Biology (8/28/23)

Evolution>Ecology>behavior>

Ecosystem Services

(Things we get for free from Ecosystems)

- Oxygen
- Water supply
- Soil
- Wood fibers
- Water purification
- Element cycling
- UV shield
- Wild genetic material
- Climate moderation
- Flood prevention
- Air purification
- Pollination
- Recreation
- Inspiration

What is evolution $ how does it work?

Outline

- Evolution-3 circumstances 2 consequences
- Observations of evolution in progress
- Artificial selection: intentional
- Artificial selection: unitnetional
- Brek depths of Galapagos finches
- Sickle back armor
- Evidence of past evolution
- Fossils
- Molecular homologes
- Anatomical homologies
- Convert evolution
- Species diversity on archipelogos

Evolution: Defination

A change in the composition of a gene pool.

Gene Pool= All the genes in a population of a species

Gene= A unit of heredity

Population+ A group of members of the same species with opportunities to interbreed.

Theory of Evolution Explains

1. How species change
2. How new species arise

Selective breeding- Picking preferred traits and breeding those animals. Don't breed the ones that have undesired traits.

"Artificial" Selection- People determine which individuals reproduce

Charles Darwin called evolution "Decent with modification"

Natural Selection: natural, ecological processes determine which individuals survive and reproduce.

[The 3 circumstances that routinely occur in nature lead to the inevitability of natural selection which in turn results in evolution]{.underline}

1. More are born than the environment can support.
2. Individuals are not identical.
3. Some of the differences are heritable.

Two Consequences of those 3 circumstances

1. Individuals best suited to the environment are most likely to leave offspring (natural skeleton)
2. Because only the reproducers leave genes in the next gen, the composition of the gene pool changes (evolution happens)

Tons of Evidence for Evolution

Some of the real-time evidence

- Artificial Selection

Intentional artificial selection

Unintentional artificial selection

- Natural Selection

Break depths of Galapagos finches

Armor of stickleback fish

Molecular Homology: Amino Acids sequences. Human sequence most similar to similar species.

Convergent Evolution: Dissimilar organisms (Without a recent common ancestor0 Subjected to similar selective forces develop similar adaptations.

Historical evidence consistent with evolution by natural selection

Fossils

- Molecular Homologies
- Anatomical homologies
- Convergent homologies
- Species diversity on archipelagos

Anatomical homologies

Bone structure (distant, non-flying ancestors)

Convergent Evolution

Wings skin vs feathers- more recent evolution

Species diversity on archipelagos

Galapagos habitat variation:

Different ecological circumstances (selective Forces) on different islands led, eventually, to enough evolution to give rise to different species.

An inconceivable amount of time for evolution to occur (billions of years)

Inconceivable # of opportunities for beneficial genetic changes

Next Level of understanding evolution

- Mutations
- Inbreeding depression
- Common patterns of evolution
- Gene flow
- Genetic drift

Outline

- Basic genetics of inheritance
- Fitness- formal definition
- Process that alter allele

[Population]{.underline}: a group of individuals of the same species with opportunities to interbreed.

[Species]{.underline}: A set of individuals with the potential to interbreed in nature

[Gene]{.underline}: a unit of heredity made of DNA

[Allele]{.underline}: A variant of gene- e.g. A length of DNA that codes for a particular trait, such as black hair

Fitness

The relative contribution an individual makes to the gene pool of the next generation.

"Survival of the fittest-(not the strongest individual but the best suited to the environment.)

Process that alter allele frequencies

("alter allele frequency" = "causes evolution")

-Mutation

Creates new alleles=new genetic varieties= new possibilities

-Evolution by natural or artificial selection

Adapts populations to current conditions

-Gene Flow

-Genetic drifts

Mutation- a change in a DNA sequence

- Mutations occur randomly, not because they would be beneficial or for any other reason
- Mutations often create new genetic variants
- Any specific mutation is extremely unlikely
- Most mutations are inconsequential or harmful random change to functional system
- Rarer, beneficial mutations enable populations to develop genetic diversity to adapt to new circumstances

The problem with mutations for individuals

- Two copies of most genes- one from each parent
- Thuse 2 alludes-same or different
- Phenotype= the expressions of an individuals genotype. (Genotype= individuals complete set of alleles)
- Natural selection acts upon phenotype, not genotype
- One allele may be dominant over another, recessive to another, or related in a more complicated manner
- Dominant does not mean selected for.

