- ash blocks the sun → cooler and plants can't photosynthesize

B. asteroids

- lot of good evidence for asteroids @ different times and especially for dino extinctions
- Ramprino 2017 American Scientist
- these events have huge implications for what comes later
- most compelling evidence for past mass extinctions
- Tanzania event (some asteroids smaller than others)
- tremendous amount of forest fires → ash in air → cooling → carbon in wood then carbon in atmosphere → warming → melting snow and ice → less reflective → warming

how asteroids set off climate changes - lots of regional impacts where it hits but effects resound across globe

"Grizzly bears are like golden retrievers now."

- why are there golden retrievers? artificial selection
- why would there still be grizzly bears in the future? it depends on the decisions we make - if we don't intentionally keep them around, will unintentionally wipe them out

background extinction rate between mass extinctions

10/16 CIRCUMSTANCES THAT MAKE SPECIES ESPECIALLY SUSCEPTIBLE TO EXTINCTION

no ecologist knows exactly how all the parts work (doesn't mean they know nothing either)

some species are much more susceptible to extinction than others

niche not where a species lives but the function it fulfills

hunters aren't driving anything extinct now

Hagerman manages the land to offer a migratory haven for birds

hole nesting birds

- holes found in dead trees, which humans tend to cut down

Costa Rica fig trees x Costa Rica wasps / fig trees

big rivers particularly valuable to people (cities along big rivers)

define endemic — species most affected by pollution are river species

how statistics work

lab: Friday, October 13th

magnitude tells how much about the pattern
- there was more Grass in Field A than in Field B
- yeah but how much? → magnitude (like Reed's physics lab example)

data usually varied in bio (more factors than in physics)
The question is: is this a pattern or is it just random variation?
Sometimes patterns are due to chance

How do we conclude if there is a pattern in data?
Key characteristic of science is that it seeks to prove its hypothesis wrong
- doesn't make sense to go "I don't know, let's start over"

statistical tests determine whether or not patterns are statistically significant
- useful data but not perfect measure
- stats are not a be-all, end-all

* be able to explain the three questions on the title slide
- tool to enable critical thinking

descriptive vs. experimental statistics
- no hypothesis or comparison, just ~~defining a~~ describing something
  - e.g. mean, σ, variance, n
- looking for a statistically significant result
  - e.g. regression, analysis of variance, Chi-square test, Kruskal-Wallis test, paired t-test
  - (all test for statistically significant relationships)

2 Categories of experiments:
1) experiments w/ highly repeatable results (still has a narrow range)
2) experiments with substantial replicate-to-replicate variation w/ treatments

1 is not a better experiment than 2
Lots more things affect our heart rate than what affects how fast a ball falls
- doesn't mean you're manipulating all of them but just inherent variation

we are arguing about patterns in category 1 (no need for statistical tests)
do need statistical tests for category 2
why there's a pattern in the data is a different question

Excel always gives you line of best fit (not an indicator of a good pattern
is not a pattern if taking a point away changes the pattern
All conventional statistical tests calculate the likelihood of obtaining

- statistically significant if less than a 5% chance of getting that pattern

* all a statistical test can tell you is how often you can get that much pattern with chance alone

IMPORTANT DISTINCTION

p-value = the probability of obtaining at least as pronounced a pattern (or more pronounced pattern) in data on the basis of random variation

- p-value is not the probability that the data are due to chance

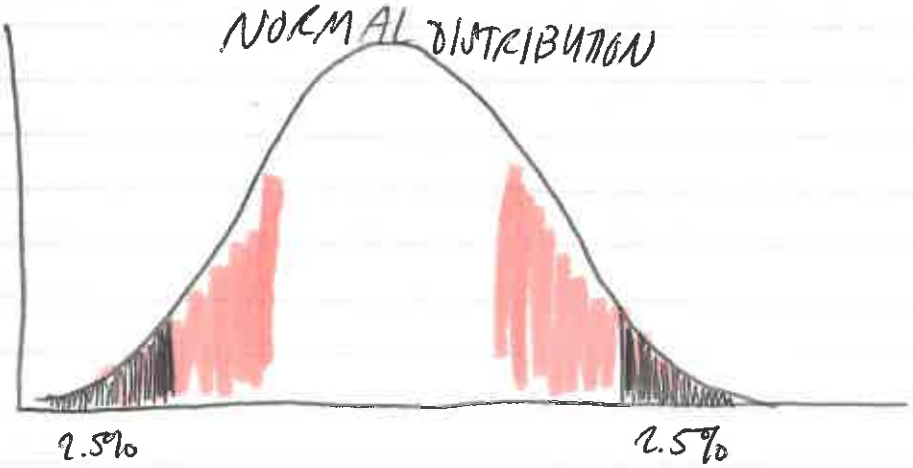
Random processes can certainly generate patterns

~~but~~ not exactly as predicted because of that random variation

2:20

p = .05

p = .50



the results in these 2.5% ranges statistically significant because unexpected

nothing right about the p-value cutoff, just convention

We don't say it was random variation but that we have no reason to believe it wasn't random variation

