Evolution of Sex, Part 1.

Biology of Sex

No area of evolutionary biology offers a more fascinating mixture of strange phenomena ... than the evolution of sex ... (Stearns, 1987)
Why does sexual reproduction exist?
Why has it persisted for so long?
What are the benefits/disadvantages of sexual vs asexual reproduction?
Why are there two biological sexes (male/female)?
Is sexual reproduction cooperative or competitive?
Who benefits most from sex: males or females?
Would humans exist in a world without sexual reproduction?

Reading Assignments (Online Syllabus):

2. *The Trouble With Sex*
3. *Battle of the Sexes Pgs 13 - 18*
4. *Why the Y?*
5. *Male Sex Chromosome to Stick Around*
6. *Bowerbirds*
7. *Understanding Evolution*
8. *Rediscovering Biology: Sex & Gender Pgs 1 – 4*
Meaning of Sex:

- From Latin “secare” = means to cut or divide something that was once whole.

- Modern term for sex: “Syngamy” = fertilization, or the union of genetic material (eggs & sperm) to produce offspring.

Ques: Like male and female?

Did distinct male and female of species always exist??

From biological standpoint the function of life is to survive long enough to reproduce & pass on genes.

> To reach this goal need to
  - increase chances of reproducing
  - have increased survival of offspring.

Collectively this is called “Evolutionary Fitness” = the most evolutionarily “fit” individual is one that produces the most surviving offspring in its lifetime.

“The egg is the hen’s way of making more hens.” (Samuel Butler)
Reproduction is the name of the game, and sex is the way we do it.

Evolution & Natural Selection – Pgs 183 187

**Evolution** = slow process by which inherited traits in a population change over long period of time. [Need *reproduction* for evolution to occur]

*Charles Darwin - 1859*
Evolution & Natural Selection – Pgs 183 187

**Evolution** = slow process by which inherited traits in a population change over long period of time.  
[Need reproduction for evolution to occur)

**Natural Selection**  
Theory refined by Charles Darwin.  
= individuals with traits that provide survival advantage in particular environment tend to survive long enough to reproduce & pass those traits on to offspring.

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**Example of Natural Selection - Darwin's Galapagos Finches**  
Different islands in the Galapagos have slightly different environments. Finches on diff. islands have slightly diff. physical traits (are diff. species), which evolved to exploit available resources. (Ex. diff. beak shapes and sizes)

- **Cactidea olivacea**  
  - Probing bill, insect eater  
  - Feeds in trees

- **Camarhynchus pallidus**  
  - Probing bill, insect eater  
  - Uses twig or cactus spine to probe insects from cactus

- **Camarhynchus heliobates**  
  - Grasping bill, insect eater  
  - Feeds in trees

- **Camarhynchus crassirostris**  
  - Crushing bill, cactus seed eater
Example of Natural Selection – Giraffe’s long neck

Natural Selection in action

Example of Natural Selection – Crypsis (camouflage)

Cryptic prey stay hidden from predators to avoid being eaten, or Cryptic predators hide from their prey in order to sneak up on them, or ambush them.
Example of Natural Selection – Industrial melanism of the Peppered moth.

Industrial melanism in the peppered moth, first noticed by English geneticist Henry Kettlewell. He observed that whereas in rural areas peppered moths were light in colour to camouflage them against the lichens, in industrial areas where the tree trunks were dirtied with soot, peppered moths were darker. Natural selection favoured the darker mutation in industrial areas because it offered better camouflage there, so it had become widespread, whereas in rural areas the darker mutant was highly visible against the lighter tree trunks and so was easy prey to insect feeders.

“Crypsis” = coloration and/or morphology of animals that makes them hidden (cryptic) in their environment & avoid being eaten.

Example of Natural Selection – Peacock???????
The flashy male Peacock was always a thorn in Darwin’s side.

This animal was definitely NOT CRYPTIC!
- Very visible means more visible to predators.
- Excessively long tail feathers are heavy and make flying difficult (more difficult to escape predators)

- This seems like a handicap. So ... WHY??

What could possibly make this handicap worthwhile?