Finches Simlab

Ex. 1

Smallest Beak: 9.75 largest beak 13.3

7.1 Over the years the finches composition changes from having a little bit of every size beak to a lot of them having bigger beaks

7.2 Yes the beaks got bigger over time

8. Selection strength .05 Average depth 11.5

9.1 Average B. Depth 12.1

9.2 It increased by 6

10. Selection strength: 15 or higher

Average B. depth 11.5

11.1 Average B- length 12.6

11.2 B. length increased by 1.1

11.3 Yes, the beaks get bigger faster

12. Beak sizes got smaller but slowly

Ex. 2

Wet Optimal beak length 10mm

Dry Obtain beak length 14mm

1. What is the average beak depth? 11.5
2. What is the range of beak depths? 9.75-13.3
3. Difference between largest vs smallest beak? 3.55 mm

> 4 Dry

4.1 Average Depth 12.7

4.2 Range of beak depths 6.00-14.00

4.3 Difference between biggest vs smallest beak 8mm

4.4 How composition has changed? Beaks got bigger

4. Wet

5.1 Composition actually turned out similar to in part 3.0

6.1 Did population evolve on average beak depth well adapted for rainy conditions?

The beak depth got smaller

7.1 Is it possible to drive the to extinction

Yes, turn selection strength up all the way and switch between dry and wet

7.2 Since break depth has no effect on survival when forced with dry spells or wet spells, they cannot immediately evolve to survive such conditions evolution takes time

Q1. Why are birds discussed called Darwin's Finches

Q2. A medium ground finch ability to survive often depends on its beak size primarily because

Q3 Which statement best describes the pattern of natural selection on beak size?

Q4 What can happen to our natural finch population if environment changes from wet conditions to dry conditions too rapidly?

Q5 What happened to break depths in the finch population when selection on beak depth was eliminated (selection strength) and mutation rate for alles determining beak depth was greater than zero

Q6 The correlated trails exercise shows?

Q7 In the mountains and valleys ex which of the following parameters had the largest influence one ether the finch population evolved a bimodal distribution

Q8 The final ex, large and small seeds showed that?

Q9 Under which of the following conditions is a population most likely to evolve a bimodal distribution

Q10 In the lab, which of the following factors made it more likely that similar individuals would mate with each other?

Biology (9//8/23)

Sexual Selection- Male Choice

- One sex is generally (in most species) chosen about mates Usually females (Why?)
- Females' fitness depends more on genotype of individual offspring than does male
- Fitness- because females cannot reproduce as often
- If a male makes a bad mate choice he can mate again- little impact of one bad choice on fitness

[Exceptions]{.underline}

In species where males raise young, males are the choosier sex

In other species only or a few male's mate. Females have no choice

What would happen to alleles that cause females to choose poorly?

- Offspring would have lower fitness
- Alleles that led to such choices would be selected against
- Male choice criteria (of wild species) Must lead to high fitness or alleles that lead to those choices would have been selected against

Processes that alter allele frequencies

> -Mutation
>
> - Natural selection

Gene Flow

Gene drift

Movement of genes from one population to another

Gene Flow

Critically important to prevent inbreeding depression in small population

Genetic Drift

Chance change on allele frequency individuals

Gene drift can be important in very small population but chance changes in allele frequencies are unlikely in large populations

Population Bottlenecks

Almost all individual's population regrows

Founder Events

A rewind, found a new population in a new location

Mutation Random

Natural selection Kind of random

Gene Flow Not random

Genetic drift Random

Creatures are continually subjected to selection pressure

5 reasons why natural selection does not eliminate genetic variation

Diploidy= 2 alleles for most genes so recessive alleles are "hidden" in heterozygotes (not selected against)

Valuable selection pressure (different alleles favoured in different times and places)

Heterozygotes sometimes have higher fitness than either homozygote

Neutral seriation (variation with no fitness consequence)

Mutations continually add new variants

Evolution Does not lead to perfect organisms

- Natural selection involves trade offs (faster/strange)
- Natural selection can act only upon existing genetic variation
- Muattions occur randomly, not because they would be adaptive
- -Delay between when selective forces change and when allele frequencies a change. Natural selection always playing catch up

- Gene regulation problems (epigenetic processes) interfere with fitness

Some imperfections of humans

> -Pharynx used for both breathings and eating
>
> - We can't synthesize vitamin C
>
> Babies' heads to big
>
> Fitness- The relative contribution an individual makes to the gene pod of the next gen

"Survival of the fittest"

