45.7 behavioral biology: proximate and ultimate cause of behavior

innate behaviors

behavior: change in activity of an organism in response to a stimulus
innate behavior: strong genetic component, independent of environmental influence
learned behavior: from environmental conditioning
↳ reflex action } the difference?
↳ kinesis - klinokinesis, orthokinesis
↳ taxis - toward or away from a stimulus
- phototaxis, chemotaxis, geotaxis
↳ fixed action pattern - keeps going even when stimulus is removed
↳ migration
- obligative (innate) and facultative (learned)
↳ foraging
↳ mating behavior
↳ signals: communication b/ animals
- pheromones
- songs
- courtship displays
- aggressive displays
- distraction displays
↳ altruistic behavior (lower fitness of individ but increase another's)
- worker bees, only queen reproduces
- meerkats have sentry at entrance of colony
- wolves bring meat back to pack
- lemurs take care of children that aren't theirs
kin selection (increase fitness of those related to you)
- indirect increase in individual fitness
↳ intersexual selection + intrasexual selection (competition for mates)
- monogamy, polygyny, polyandrous (rare)

learned

habituation - stops responding to a stimulus after repeated exposure
- stimulus not associated w/ anything positive or negative } non associative
imprinting - attach to first adult they see
conditioned behaviors - associative, stimulus does have consequence
- classical conditioning - conditioned response to conditioned stimulus
  - Pavlov's experiment
- operant conditioning - conditioned behavior gradually modified by its consequence as animal responds to stimulus
  - can be induced to do things they wouldn't normally do
- cognitive learning - abstract thought capabilities

11/06 lecture

physiological & population ecology

does the abundance of non human species matter?
what determines if those abundances increase or decrease?
- even bacteria abundance (think ebola, COVID, etc.)
ex: COVID not as virulent now than it was then (makes you less sick than it initially did)
- if it's super virulent, can't spread as easily (natural selection selects for intermediate / lower virulence)
- COVID not out to kill you, just out to reproduce
- epidemiology + public health / population ecology critically important
- this is an interesting field to me, maybe ask him about it during OH one day
what affects / determines if those abundances increase or decrease?
- high juvenile mortality (die before they get chance to reproduce)
  - ex. polar bear moms don't have enough energy to reproduce and/or raise children, population declines
  - different for type (Type I, II, III) of species
  - oak have high juvenile mortality but produce so many acorns it doesn't matter
- climate change
- disrupts dispersal
- natural disasters
- not having any predators
nobody knows the consequences of 50% of amphibians dying (like pilots on a plane)

physiological **niche**: the set of physical and chemical conditions required by an organism
- species tend to occur only in certain biomes
- will elaborate on this definition later

- niche for an organism has a lot of dimensions - hard to define all the niche requirements (73 variables, N-dimensional niche)
- species can't live in habitat that doesn't meet its niche requirements
- natural selection is ecological processes. this causes evolution, this difference can change ecological processes, even if miniscule.
- adaptations make niche boundaries wider

life history adaptation - Type I, II, and III species
- seeds can be dormant for years, germinate later + grow

morphological - how it's made, its ~~water~~ parts it's made of
behavioral - turtle sunbathing
physiological - salmon go from freshwater to saltwater back to freshwater
- how is physiological different from morphological?

species live only in places they originated or places they get to
- different species have different dispersal potentials
- e.g. zebra mussels only a problem here after they got here (but we met their niche requirements even before they got here)
- species don't live everywhere that meets their niche requirements

why might dispersal be selected for?
- all species have some dispersal abilities? they differ in degree
- sm: "It's hard to get to know somebody if they never say anything" - PS
meaningful for references (why raising hand in class is good)
- want offspring to get to place w/ less competition
- ex. trees can't grow right underneath parent tree (too shady)
- avoid inbreeding
- not doing it for the sake of species - how does this fit w/ altruism?
- mutations good for species (ex. if less reproduction was good) but not good for individual not passed down
- parent's habitat becomes unsuitable
- new habitat has better reproductive success

niche

- dispersal on individual level, not the species level (though indv dispersal has ramifications for species)
dormancy - dispersal in time rather than space
- Daphnia, reproduce sexually when conditions are bad - dormant daphnia
- adaptation to survive times/places that don't meet niche requirements
- dormant organisms often undergo physical dispersion too
- is this comparable to human eggs being in grandma or only dormant if fertilized?

