EEB214 review notes

14 questions, 55 points to score.

1.identify the four areas that Darwin drew his evidence for evolution by natural selection from , and the two areas that he missed/didn't get to grips with. Also make sure you familiarise yourself with the case studies/examples that support these ideas.
2.something on conflict and cooperation and the rules/concepts that govern them.

LECTURE 1 WHY IS EVOLUTION UNDER DEBATE?

-The Scopes Trial (1925)
"The Trial of the Century"
• Clarence Darrow was permitted to call William Bryan to the stand as an 'expert of religion'.
• Bryan couldn't perform and was seen to be largely ignorant of many fundamental Christian concepts.
• But despite Darrow's expert questioning, Scopes was ultimately found guilty, and fined.

-FACTS:
• The last of the anti-evolution state laws were finally dissolved in 1968, when the United States Supreme Court ruled that banning the teaching of evolution on religious grounds violated the First Amendment (Epperson vs. Arkansas (1968))
• MacLean vs. Arkansas (1982) saw the Creation Science movement arguing for balanced treatment to "creation-science" and "evolutionscience"; they lost.
• Edwards vs. Aguillard (1987) [wiggle room]… "if a valid scientific alternative to evolution did arise, then it could be taught alongside evolution"

-intelligent design
argues that certain aspects of life are too complex to have evolved naturally, instead, there must be a form of intelligence, a "designer," to provide guidance along the way.

-of pandas and people
Why is this happening now?

Why do men have nipples?
• Useful to men therefore favoured by natural selection
• Useful to women and because men and women share many genes men have them too

LECTURE 2 DARWIN'S IDEAS

John Edmonston, a freed slave from the West Indies, tutored Darwin on how to prepare bird sins. And so after a series of serious family discussions, Charles Darwin was redirected toward the church… Darwin saw variation among beetles, and this must have led him to question what drove that variation…it is but a short step in logic to start thinking about evolutionary change.

** – **Darwin's Dangerous Idea**
William Paley:
• The English philosopher most famously explained that if you found a watch on the ground you would recognise it as the work of a watchmaker.
• Ergo, well-adapted organisms and their intricate features surely implied a conscious, celestial designer -God.
• He was one of a group of 'natural theologians' who sought to know God by studying, cataloguing and describing God's creation - all plants and animals.
Adam Sedgwick, professor of geology
John Henslow, professor of botany
William Whewell ('Hule'), professor of mineralogy

The Beagle Voyage (1831 - 1836)
Charles Lyell:
Lyell's ideas (which Whewell called "uniformitarianism" were that the forces that we see around us today -- wind, rain, deposition , erosion, earthquakes -- caused the geological features of the earth. It can be considered a steady state view of the Earth's history. And that the Earth's surface slips around, so land becomes water and water becomes land. Therefore explaining the existence of tropical looking fossil palms in Paris.

Darwin, never the great mariner

****Darwin began to believe in the idea of evolution (transmutation)** What is the mechanism?**
William Whewell ('Hule'), professor of mineralogy:
Hypothetico-deductive system - holds that one starts with a number of premises and then deduces everything from them.
So for Newton you start with the laws of motion and of gravitational attraction, and then you deduce Kepler's laws.
Whewell was a rationalist - he constructed the idea of the
'Consilience of Inductions' - the reconsilation of inductions,
which are logical arguments based on observations.
Herschel an empiricist - and liked to see for himself
e.g. think of a murder
Darwin took a very Hershelian approach to find his cause for
the change in animals and plants through time by looking to
artificial selection in domestic animals.
AND a Whewellian approach in incorporating the ideas of Thomas Robert Malthus's Essay on the Principle of Population.
(Malthus observes that human populations can increase in size faster than does their ability to produce food, causing a struggle for existence.)

by 1838 Darwin combined artificial selection with the idea of the struggle for existence to find his cause for the changes over time in animals and plants.
But a small leap in logic to go from assuming some form of natural selection happening in the wild, where struggle for existence means only some survive. Natural selection was
the mechanism that causes evolution.

