  - Blackbirds
    - A male defends a nest more of the young are his
    - The level of defence is paternity dependent
  - Mobbing
  - Distraction displays
    - A small ground nesting birds lead predators away with a rodent run
    - Ducks give a broken wing act
      - Acts injured to bait the predator
        - Feigned injury
    - Kill deer
      - Fakes an injury and has visual distracts such as the bloodish color on its back
  - Ducks and goose broods can be extremely large due to: brood amalgamation
    - Some females bring their young and leave them with another female
    - Called a Creche
    - Females don't feed the ducklings
    - But if a hawk attacks there is safety in numbers
    - Ex. 1/24
    - Not all the young are hers when they hatch
      - Egg dumping
        - When female ducks sneaks in an egg into another females nest
        - Facultative brood parasitism
          - Intraspecific - when the eggs are put into the same species
          - Interspecific - when the eggs are put into a different species
        - Black-billed cuckoo are also facultative brood parasites
  - Opossums have about 20-50 babies but the opossum have only 13 nipples
    - Only 13 of the fittest young survive
    - Brood (litter) reduction
    - Female eagles also have brood reduction
      - The female only incubates 1 egg and 1 egg alter
      - The oldest eagle kills the youngest
      - Two young hatch but only one survives
      - Siblicide
        - Siblings killing
      - Eagles live for 20 years
  - Muskrats
    - Muskrats goes and kills the neigspechbours offspring to reduce competition
      - Infanticide
  - When a female tree swallow re-mates, the new male kills all of her young
    - The female lets them kill the babies
    - A mammal that does this is the lion
      - If a new male comes in, the male lion kills all the babies
    - The males do not eat the bablies
  - If a pregnant female smells a male urine or scent
    - Will abort their fetuses
    - Called the bruce effect
  - Brown headed cowbirds
    - Do not display parental care
    - Do not have uniparental care
    - Never build nests
    - Never incubate eggs
    - Never feed babies
    - They are obligate brood parasites
    - They are interspecific
    - Adaptations
      - Fast egg laying (20-40 secs)
      - Thick egg shells
      - Fast hatching (10days)
      - Removal of host eggs prior to laying (sometimes)
      - Young cowbirds
        - Outcompete nest mates
        - Can physically crush them

- Thick egg shells
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  - Can physically crush them
  - Can knock them out of the nest

- Find host in 3 ways
  - Sit on high berch
  - Walk on ground
  - Drive birds off nests
- Many birds cannot recognize a cowbird egg
- Some do
  - Some build nest on top of the parasitized nests
  - Some throw them out
    - Rejectors
    - American robins and gray catbirds
- Mafia hypothesis
  - If a bird throws out a cowbird egg, the cowbird comes back and breaks the host's eggs