The Handicap Principle
By Amotz Zahavi

"An individual with a well developed sexually selected character [such as a peacock's flashy tail] is an individual which has survived a test. A female which could discriminate between a male possessing a sexually selected character, from one without it, can discriminate between a male which has passed a test and one which has not been tested. Females which selected males with the most developed characters can be sure that they have selected from among the best genotypes of the male population." (Zahavi 1975)
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Source: https://en.wikipedia.org/wiki/Handicap_principle

The Handicap Principle: A male with a exaggerated sexually selected trait that has SURVIVED having that trait, despite the difficulties & dangers (its handicap) must be EXTREMELY FIT! Thus, be extremely attractive and chosen preferentially by females through sexual selection.

“Sexual Selection”
= a form of natural selection in which a trait is preserved in a population IF it is deemed attractive to opposite sex & provides more mating success (fitness). Then those traits get passed on.

Example: Peacock (dance video 0.41 min)
Sexual Selection & “Female Choice”

A very controversial topic in Darwin’s time was “Female Choice”.
*This did not set well with the Catholic church which viewed human females as entirely passive sexually and males do the choosing.*

**Female choice** = females choose to mate with male having most attractive traits.
- females bear most of cost of reproduction (especially mammals).
  - Pregnancy & birth are dangerous. Nursing is energetically expensive.
  - Offspring take time to become independent of mom.

- females want best genes for reproducing because ...
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> females want best genes for reproducing because ...

“Eggs are expensive while sperm is cheap.”

Example: Sexually mature human female can, at most, ovulate 500 eggs in her lifetime. Not all will be fertilized. Not all embryos make it to birth. Whereas sexually mature male can produce millions of sperm a day – 100 million in an ejaculate.

Result: Females are choosy

Example of Sexual Selection – Giraffe’s long neck

Necks for SEX!
Example of “Female Choice”

*Birds of paradise - males trying to be pretty*

Example of “Female Choice”

David Attenborough in *Planet Earth* series

**Superb Bird of Paradise video**
(~ 2min)

**Bulwers pheasasnt video** (3.24)

*Think humans are different??*
Think humans are different??

Nigerian Wodaabe men compete in “beauty pageants” to impress the ladies. 
Source: https://www.youtube.com/watch?v=tKAYsLE-wqo

Think humans are different??

Remember the 2013 VMA Show? 
(Miley Cyrus & Robin Thicke)

Think humans are different??
Still not convinced???

[This one’s a little crazy!]
Source: https://www.youtube.com/watch?v=oZ_pruSFioc

Example of “Female Choice”

Male Bowerbirds create elaborate nests, decorated with objects that females find attractive. If he can attract a female to his bower, the Bowerbird begins an intricate dance and song to entice female to mate with him. But the female decides whether it meets her standards.

See reading assign “Bowerbirds” (National Geographic)
**Female bower bird “fembots”** created by biologist Gail Patricelli Univ. of Maryland. The more the mechanical female bird crouched, the more frequently and intensely the male Bower bird displayed. Demonstrated that female behavior drives male’s behavior.

![Fembot with remote control](image1)

**“Female Choice” Experiments:**

1. **Tail Length Experiments:**
   with African Widow birds and Barn swallows

   ![Graph](image2)

   **Widow bird male has extremely long tail feathers.**

   **Researchers (Malte Anderson):**
   - Cut tail feathers and glued them on to birds producing varying lengths of tails.
   - Recorded female choice for these males having diff. tail lengths.

   **Results:** males with longest tails had greater mating success.
“Female Choice” Experiments:

2. Parasites & Plumage Experiments

- Birds lacking parasites tend to have better, brighter plumage & are more attractive to females. Have greater fitness.

- Birds with parasites had poorer, duller plumage & less attractive to females. Had lower fitness.

Sexual Selection & “Female Choice”

Why do male White Tail deer have antlers??

Disadvantages:
- Their big and conspicuous
- They are energetically expensive to grow/maintain
- They get caught in stuff

Advantages:
Signal to females: (handicap)
> I’ve survived despite these costs.
> I’ve got the energy reserves to grow these.
> I’ve got the stamina to carry these.
> I’ve got the best genes.

Also signal to rival males:
> same signals as above but for competition rather than sexual attraction.
A sexually selected male “handicap” is a careful balance of disadvantages and advantages.