****Artificial selection + struggle for existence = cause of change in natural world****

****Evolution by means of natural selection****
Life on Earth evolved gradually beginning with one primitive species that lived billions of years ago; this life branched our over time, splitting and throwing off many new and diverse species; the mechanism for most of evolutionary change is natural selection.

- Evolution – simply means that a species undergoes heritable change over time.

• Natural Selection- if individuals within a species differ from one another, and some of differences affect an individual's ability to survive and reproduce, then they will leave more descendents, and ultimately increase in frequency in the population.

• Common Ancestry - if we look back in time we (say using the fossil record) we will find that the animals and plants at the tips -- the descendants lineage -- fuse at their ancestors

• Gradualism - it takes many generations to produce substantial evolutionary change, true
some are quick (think drug resistance), but the really big changes (think the emergence of birds from reptiles), well, it takes some time.

• Speciation -a splitting process in which a new species is formed from an initial one.

LECTURE 3 EVIDENCE FOR EVOLUTION: WRITTEN IN THE ROCKS

The fossil record

Fossilisation

• Fossilisation requires that animals and plants must die, preferably somewhere near water, sink to the bottom, and get quickly covered in sediments.
• Once buried, soft tissues (usually) decays, and the hard parts are filled in with sediments that crystallise - soft bodied animals don't fossilise well, therefore early life forms are little understood, bones and teeth are abundant, as are shells and insects.
• Fossils have to survive folding, heating and crushing forces.
• Exposure to the elements, and if they/we are lucky, very lucky, someone stumbles over them.

What would evidence for evolution in the fossil record look like?

If life gets more complex through evolutionary time, the simplest should be at the bottom. TRUE
Animals in adjacent layers are more similar to each other than animals further apart, and you should see gradual change as you move up. TRUE

If species are related to one another then you would expect to see evidence of their ancestors in the rocks. YEP.

-But can you think of any intermediate forms, where a small wing might have been better than none?
-Gliding has evolved independently in marsupials, mammals and lizards
• Since 19th century palaeontologists have marvelled at the similarity between theropod dinosaurs and birds.
Are there any transitional forms?
• 200 million years ago theropods roamed Earth, 70 million years ago birds appear.

Archaeopteryx "ancient wing"

- Reptilian-like features: jaw with teeth, long bony tail, claws, neck attached from behind
- Bird-like features: feathers and opposable toes

Sinornithosaurus millenii - whose body was covered in tiny feathers, so small they couldn't have helped it fly.

Microraptor gui - who had feathers extending from its wings and legs, and probably used them to glide.

Mei long - "soundly sleep dinosaur" is a theropod dinosaur fossilised when it was sleeping

So far…

- Non-flying feathered dinosaurs date to 135-110 million years ago, while Archaeopteryx is from 145 million years ago.
- Therefore these animals were not Archaeopteryx's direct descendants, but they could be cousins.
- This generates a testable prediction that we will find older specimens.

- **Feathers evolved before flight, so what were they used for?**
- **How did flight evolve in theropods?**

"ground-up" OR "tree-down"?

- Evidence exists that therapods lived partly in trees, feathery forearms would help these animals cushion a fall or glide to evade predators.
- Evidence from today's birds that dinosaurs could have used rudimentary wings to help them run uphill to evade predators.

(Chukar birds can run up vertical walls propelled by their wings)

If species are related to one another then you would expect to see evidence of their ancestors in the rocks. YEP.

- We see progression from tiny theropods with light covering of feathers to dinosaurs that glided (the deepest/oldest are least birdlife)
- We see refashioning of old features (hands and fingers and skin) into new ones (fingerless wings and feathers)

LECTURE 4 EVIDENCE FOR EVOLUTION: VESTIGIAL TRAITS, ATAVISMS AND BAD DESIGNS

How can we explain the existence of ear wiggling and goose-bumping?

A trait is vestigial not because it is functionless, but because it no longer performs the function for which it originally evolved

e.g. the wings of an ostrich have a function, but they originally evolved for flight. Look at the bones in the wing, they are the same as those in the wings of birds that fly.