- can't know for sure
- p-value doesn't mean it wasn't random, means we have reason to believe it wasn't

problems with statistics: _ Type II error
- drug that gives p = 0.07, can't say that is statistically significant

Type I Errors:
unlikely events occur randomly but statistical ~~events~~ tests will suggest unlikely random data are consistent with the hypothesis of one variable affecting another
false positive is an example of a type I error, don't need to remember which error is type I but remember the error
If a study isn't designed well → Type II Errors: false negative
experiment doesn't detect effect
p-value cutoff guarantees many "Type II" errors
What are the pros and cons of other p-values
- very low p-value, lots of Type II errors
- very high p-value, lots of Type I errors
.05 is not correct, it's convention, and a pretty low #
- more worried about Type I error than Type II errors
- build off of statistically significant results; research builds on research
- if you're looking for a hazard, Type II errors are especially bad
- easy to say it's not hazardous but that doesn't mean it's not

if $p > .05$ conclude no evidence of a relationship not no relationship
if $p < .05$ don't conclude proof (could be a Type I error) conclude ∴ consistent with the hypothesis that independent variable affect the dependent variable

human evolution

October 16th

HUMAN ANCESTRY: PRIMATES, MONKEYS + APES, HUMANS, MODERN HUMANS

only primates have both binocular vision + grasping fingers/toes
relatedness doesn't matter as how recently it branched off
↳ to a common ancestor
- tarriers and humans the same amount of related to archonta
- relatedness to a common ancestor discussed in terms of time (not generations)

lemurs, louses, tarriers only in Madagascar
- been left alone because you can't swim there

fossil evidence (when we see more than one kind) used to construct these trees

DNA sequencing
- some genetic variation is neutral
- molecular clock: look for # of DNA differences used to estimate how recently a divergence occurred
- assumes neutral DNA changes accumulate at a constant rate

all these big apes are endangered
larger eyes → active at night
savanna: some trees, spread out from one another though
gorillas live on the ground
chimpanzees do go in trees
many primate species were adapted to living in trees but then the climate changed and they had to go on the ground
- human ancestors became bipedal — shows you a lot about nature of evolution
- not using hands if you're swinging through trees
you can see a lot further if you're bipedal - can't see well if you're just crawling on the ground
observed
trying to interpret changes in selective forces from changes in fossil records

make list of all readings
- review readings

tool use thought to stimulate selection for larger brains
gorilla can't walk around as upright as we can (+ we don't need to)
more fossils will get found! - cause our diagrams to be refined, not thrown away
systematists
- harder to distinguish b/ species when you have few fossils to go off of
- lumpers and splitters (seems kinda arbitrary to me)
- we mated w/ Neanderthals and are still diff species
- may be asked why he doesn't require us to memorize the details of graphs like the one on page 10 of the PowerPoint

2:22

creatures that eat more plants have larger jaws
arguable to call these different species
(first ones all in Africa and then spread to other places)
know the order of magnitude if not specific dates/years
- get the point; variety of populations, some genetic exchange, hard to say what is and isn't a species

Genetic Structure of Modern Human Populations
are all very closely related
races is not a term used in biology - genetic similarity too large even across different areas
95% of variation is w/i population, only 3-5% outside the population

ch 44 ecology & the biosphere

44.1 the scope of ecology

ecology: the study of the interactions of living organisms with their environment

organisms < populations < communities < ecosystem < biosphere

organismal ecology: interested in adaptation

population ecology: ? conspecifics ?

biological community - all the species w/, an area and the interactions w/i + among species

- heterospecifics → different species
- interactions: predation, parasitism, herbivory, competition, + pollination

mutualism: +/+ heterospecific interaction

ecosystem ecology: all the biotic + abiotic components of an area

44.2 biogeography = geographic distribution of living things + abiotic factors + distribution of barriers abiotic factors that affect their distribution

endemic species: naturally found only in specific geographic area

usually restricted in size

- nonendemic species = generalists

ocean upwelling = rising of deep ocean waters occurs when winds blow along surface waters near a coastline

- nutrients in bottom ↑

spring and fall turnover - recycle nutrients and oxygen from bottom to top of lake - in response to air temp and wind changes

- caused by formation of thermocline: layers of water w/ temps significantly different from those around it

Denser water sinks ↓, bottom water moves to replace it + oxygen increases species distribution

- migrate to areas of different temperature

hibernation - survive cold estivation = survive hot and dry

torpor (lower heart rate)

organisms have adaptations to retain water
inorganic nutrients (nitrogen & phosphorous?) → distribution
- soil?
net primary productivity = all carbon fixed per year - carbon oxidized during cellular respiration
- measured from above-ground biomass