population growth and regulation

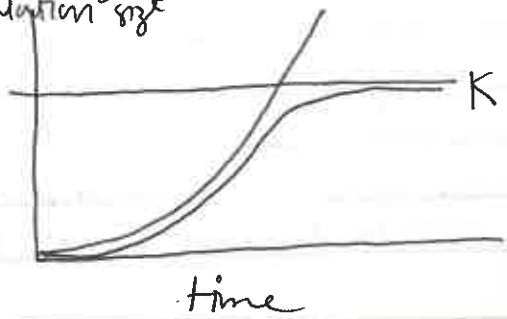
deer/frozen lake example
- per capita: per individual (sometimes per female, etc.)
- doubling time uniform in theoretical exponential growth
- paper folding example
- population growth insight realizes necessity of natural selection
- ex. some organisms have to evade predators constantly
- what keeps bacteria from reproducing unchecked?

competition
carrying capacity (K): pop size an environment can support
- tall spindly trees competing for light
- what does K of bacteria type stuff look like?

intraspecific competition - competition among indvls of same species
interspecific competition - among indvls of two or more species
- diff tree species diff colors / don't understand relevance here

competition regulates population size
- system dynamics (something changing in amount due to interaction of factors)
- masks regulated COVID ex.
- stop epidemics +/ regulation

regulation: to increase when low and decrease when high



- to push a system back toward equilibrium
ex. HVAC regulates; breaking window affects temp. of room
- our bodies regulate our temperature
density dependent (organisms per area)
- per capita population growth rate depends on pop. density
- only density dependent processes can regulate population size
- competition happens because of population density
- predation can happen b/c of population density (?)
  - predator goes to where prey density is highest
- competition reduces per capita growth rate
- pay careful attention to units (address them in answers too)

11/08 lecture

- population regulation/per capita measurements are what matters
- how many individuals are born, how many die, how many move in, and how many move out
  - immigration/emigration typically not a big deal in wild populations
- other processes (density independent) can affect but not regulate pop. sizes
- biological interactions are most often density dependent
  - competition more relevant if pop is dense

~~not that fast~~ < 0 → decreasing
per capita growth rate $= 0$ → growing ~~b/c 0 and + → decreasing~~

- knowing something is regulated doesn't mean we know it is regulated
- regulation isn't perfect, means it won't get too too too far away from equilibrium / how it is regulated ≠ the tightness with which it is regulated different question
- if a pop is low in certain area, predators will go looking somewhere else → prey pop grows → predators go to prey and get eaten → prey pop decrease → ...
- parasites spread more easily in dense pops
- I feel like there's some nuance to this? disease w/s is parasitism regulating?
- Bubonic Plague didn't affect long term population growth (same for nonhumans)
  - I wonder if this is the only time our pop. went down?

46.1 ecology of ecosystems

ocean ecosystems most common (~70% of surface) - shallow ocean, deep ocean, deep ocean surfaces
- phytoplankton perform 40% of Earth's photosynthesis
freshwater rarest (1.8%)
environmental + human disturbances in ecosystems
equilibrium - all org.s in balance w/ environment + e/ other
measurements of changes in ecosystem
resistance - ability to remain @ equilibrium despite disturbance
resilience - speed at which equilibrium is recovered
- ecosystem can lose its resilience → destruction
food chain - primary producers < primary consumers < ... consumers
- trophic level (linear)
energy limits length of food chains heat
- 2nd Law of Thermodynamics (tendency toward entropy)
food web - nonlinear, more holistic, made of food chains
- grazing food web (typical)
- detrital food web - orgs that feed on dead organic matter (decomposers) at the bottom
mesocosm: partition of natural ecosystem for experimentation
microcosm: laboratory environment

46.2 energy flow t/ ecosystems

photosynthesis — autotrophs — sunlight
chemosynthesis — inorganic molecules — mostly bacteria in places w/o sunlight
digestion
net primary productivity
trophic level transfer efficiency $= \frac{\text{production @ present trophic level}}{\text{production @ previous trophic level}} \times 100$

- can't have unlimited amount of energy transfer

net production efficiency = $\frac{\text{net consumer productivity}}{\text{assimilation}} \times 100$

↳ energy content available to next trophic level

↳ biomass of present trophic level after accounting for energy loss

cold-blooded use less energy than warm-blooded - low NPE

biomagnification - ↑ concentration - have to eat more to generate heart of persistent toxic substances up the food chain

ex. DDT, PCBs, heavy metals

POPULATION ECOLOGY 11/08

- humans have artificially increased K / depleting a "one-time inheritance of natural capital"
- exceeding K requires depleting (ing way) that resource can't be used again
  - wedding ring example + trust fund interest example
  - can use resource in a way that it's recyclable or in a way that's not recyclable
- maintaining human pop has consequences though
- did physiological ecology refer to adaptations?