Darwin noted: "an organ rendered, during changed habits of life, useless or injurious for one purpose, might easily be modified and used for another purpose"

Vestigial traits demand us to ask:

- Why did it lose its function? (Hint: Islands)
- Why hasn't it disappeared completely? Co-opted?

Could natural selection favour winglessness?(recall natural selection)

other examples:
firefly
inflamed appendix
mole rats
"• Why did it lose its function?"
"• Why hasn't it disappeared completely?"

The coccyx
(Atavism) Coccygeal projection

What do these animals have in common? They are all cousins
Whales' vestigial hindlimbs
• Whales likely evolved from a wolf-sized creature called Pakicetus, that lived around 52 million years ago.
• We know Pakicetus was aquatic because its bones were denser to stop it bobbing around in water.
• Very quickly (by 50 mya) Ambulocetus ("walking-whale") appeared.
• The Rodhocetus whose nostrils had moved backwards to help it breath in water.
• All in all the evolution of whales from land to being fully aquatic took only 10 million years

Karl Ernst von Baer:

• von Baer studied baby chicks and compared them with the embryos of other vertebrates, he found that they looked very alike.

From his studies he came up with a few ideas…
• The general features of a large group of animals appear earlier in development than do the specialised features of a smaller group.
• Less general characters develop from the more general, until finally the most specialised appear.
• Higher animals (we would interpret this as animals who have evolved more specialised traits) go through what looks like earlier stages of other lower animals, but the “lower fish” stick with these simply slits and convert them to gills.

Do von Baer’s ideas make sense in the light of evolution?
• In sharks (which are fish) the branchial slits become the jaw and gills simply by enlarging.
• In humans the branchial slits become our inner ear, jaw and throat (tonsils, larynx, nerves.
• Both fish and mammals have a salt problem, fish resolve it with gills, we resolve it with the parathyroid gland.
• The gills and parathyroid gland are derived from the same tissues, the branchial slits..

Darwin recognised that it wasn’t from a shared experience:
“The points of structure, in which the embryos of widely different animals of the same class resemble each other, often have no direct relation to their conditions of existence. We cannot, for instance, suppose that in the embryos of the vertebrata the peculiar loop-like course of the arteries near the branchial slits are related to similar conditions, in the young mammal which is nourished in the womb of its mother, in the egg of the bird which is hatched in a nest, and in the spawn of a frog under water.”

Understanding this requires that we recognise that one species evolves from another. For example, all tetrapods (fourfooted)

- including those that have since stood on two - have evolved from fish.

If we all evolved from a common ancestor then if is not surprising that we all have a similar body plan.… because we have inherited our developmental programme from our ancestors.

Changes to this developmental plan (as new structure evolve) are best done later in development because those done early are more likely to have major effects, which will probably have negative consequences for the animal.

Ernst Haeckel "Ontogeny recapitulates phylogeny":
However, this idea has its problems:
• Claimed embryonic stages look like adults of their ancestors, they don't they look like the embryos of their ancestors
• Not every feature of the ancestor appears in the embryonic stage
• There is variation in how much embryos of different species resemble their ancestors
• Haeckel adjusted his drawings to make embryos look more
similar than they really were But just because he massaged his data a little doesn't mean that the concept is totally wrong.

other examples:
-After 6 months human and monkey embryos get completely covered in hair, in humans it is called Lanugo; but humans shed it before birth, so do whales.
-Human kidneys go through 3 different forms and first two are discarded, and look like jawless fish and reptiles.
-Baleen whale embryos produce teeth that are reabsorbed before forming the baleens

Bad designs

New parts evolve from old ones, and so we should expect compromise

• Testes migrate into the scrotum at 4-6 months old through the inguinal canal, leaving men vulnerable to hernias.
• Testes have evolved from fish gonads, which are internal, descending out of the body was a later adjustment in evolutionary time.