- More advantage = greater fitness
- More disadvantage = greater chance of death & extinction.

“Runaway Selection” by Ronald Fisher

= sexual selection of handicap traits in males, by female choice, can lead to increasingly exaggerated (runaway) male traits that tip the scales towards more disadvantage.

Example: The Irish Elk

The Irish Elk – stood 7 ft at the shoulders with antlers that stretched 12 ft across and weighed nearly 90 lbs!

Disadvantages proved too great. It became extinct.

Sources:
http://en.wikipedia.org/wiki/Irish_elk
http://evolution.berkeley.edu/evosite/evo101/IIIIE3aRunawayselec2.shtml
Runaway Selection

Example: Widow birds and tail length

"... the process may run out of control, until the male trait becomes so exaggerated that it is disadvantageous. In other words, female preference, instead of survival advantage, may begin to drive the evolution of ever-longer tails, until males are encumbered by showy plumage that no longer helps them avoid predation."

Source: http://evolution.berkeley.edu/evosite/evo101/IIIE3aRunawaysele2.shtml

Runaway Selection – Male guppies & risky behavior

Reading assign. “Battle of the Sexes” Pgs 15 - 16

Example:

Trinidadian male guppies that display more boldness (approach predators) are chosen as mates by more females.

Risky behavior of bold male guppies pays off w/increased fitness.

But the males aren’t stupid! When no females are present they don’t go anywhere near a predator! They only display boldness when female guppies present.
Sexual Selection (by males) for traits in females

permanently enlarged breasts in women

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permanently enlarged breasts in women
Sexual Selection (by males) for traits in females

*permanently enlarged breasts in women*

Why??

**Signals:**
- Reproductive maturity
- Have enough fat stores in body
- Also “hides” female’s stage of reproduction. (Primates only develop breasts when pregnant & nursing. Mature human female — cannot always tell.)
What About Breast Size?

(Do bigger breast provide more milk?)

Marilyn Monroe

Miley Cyrus & Katy Perry

Nicki Minaj

What About Breast Size?

(Do bigger breasts provide more/better milk?)

Marilyn Monroe

GOT MILK?
What About Breast Size?

(Do bigger breasts provide more/better milk?)

No!
Fat content of breast varies, glandular content usually does not

Sexual Selection (by males) for traits in females

Adult female body shape due to fat deposits at puberty. Fat stores needed to fuel costs of pregnancy and lactation.
Need 7% body fat to menstruate
Need 22% body fat for pregnancy
What About Penis Size?

(Does size matter?)

Penis Size in Primates:

- Smallest penis
- Medium penis
- Biggest penis
What are you smiling about, Bob?
Review

Vocabulary!

Secare
Syngamy

Evolutionary fitness

Evolution (and under evolution, what is difference between Natural Selection and Sexual selection due to female choice?)

Natural selection examples: crypsis, giraffe’s neck, industrial melanism

The handicap principle by Amotz Zahavi.

Sexual selection examples: peacock’s tail, giraffe’s neck, birds of paradise, the Trinidadian guppy and “Bower birds, permanently enlarged breasts in adult women)

Know the 3 experiments demonstrating female choice:
1. Bower bird female “fembots”
2. Widow birds and barn swallows tail length experiment
3. Parasites and plumage experiment

Runaway selection by Ronald Fisher

Review

Reading assignments:

Bowerbirds
- Who is Brett Benz, and who (what) is “Donald”
- What does Polygynous mean?
- Who is Natalie Doerr? What birds does she study in Australia?
- What did Doerr discover about these birds, with respect to the types of things placed in their bower to please females, and theft and bower damage by rivals?

Understanding Evolution
- Read about natural selection, fitness based on how many surviving offspring you have, sexual selection with respect to female choice and male competition, adaptation examples of echolocation in bats, trees competing with toxins, and insect (katydid) mimicry (another word for crypsis), and how vestigial structures are not necessarily an example of adaptation.
Paragraph titled “Why Be Choosy” – read about tail feather length in barn swallows and female choice. What was the significance of long healthy tail feathers and incidence of parasites (lice)? (this overlaps with the Parasites and Plumage discussion in lecture.)