44.3 terrestrial biomes

temperature and precipitation → distinguish terrestrial biomes
what details about biomes should I know? basic characteristics
tropical rainforest - plants w/ broad leaves that fall & replace t/o year
- no seasonal loss of leaves — constant daily amount of sunlight
- temp & sunlight stable, year-round plant growth
- annual rainfall variable (wet & dry months occur but dry months aren't that dry)
- high NPP, high species diversity
- epiphytes (plants grow on other plants)

savanna grassland w/ scattered trees, usually hot — grass
- long dry season - fire common → plants have root systems to recover

subtropical deserts very dry, low annual precip and little monthly variation in rainfall
- low species diversity
- mostly annual plants - water-conserving adaptations and nocturnality & burrowing

chaparral - most rain in winter, summers are dry & plants are dormant during the summer - shrubs - fire common — shrubs

temperate grassland prairies & steppes, hot summers & cold winters
- specific growing seasons - further from equator than savannas, savannas have more trees & less rain & tropical or subtropical
- few trees
- dense vegetation and fertile soil - controlled burns for maintenance

temperate forests mid latitude, defined growing seasons due to temp variation but consistent precipitation, deciduous trees (seasonal leaf loss)

C

- Less NPP than tropical ent and less diversity
- rich soil from leaf litter
boreal forests (evergreen) taiga, coniferous trees, cold + dry winters w/ cool, short, wet summers, snow warm precip w/ little evaporation
less energy needed to warm a needle like leaf than a broad (deciduous) leaf
more acidic soil with less nitrogen (less leaf litter)
NPP lower than temperate, less diversity
arctic tundra very short growing season but rapid growth b/c lots of sunshine, little precip and little variation and little evaporation b/c cold, plants low to ground, low density, low NPP (low above ground biomass), soil perennially frozen = permafrost → roots cant go deep and decay so slow

44.4 aquatic biomes

light distinguishes ↳ stratification, currents
water absorbs light
↳ thermal properties of water

open water = pelagic realm
benthic zone = shoreline - ocean floor
- high oxygen
shoreline - photic zone (light penetrates) thermal stratification
- aphotic zone (most ocean) → scarce minerals
ocean relatively uniform in composition - abyssal very cold, high pressure, low nutrients
- physical diversity (different zones)
intertidal zone - b/t high + low tide, closest to land, tidal ebb and flow
neritic zone - intertidal → continental shelf, photosynthesis
coral reefs skeletons of coral organisms → reef
mutualistic relship with algae crypt fauna planktivores
estuaries freshwater meets ocean, diluted saltwater
- salinity varies with seasonal rainfall and tides
- halophytes
lakes + ponds temp - thermal stratification
phytoplankton eaten by zooplankton
nitrogen + phosphorous determine phytoplankton growth
algal bloom from too much → bad ? turbidity ↓ photosynthesis ↓ oxygen

rivers and streams continuously moving
source water - usually cold, low in nutrients & clear, narrow channel (width of river or stream) channel → faster current → low silt
- energy input from things photosynthesis from algae on rocks a accumulation
that fall into the water no phytoplankton
width of channel ↑, current slows, sedimentation ↑, phytoplankton & warmer ↑
wetlands soil either permanently or periodically saturated with water
wetlands shallow
emergent vegetation - roots in soil with tops of plants out of water
marshes, swamps, bogs, mudflats, salt marshes
- slow steady waterflow - no waterflow

445 **climate and the effects of global climate change**

all biomes affected by global conditions (ie climate)
climate - long term, predictable atmospheric conditions of an area
- weather - short-term
historical evidence of Earth's past climate:
- antarctic ice cores
milankovitch cycles → slight changes in Earth's orbit affect climate
solar intensity ↑ temp ↑ - changes in solar intensity
volcanic eruptions - gases released generally cool (block sun)
greenhouse gases trap heat from sun → greenhouse effect ↑
human activity → CO_2, methane ↑ / burning of fossil fuels, deforestation, agriculture
melting of clathrates (frozen chunks of ice and methane @ bottom of ocean) → release methane as temps warm
- positive feedback loop
permian extinction caused w/ increase in temperature
melting glaciers ↑ sea level

ecology - intro - biomes

lecture: october 18th

"just surviving is an evolutionary dead end"
- there's not as strong of selective pressures at post reproductive age
get energy + nutrients from food - need enough to survive + reproduce
need to not get eaten or succumb to the environment
natural selection - natural (ecological) processes determine which individ reproduce and which don't
must be able to tolerate the environment (physical + chemical conditions)
studying ecology: helps to understand natural selection and environmental problems
do we owe anything to future generations? do we owe anything to other species - is that an injustice issue?
we depend on oxygen w/ a fairly specific range of concentration
- too much and too little both bad
geological processes regulate amount of oxygen in atmosphere
soil product of food web interacting with food chain + climate
those in the future depend on us making progress in today's ecological problems
can't make water at the quantities we use it - comes from ecosystem
these problems get unintentionally worse w/o intervention
almost no one is running around trying to damage an ecosystem
we can't not damage ecosystems at all
"life support potential of the planet"
consciousness of global scale environmental degradation 'til recently
can't just stop oil because we're dependent on oil, but we need to switch as fast as we can
Tar Sands oil (Alberta)

ecosystem services: oxygen, water supply, soil, wood and fibers, food, water purification, element cycling, UV shield, wild genetic material, climate moderation, flood prevention, air purification, pollination, recreation, inspiration
(no one inventing cars / computers etc.)