Summary: The evidence for evolution in embryology and developmental biology
• New structures evolve from old ones and give clues to our shared ancestry and is evidence for gradualism
• Most creatures are far from perfectly evolved, there are many examples of vestigial traits e.g redundant legs and tails, and nefarious appendices
• And many examples of 'bad designs', where evolution has tacked on an adjustment

LECTURE 5 EVIDENCE FOR EVOLUTION: BIOGEOGRAPHY

Same environments but different plants and animals:
On a large scale, S.America, Africa and Australia all contain some regions with very similar climate but there is little or no overlap in the organisms found in a deserts or tropical forest in Australia when compared to Africa or S. America.

But then there are other cases where similar looking but genetically different plants and animals living in similar environments.
You could be mistaken and think these are all similar plants but they are very distinct: succulents come from Asia and Africa, while cacti from North and South America but all exist in deserts.

Transplantation seems to work

Why are nearly all of Australia's native mammals marsupials, while placental mammals dominate the rest of the world?

Why do placental mammals and marsupials (and succulents and cacti) look and act so much alike?

CONVERGENT EVOLUTION: Species that live in similar environments will experience similar selection pressures, so they may evolve similar adaptations.

Think about coat colour in cold environments.

How did marsupials and placental mammals end up in different places?
-Earliest marsupial fossils (from 8 million years ago) were not found in Australia but North America.
-Fossils of Marsupials have been found in Antarctica

Why are nearly all of Australia's native mammals marsupials, while placental mammals dominate the rest?

Other patterns that need explaining:
Glossopteris
• Some of Darwin's ideas:
• **transport by bird**
• **floating seeds**
• **land bridges**
What Darwin was missing: **continent drift**

-evidence from islands

Why are some animals missing off islands?
Why do islands have lots of ecologically diverse forms of animals?
Why do island animals and plants resemble those of close mainland?

The inhabitants of oceanic islands descended from earlier species that colonised the islands, usually from nearby continents, in rare events of long-distance dispersal. Open niches, and a lack of predators on islands lead to 'adaptive radiations', like we see in the finches.

- Adaptive radiations: begin with a recent single ancestor, that splits into different morphological and physiological traits with which they can exploit a range of divergent environments.
- These finches descended from one type of ancestor and then, due to isolation and through chance, different climates and natural forces such as food availability and type, they evolved into many different types of finches.
- Robinson Crusoe Effect - time and chance determine what might get marooned.
- [**Evolution by Natural Selection from Common Ancestor + chance = speciation**]

LECTURE 6 EVIDENCE FOR EVOLUTION: ARTIFICIAL AND NATURAL SELECTION

What is the difference between artificial selection and natural selection?
Under artificial selection humans are determining who reproduces, while under natural selection, the environment is.

what is the evidence that natural selection operates in nature?
e.g.:The "oldfield" mice vary in colour but are generally darker
than those "beach mice" that invaded the barrier islands off the Gulf Coast of Alabama and northern Florida and the coastal habitat on the Atlantic seaboard.

How do we know that their coat colour has changed in response to natural selection?

Kaufman's (gruesome) Experiment
• Created large enclosures with light and dark soil.
• Into them he released light and dark mice.
• And finally he added an owl, a hungry one.
• The mice with the more conspicuous coats were picked off most readily, the more camouflaged mice survive better.

How do we know that the predators were being selective based on coat colour?
control soem variables.

Natural selection, acting on coat colour, has simply changed the genetic composition of a population, increasing the proportion of genetic variants (the light-colour genes) that enhance survival and reproduction.
what do we need for natural selection to act?
Three things are required for NS to work (create an adaptation):
1. Variation
2. Heritability
3. Selection must act to affect an individual's probability to leave offspring.

We know that the oldfield mice vary in coat colour
Where does this variation come from?
Mutations - accidental changes in the sequences of DNA that usually occur as errors when the DNA is copied during cell division.
The mutations occur at random.

If you take pregnant females out of the wild and let them reproduce under lab conditions. You see that coat colour is heritable

genetic variation must affect an individual's probability of
leaving offspring
• Think about the Kaufman experiments.
• Evolution by selection is then a combination of randomness and lawfulness. The occurrence of mutations that generate an array of genetic variants, both good and bad; and then the lawful process of natural selection that orders this variation, keeping the good and winnowing the bad.
• Richard Dawkins definition of natural selection is "the non-random survival of random variants".