> (Not the strongest individuals, but rather the individuals best suited to the environment)

Process that alters allele frequencies ("alter allele frequency" =" cause evolution")

- Mutation (creates new alleles= new genetic varieties= new possibilities)
- Evolution by natural or artificial selection
- Adapts populations to current conditions
- Gene Flow
- Genetic drifts

Mutation- A change in a DNA sequence

- Occur randomly, not because they be beneficial
- Create new genetic variants
- Any specific mutation is extremely unlikely

Speciation 9/20/23

Formation of new species

Outline

- Species definition
- Species in dentification
- Origin of new species

```
<!-- -->
```

- Allopatric Speciation

- Sympatric Speciation

```
<!-- -->
```

- Mechanisms that prevent hybridization between species
- Major changes due to evolution of genes that regulate development

A species is a group of individual organisms that have the potential to breed and produce fertile offspring under natural circumstances

If members of 2 different species breed, they do not produce fertile offspring

Thus, members of separate species are reproductive isolated.

In practice- it is often impossible to test whether two individuals can breed and produce fertile offspring so...

Species identification on basis of

- morphology (unique features or combinations thereof or

- genetics (unique DNA sequence)

Suggest unique features implies reproductive isolation

Morphological features that do not vary from individuals to individuals within a population and distinguish population with those features from other population (of closely- related species)

In some cases, biochemical data = such as DNA sequence, must be used identify species with any certainty.

"Bar coding species"

Thus, 2 methods for distinguishing species

1. Reproductive Isolation
2. Distinctive morphological or biochemical features

Problems with these methods

1 often cannot be tested

#2 can confuse long-isolated populations and actual separate species

How do new species rise?

-1 Separate populations experience different selective conditions that favor different alleles

Changes accumulate until 2 populations of one species become 2 different species

-2 Much rarer but common in plants: reproduction "error" produces a new species in one generation

For 2 populations to diverge into separate species they must be sufficiently reproductively isolated that their gene pools can diverge

Biology 9/25/23

How did you study for the quiz?

I went over notes as well as reviewed all powerpoint slides

Was that how you intended to study?

No. I was hoping to get to study with a friend and make flash cards

If not, what was the difference?

I didn't have enough time

Were you confident that you were ready for the exam?

No I had a lot of anxiety before and after

Have you identified any ways to improve your methods for studying an learning?

Looking at slides is useful for memorizing but not for when you need to explain in other ways I need to practice explaining the topics

Would you change your procedure for next time? If so, how?

I'll start earlier and use more methods than memorization.

SPECIATION CONT

If there is substantial gene flow between population, they will not diverge genetically

Allopatric Speciation

Speciation involving geographic isolation

Sympatric Speciation

Two population become isolated even though they occur in the same area.

Factors That increase likelihood of Allopatric Speciation

1. Different selective pressures in different locations
2. Many different populations
3. Initial allele frequency differences among populations

Islands chains are often sites of adaptive radiation

- Isolation from mainland
- Small founder populations
- Different selective pressures on different islands
- Infrequent movement from Island to Island

Sympatric Speciation

- Speciation without geographic isolation
- Possibly common difficult to detect
- (Ambiguity of "geographic" isolation?)

> Sympatric speciation due to nondisjunction of chromosomes during mitosis- common in plants
>
> Mechanisms that prevent hybridization between species (very closely related)
>
> **Behavior Isolation [-]{.underline}**Birds not recognized as potential mates
>
> Temporal Isolation - Mate at different times of the year

Major Changes due to evolution of genes that regulate development.

Evolution of development

- Small genetic changes (eg. Single mutation) that affect the development of embryos can cause tremendous morphological changes
- In other words, a small genetic change sometimes causes a major phenotypic change.

2 genes determines whether a bird's foot is webbed

A single mutation prevents armor formation in sickle backs

Small genetic changes that affect development can have huge evolutionary implications

Intermediate forms are not always necessary to get from one form to a distinctly different form

History of Life

Outline

Common ancestry

Domains of Life

Past conditions on planet

Historical mass extractions

Present mass extinction

Some reasons all creatures are thought to be related:

- All composed of same biochemicals, such as DNA and amino acids
- Sequence similarities among fundamental genes
- Evolve through gradual changes in genetic information

Prokaryotes- No nuclei (archara + bacteria)

Eukaryotes- Cell nuclei (Fungi, animals, plants, protists, algae)

Bacteria

First Evidence 3bya, 1 billion years after archea peptidoglycan in cell walls (unlike archea)