Amotz Zahavi suggests that females assess only traits in males that are “honest indicators” of fitness. These honest indicators are often a handicap, which only fit males can survive to be viewed as attractive to females. This female choice of males surviving a handicap as an honest indicator of fitness is known as the Handicap Principle.

How did the Trinidadian male guppies’ risky behavior and honest indicator of fitness and the handicap principle?

How did male guppies behave toward a potential predator when a female was present compared to when she was absent?

How did male guppy coloration (flashiness) correlate to their boldness & attractiveness to females?

Why would a female guppy prefer a flashier bold male than a dull and bold male? (Does being flashy AND bold carry increased risk (handicap) when around predators?)

What is Runaway Selection?
Let’s Play the Evolutionary Fitness Game:

Arnold

Evolutionary Fitness

“'I'll be back!"
Arnold

Evolutionary Fitness

THEN

NOW

“I’ll be back!”

“Oh, my back!”

The Evolutionary Fitness Game

How “fit” is Arnold?
How “fit” is Arnold?

4 kids
Fitness: high

The Evolutionary Fitness Game

Sylvester Stallone:
The Evolutionary Fitness Game

Sylvester Stallone:

4 kids

Fitness: high

The Evolutionary Fitness Game

Tom Cruise:
The Evolutionary Fitness Game

Tom Cruise:

- **1 kids**
- **Fitness:** below average
  (other 2 with Kidman were adopted)

The Evolutionary Fitness Game

L.L. Cool J:
The Evolutionary Fitness Game

L.L. Cool J:

4 kids
Fitness: high

The Evolutionary Fitness Game

J Lo:
The Evolutionary Fitness Game

J Lo:
- **2 kids**
- **Fitness:** average

The Evolutionary Fitness Game

Denzel Washington:
The Evolutionary Fitness Game

Denzel Washington:

4 kids
Fitness: high

The Evolutionary Fitness Game

Johnny Depp:
The Evolutionary Fitness Game

Johnny Depp:

2 kids
Fitness: average

The Evolutionary Fitness Game

Brad Pitt:
The Evolutionary Fitness Game

Brad Pitt:

3 kids

Fitness: above average
(other 3 are adopted)

The Evolutionary Fitness Game

Vin Diesel:
The Evolutionary Fitness Game

Vin Diesel:

2 kids
Fitness: average

The Evolutionary Fitness Game

Halle Berry:
The Evolutionary Fitness Game

Halle Berry:

2 kid
Fitness: average

The Evolutionary Fitness Game

Samuel Jackson:
The Evolutionary Fitness Game

Samuel Jackson:

1 kid
Fitness: below average

The Evolutionary Fitness Game

Matthew McConaughey:
The Evolutionary Fitness Game

Matthew McConaughey:

2 kids
Fitness: average

The Evolutionary Fitness Game

Beyonce & Jay-Z:
The Evolutionary Fitness Game

Beyonce & Jay-Z:

3 kids

Fitness: above average

The Evolutionary Fitness Game

Hugh Jackman:
The Evolutionary Fitness Game

Hugh Jackman:

0 kids
Fitness: Loser!
(adopted 2 kids)

The Evolutionary Fitness Game

Chris Pine:
The Evolutionary Fitness Game

Chris Pine:

0 kids
Fitness: Loser

The Evolutionary Fitness Game

Scarlett Johansson:
The Evolutionary Fitness Game

Scarlett Johansson:

1 kid
Fitness: below average

The Evolutionary Fitness Game

Cameron Diaz:
The Evolutionary Fitness Game

Cameron Diaz:

0 kids
Fitness: Loser!

The Evolutionary Fitness Game

Chadwick Boseman:
The Evolutionary Fitness Game

Chadwick Boseman:

0 kids

Fitness: Loser!

The Evolutionary Fitness Game

Jason Momoa:
The Evolutionary Fitness Game

Jason Momoa:

3 kids

Fitness: above average

The Evolutionary Fitness Game

Charles Darwin:
The Evolutionary Fitness Game

Charles Darwin:

10 kids
Fitness: Hot Stuff!

(remember there was no T.V.)

The Evolutionary Fitness Game

Michelle and Jim Bob Duggar:
The Evolutionary Fitness Game

Michelle and Jim Bob Duggar:

20 kids
Fitness: Are you nuts?