Darwin thought that natural selection acted extremely slowly over many generations, altering populations over thousands and millions of years.
He was wrong.
We can see natural selection acting not only in our lifetime, but within a single experiment.

Tales of evolution from the common gut bacteria
(from microbiologist Richard Lenski, MSU)

Three things are required for NS to work (create an adaptation):
1. Variation
2. Heritability
3. Selection must act to affect an individual's probability to leave offspring.

• Eventually another mutation occurred that allowed the bacteria to produce more of the enzyme that had newly acquired the ability to break down lactose
• And then other that allowed the bacteria to pump more lactose into them cell, so it could eat faster.

• Evolution of complexity?

LECTURE 7 WHAT DARWIN MISSED -- UNIT OF HERITABILITY_1

gemmule(pangenes) theory:
Gemmules were imagined particles of inheritance proposed by Charles Darwin as part of his Pangenesis theory. This appeared in his book The Variation of Animals and Plants under Domestication, published in 1868, nine years after the publication of his famous book On the Origin of Species. Gemmules, also called plastitudes or pangenes, were assumed to be shed by the organs of the body and carried in the bloodstream to the reproductive organs where they accumulated in the germ cells or gametes. They thus provided a possible mechanism for the inheritance of acquired characteristics, as proposed by Jean-Baptiste Lamarck, which Darwin believed to be a cause of the observed variation in living organisms.
This was prior to Gregor Mendel's discovery of the particulate nature of inheritance becoming common knowledge among biologists after their rediscovery in 1900.

-DOES pangensis allow evolution of characteristics?
-individual gemmules did not contain a complete microscopic blueprint for an entire creature.
-Darwin proposed that some limited effects from the environment might become embedded in an individual's constitution and this be liable to be transmitted, via the gemmules, to the offspring.

Jean-Baptiste Lamarck
• Lamarck noted that the sons of blacksmiths have larger, stronger arms than the sons of weavers - he called this the Inheritance of Acquired Characteristics.
• The idea suggests that blacksmiths exercised their arm muscles as they worked and this caused growth of the muscles. Having acquired larger arm muscles the blacksmiths passed that trait onto their sons.

• Weavers did very little heavy work with their arms (certainly not as much as blacksmiths) so they failed to develop muscular arms and their sons inherited the same unremarkable arms as their fathers.

Francis Galton's Experiments: 杂交兔

Blending inheritance
-The idea of blending inheritance simply proposes that when make and female sex cells, the gametes combine, the characteristics combine.

e.g.the height of a person, short and tall parent

-problems:
1.how can distinct former characters -> later generations?
2.how can varieties favoured by natural selection be preserved and not diluted to oblivion?

William Bateson
Mendel's work was published in 1866 and ignored for 34 years until three botanists, Huge de Vries, Carl Correns, and Erich Tschermak independently rediscovered it.
• Bateson rediscovered Mendel's work in 1900.
• Today's reading The Monk's Bulldog is a chapter from 'A Monk and Two Peas' by Robin Marantz Henig

Mendel's Experiments
Mendel made two unique proposals:
• Each elemente has two possible expressions in the same individual (today we call these alleles) - one dominant, one recessive = Principle of Segregation

Most multicellular organisms have two sets of chromosomes, that is, they are diploid. Diploid organisms have one copy of each gene (and therefore one allele) on each chromosome.
If both alleles are the same, they are homozygotes. If the alleles are different, they are heterozygotes.

Principle of Segregation - Cross 1
Mendel first crossed two different true breeding strains together, one that produced round peas and one that produced wrinkly peas. We'll use letters to represent alleles. Capital "A" will represent the round pea allele and lowercase "a" will represent the wrinkly pea allele. When Mendel looked at the results of his first mating (F1), he saw that all of the offspring had round seeds.

1. Begin by writing the parent's genotype along the top and side of the Punnet Square.
2. Next, fill in each cell with two allele, one from the parent along the top and one from the parent along the side.
3. The letters in the middle show you all possible combinations of alleles that can happen from mating these two genotypes.
In this case, all offspring have the same genotype and phenotype.