Includes cyanobacteria

-Photosynthesizes (give off O2)

-Responsible for O2 in atmosphere

-Enabled formation of stratospheric ozone layer

- Stratospheric ozone layer blocks ultraviolet light

- No life on land until the ozone layer formed

- So, we owe our lives to pond scum

Prokaryotes (organisms whose cells lack nuclei, archaea, bacteria0 had the planet to themselves for more than 1 billion years

Eventually the first eukaryotes arose (organisms with chromosomes enclosed inside the membranes of cell nuclei)

Prokaryote (Archear, bacteria)

Eukaryotes (everything else)

Endosymbiont hypothesis for origin of eukaryotes

Evidence

Chloroplast + mitochondria are similar in size to bacteria

Chloroplast + mitochondria reproduce by splitting, like bacteria

Chloroplast + DNA include sequences very similar to cyanobacteria DNA

Evolution is a change in the gene pool

Human Ancestry

Primates

Tarsier Monkey Vs Humans

All primates have

1. Binocular vision
2. 2. Grasping Finger toes (No other mammal has both)

Primate evolutionary tree

65 mya Mammals called archota give rise to primates

36 mya Some primates become diurnal- monkeys with opposable thumbs

25 mys First apes

5-10 mya Climate cools, African forests replaced by savanna and grasslands

4.5 mya Tool use

2 mya Brains get larger presumably because to use tools

Neanderthal genes live on in modern humans

Homo naledi- Found in S. Africa in 2015, has characteristics of both Australopithecus and homo

Immediate Ancestors of Humans

5 bya: Hominids Split from Apes

4.5 bya: "Lucy" truly bipedal, survived 2m yrs

2.1 mya: Homo erectus in Africa, Europe Asia

500,000 ya: H. neanderthalis in Africa

300,000 ya: H. Sapiens in Africa and middle East

100,000 ya: H. neanderthalis in Europe and Liberia

200,000 ya: (2019 Nature Report, Apidimal 1)

28,000 ya: H. neanderthalis still in Europe

Genetic Structure of Modern Human Pop.

"Within- population differences among individuals account for 93 to 95 of genetic variation, differences among major groups constitute only 3 to 5."

Genetic similarities among people from different areas.

No biological basis for conventionally identified races. Criteria for race distinct

Biomes

Types

Distribution

Determinants of distributions

Human impacts on distributions

Biome- a type of ecosystem

Why does temperature and water availability vary around the planet?

Orbit= Seasons

An air mass moving towards the equator moves more slowly than earth's surface and is therefore deflated to the west

An airmass moving toward the poles moves faster than the earth's surface and is therefore deflated to the east.

During the day as warm air rises, cooler air rushes in from the ocean to replace it.

Density dependent: Per capita population growth rate depends on population density

Only density dependent processes can regulate population sizes

Regulation occurs only per capita birth rate, death rates, or both vary with population density.

Biological interactions are often density dependent e.g. competition, predation, parasitism

Abiotic factors are not generally density depend

Current human population is maintained at expense of costs to future

Depleting a "one time inheritance of natural capital".

Summary

- Species maintain populations only where niche requirements met
- Adaptations broaden niche boundaries
- Some potential habitats are uninhabited due to failure to disperse to those cites.
- Once a population reaches a new site it may grow, but will not grow indefinitely
- Population sizes tend to be regulated, but sometimes only loosely.

- The human population has grown dramatically as if not regulated.

Community Ecology

Outline:

- Types of interactions among Species
- Competition
- Predation
- Mutualism
- Coevolution

Species Diversity

How does species diversity affect ecosystem functioning?

Factors that reduce species diversity succession

Community

An assemblage of organisms living close enough together to have potential to interact.

Types of interspecific interactions

- Interspecific completions- > 2 species use same limiting resource, one or both suffer
- Predation (including parasitism): One individual benefits other suffers.
- Mutualism- both species benefit
- Commensalism- One species benefits, other is unaffected
- Coevolution: reciprocal evolution of > 2 species in response to each other

Fundamental vs Realized Niche

Fundamental niche- The set of conditions where a species could live in the absence of competitors and predators

Realized niche- The sets of conditions where a species actually does live in the presences of competitors.

Interspecific competitions and realized niches

Predation

Selection favors individuals that survive and reproduce selection also favors individuals that obtain sufficient resources thus almost all creatures are routinely at risk of predation or have effective defenses against predation.