→ 45.1-4

LECTURE

Le) 11/08

community ecology

he's not going to ask if something is population or community ecology? mostly an arbitrary difference

pretty hard to put boundaries around a community

only competition if there is a limiting resource

difference?
- ex. two things that breathe oxygen not in competition for oxygen, but limited amount of food is competition
- light a limiting resource for plants

predation (includes parasitism): one individual benefits, other suffers

- cow eats grass = predation
- what about one plant "takes light" from another

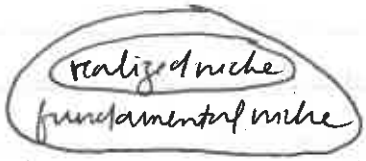
mutualism: both species benefit

commensalism: one species benefits, others unaffected (hard to determine if something is unaffected), has to go both ways

coevolution: reciprocal evolution of ?? species in response to/ other
- evolve in response to everything in environment, including interactions with other species - example?

- associated w/ codependency I think

fundamental vs. realized niche
- where a species can live in the absence of competition or predation...
- abiotic works but something missing
- ~~where a species can't~~



where a species actually lives in presence of predators and competitors

ex of difference (Chthamalus stellatus)
- intertidal zone - partitioning w/ water determines amount of day in water or not
- lots of different niches in intertidal zone
- lots of ecological study (easier than wolf pop in TX)
- close shell in air, open in water + collect zooplankton
- does this count as amphibious? or do they have to move themselves b/ water + land (not just water moving?)

- barnacles compete for space (super obvious limiting resource)
must get enough resources to survive
- selection favors effective predators, so most creatures at risk of predation or have good defense against predation
- a lot of plant material has chemical defenses
- not necessarily toxic - when caterpillars start chewing leaves, only then does tree release toxins (super sophisticated)
- milk + coffee example

so as not to waste energy on toxin when (not necessary

→ 45.6 "Community Ecology"
- know lots of examples of defenses against predation
- milkweed straight up toxic but monarchs can eat them, they segregate the toxins until they're butterflies (→ defense against predation)
- other butterflies mimic monarchs for this reason (Batesian mimicry?)
- only works if others are rare + monarchs popular (frequency-dependent selection)

Brood parasites (lay eggs in other birds nests)
- selected for because you don't have to care for it → potentially very high fitness
- birds not used to brood parasites more susceptible
- but not effective over time - why?
- evolutionary naivete

LECTURE 2) 11/13

- ~~finish statistical analysis on tree lab~~
- ~~tell him about library table~~
- LAB REPORT FORMAT

community ecology

tree lab:
- see more about p-values in "Probabilistic Reasoning" from his book
- q: so you can't say that in this case the bees visited natural plants more often but that the insignificance of the relationship means nothing can be extrapolated
- TREE LAB DUE DECEMBER 8th, set deadline for yourself
- q: when do OH stop happening as usual?
- put final exams on calendar

class content:

invasive parasite eggs vs native parasite eggs
- no selection yet for diff eggs
- selection to look more like host egg

ecological interaction over generations → selection

how would you expect predator and prey populations to affect each other's abundance?

typically not on same numerical scale (more prey than predator)
- is this an example of bioregulation?

cyclic abundance
- typically don't see it as clear as lynx/hare because hard to get data and other factors present
- recall chemical defense of plants; some for vegetation the rabbit eats
- produce when hares get abundant and then some
- lag time in biology

- most predators + preys don't this wildly cyclical
- regulated but not very tightly regulated
- happens when predator really depends on one prey source
- doesn't work when predator affects lots of different things
elk suppress little trees from growing b/c they eat little trees
- lynx didn't permanently suppress rabbits but elk permanently suppress the trees

wolves natural predators of elk @ Yellowstone; wolves wiped out