"Genotype" is an organism's full hereditary information, even if not expressed. "Phenotype" is an organism's actual observed properties, such as morphology, development, or behavior.

Principle of Segregation - Cross 2
• For the second generation, Mendel mated the heterozygous offspring from the first generation together.

• When Mendel looked at the offspring from this mating, he noticed that 1/4 of the children plants had wrinkly seeds.
• Why did this happen?
• Let's once again use a Punnett Square to answer these questions and understand what's happening to the alleles in this crossing.
• By looking at the Punnett Square, we see that there are three possible genotypes that could result from this crossing: AA, Aa, aa.
• The genotypes AA and Aa will result in the round pea phenotype because A is dominant. Only aa will produce the green pea phenotype.

• Inherited characters do not blend, but are transmitted in
discrete parcels called Elementes (today we call these genes)
= Principle of Independent Assortment

Principle of Independent Assortment
• Alleles for one trait pass simultaneously to offspring independently, without affecting the segregation of alleles for another trait.

RrYy (Round/Yellow) x RRyy (Round/green)

Other Mendelian traits?
Regular thumb vs Hitchhiker's thumb
free earlobe vs attached earlobe

Gene pool
• there are not just two alleles, but multiple alleles
e.g. blood groups (A/A, A/O, B/B, B/O, A/B or O/O), so each individual can only have two alleles, but there are many combinations in the population

Where does this variation come from/ what creates a new allele?

Mutation

Viewed at the population level, we can track evolution by tracking the fate of alleles in the gene pool across generations e.g. tracked changes in allele frequencies in mosquitoes in response to pesticide spraying
And we can look for evidence of natural selection in the genome, and find regions that show positive selection.

Pale advantage
• VD, the “sunshine vitamin” is a prohormone that regulating the concentration of calcium and phosphate in the bloodstream and promoting the healthy growth and remodeling of bone.

Cystic fibrosis

Why does the mutation persist?
• "People with only one copy of the mutated gene apparently gain protection from infection by the bacterium that causes typhoid,” says Gerald Pier, professor of medicine at Harvard Medical School.

• Typhoid fever, also known as Typhoid,[1] is a common worldwide bacterial disease, transmitted by the ingestion of food or water contaminated with the feces of an infected person, which contain the bacterium Salmonella enterica.
• Another suggestion is that carrying one copy of the gene gave you resistance to cholera.

Evolution is when species undergo GENETIC change over time
Evolution is change in allele frequency through time

LECTURE 9 SPECIATION

For most of The Origin of Species Darwin concentrates on how and why organisms change over time, but really fails to explain how the continuous process of evolution produces discrete groups of species. This finding convinced Mayr that species were not arbitrary groupings but objective facts.

How have biologists traditionally told species apart?

Taxonomic Hierarchy:
- Kingdom (animals, plants, fungi, protisa, bacteria, archaea)
- Phylum (chordata, arthropoda, annelida, mollusca)
- Class (mammalia, reptilia, aves, insecta, arachnid, crustacean)
- Order (carnivora, primates, artiodactyla, lepidoptera, hymenoptera)
- Family (felidae, hominidae, rodentia, apidae)
- Genus (Felis, Homo, Ratus, Apis)
- Species (catus, sapiens, ratus, mellifera)

BUT
Species are sometimes difficult to tell apart.

Others look different but are all one species.

At what point are differences between populations large enough to make us call them different species? When you ponder variation, you arrive at the notion that species are not distinct because they look different but because there are barriers between them the prevent interbreeding.

The Species Concept
“Species are groups of actually or potentially interbreeding populations, which are reproductively isolated from other such
groups”
– Ernst Mayr’s 1942 Biological Species Concept

Reproductively isolated simple means that different species
have differences in appearance, breeding or physiology that
prevent them from successfully interbreeding.

Barriers to Gene Flow
-Pre-mating:
->Geographic Isolation (• Different places)
->Ecological Isolation (• Different habitats• Specialised pollinators • Mating seasons differ)
->Behavioural Isolation (• Mating rituals)

->Post-mating/Pre-zygotic:
->Mechanical Isolation (• No gametes transferred)
->Gametic Isolation (• Pollen competition • Gametes don’t fuse)

->Post-zygotic:

->Intrinsic incompatibilities (• Developmental Problems • Hybrid Sterility)
->Extrinsic Selection (• Hybrids not competitive • Low fitness)

e.g.: Geeps, mules and ligers

But how do species arise?
1) Allopatric Speciation
• Evolution of isolation barriers due to geographic or habitat separation
• Populations Isolated - gene flow greatly reduced or absent
• Populations diverge by drift and selection to different environments

e.g.: salamenders
• Ensatina eschscholtzii
• Southward migration
• Population went to either side of the valley
• Adjacent populations hybridize
• Populations cannot interbreed at other end

2) Peripatric / Founder effects
• Migration of a few individuals
• Isolated smaller populations – gene flow reduced
• Strong effects of founder effects

3) Sympatric Speciation
• Isolating barriers to gene flow arise WITHIN a randomly mating population

• Divergent selection for different resources or microhabitats
• Selection then favours alleles that cause non-random mating

Adaptive Radiation
e.g. African cichlids
(300 species in ~200,000 years)
• Adaptive ecological divergence in microhabitat
• Selection for feeding morphologies

• Directional Selection (Competitive Release)

Speciation by hybridisation
• Could the many species have been produced by hybridization?
• Lonely H.cydno flit across the mountains and mates with H.melpomene to produce a hybrid.
• The hybrid facies other hybrids more than the parental types, and perhaps a new species is born.

Lecture 10: Sex, and how it drives evolution

Traits that differ between males and females are call sexual dimorphisms

RECAP: Fitness is a measure of the ability of an individual's ability to survive and reproduce relative to other individuals in the population.

DARWIN THOUGHT THAT PERHAPS THERE IS A TRADE-OFF BETWEEN SURVIVAL AND REPRODUCTION

Selection could be optimising your chance of reproducing at the expense of your survival, Darwin termed this Sexual Selection.

Sexually selected traits evolve if they more than offset the male's diminished survival with an increase in his reproduction…

Sexual selection comes in two forms:
Direct competition between males for access to females
(satin bowerbirds collect blue, spotted, collect green; competition with other males to attract the choosy females)

And competition doesn't stop once you've mated.
All these adaptations have evolved because males are competing for females

Why is it that males are competing for access to females and not the other way around? (Why are females generally the choosy one?)
In more than 90% of mammals, male's only investment in offspring is his sperm.
This differential in investment leads to a conflict….
In males, selection favours genes that make them promiscuous.
Females, because of their higher investment in eggs and offspring, take the tactic of being picky, trying to choose the best possible father to fertilise their limited eggs.

And some cheat… Phalarope, Seahorses, Pipefish

There are some cases where there is no competition because both sexes are monogamous…but it is rare.
Splendid fairy wren – mates for life, but then why the sexual dimorphism?

Females mate more with males outside their social bond.
In birds where 90% of birds pair monogamously, it turns out that three quarters of them mate outside their couplings.

But what is the female really choosing?
-Direct benefits - picking males that will help her raise many, health young
An example of an direct benefit:
HOUSE FINCH
Researchers found that some populations males vary in colour, and wanted to see if redness was associated with parental care.
By painting yellower males, Hill showed that brighter, redder males had more matings.

-Indirect benefits - picking males who have better genes
An example of an indirect benefit:
FROG
• Researchers took egg from the females and fertilised half with long-calling male sperm and half with short.
• Offspring from long-callers survived better and grew faster.

Lecture 11: Cooperation and conflict

why animals are nice to each other?
Why Belding's ground squirrels alarm call? (caller more dangerous)

Why are ground squirrels behaving altruistically?
Although alarm calling reduces its own relative chances of successful reproduction, it enhances the relative chance of others in its group to survive and reproduce successfully.

V. C. Wynne Edwards - Group Selection
His logic goes like this:
seldom in nature do we see animal populations actually outstripping their resources nor do we see a huge amount of disease and death (which could be the mechanisms of controlling numbers)
so -> therefore animal populations must be self regulating

How do animals self-regulate the numbers in their populations?
V.C.WE:
• Only dominant males mate, while lower males don't, self-limiting the size of the population
• Animals on territories breed while those without territories (and therefore resources) don't

Let's imagine what would happen to a cheater under this explanation of altruism…
Who wins in an evolutionary sense in this situation?

Wynne Edwards definition of group selection = WRONG

• Altruistic behaviour is a behaviour that reduces its owners
fitness while increasing the fitness of another
• Selfish behaviour is the opposite, gain for the giver at the
expense of others What are the alternatives for why altruistic behaviour persists?

Inclusive fitness
They proposed that an individual's total fitness can be viewed as the sum of its direct fitness, which is the number of viable offspring that it produces, and its indirect fitness, which is the incremental effect that the individual's behaviour has on the (direct) fitness of its genetic relatives.
Direct fitness + indirect fitness = inclusive fitness

Coefficient of relatedness

Inclusive fitness theory has played a prominent role in understanding the transition from solitary to group living
…showed how it could explain the behaviour of ants and bees,
whose curious pattern of reproduction means that females are
more closely related to their sisters than to their offspring.

Eusociality is often characterised by…
• Reproductive division of labour - only a fraction of the population is reproducing
• Cooperative rearing - individuals, not just the parents, rear young
• Overlapping generations - members of different generations
live and work together.

In Hymenopterans (ants, bees and wasps) eusociality is thought to have evolved at least nine separate times. Why?

What gives you higher inclusive fitness, helping your mum raise your sisters or raising your own offspring?
Sister to sister are related by 0.75
Female to offspring are related by 0.5
Sister to brother by 0.25
Females brood, while males don't

Haplodiploidy alone doesn't explain everything

Long-tailed tits

• In February–March, all members of the winter flock will pair and attempt to nest
• Pairs whose nests fail have three choices: try again, abandon nesting for the season or abandon nesting for the season and help at a neighbouring nest.
• It has been shown that failed pairs split and help at the nests of relatives (recognition being established vocally)
• The helped nests have greater success due to higher provisioning rates and better nest defence

But there is cooperation in many species which do not have these patterns of relatedness; also between animals which are not closely related, nor even members of the same species.

Reciprocal altruism
In 1971, Robert Trivers said that self-sacrifice could be understood as self-interest providing there was a chance the beneficiary would repay the deed in the future.

The Prisoners' Dilemma
• Both cooperate, each prisoner receives 1 year (R, the reward for mutual cooperation)
• If both defect, each prisoner receives 5 years (P, is the punishment for mutual defection)
• If prisoner A testifies, but B cooperates, prisoner A gets 0 years (T is the temptation to testify), and B gets 20 years (S, suckers payoff)
• As long as $T > R > P > S$, then no one will choose the cooperate.

But what if the game is played repeatedly?
• It seems when it is uncertain how many times the game will be played, individual players are more likely to cooperate in the hope that they will encourage cooperation in return - tit-for-tat model of cooperative behaviour.

Mobbing Behaviour - when a group of genetically unrelated but closely located individuals join together to drive away a much larger predator.
one hour later, after box B birds had been released…

This experiment demonstrates a simple tit-for-tat behaviour where defectors are punished for their lack of assistance, and cooperators are rewarded.
But reciprocal altruism can only exist under very specific social circumstances where the animals involved interact repeatedly.

Conflict
-Conflict among nonkin (aggressive encounters)
-Conflict over parental investment
• Trivers suggested that the decisions about how much to invest in a offspring are affected by how much energy the parent has available to help current offspring, and by how many offspring the parent is likely to have in the future.
• Investment in current offspring hampers investment in future offspring.
• Because offspring are related to their future siblings by 0.5 but to themselves by 1 (they contain 100% of their own genes), they therefore fight for more care at the expense of the care to their future siblings
• This creates a conflict of interest between offspring and parent.
-Sexual conflict