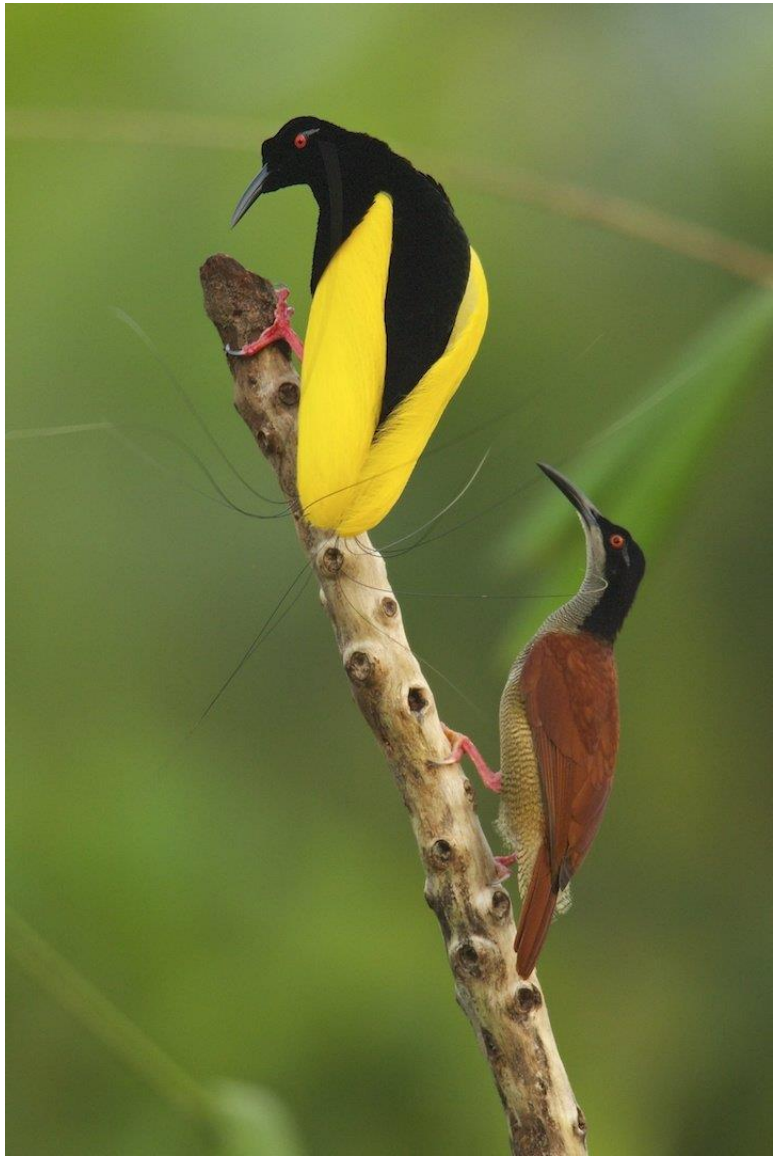
Can you find the hidden snowman?

Today's Class – Sexual Selection – continued



https://phys.org/news/2018-11-birds-of-paradise-good.html

Welcome back!! iClicker Question

On a scale of Loki Odinson – how much are you enjoying the snow?

Paid genomics internship – Indigenous People (Edmonton)

An opportunity for a 1 week all-expenses-paid Genomics internship, to pass on to our Indigenous students (including college/uni undergrads, grad students, and postdocs). This summer it'll be held in Edmonton. Applications due by end of March.

INDIGENOUSSTS.SUBMITTABLE.COM

Submission Portal - Summer Internship for Indigenous Peoples in Genomics Canada (SING Canada) 2023

SING Canada Eligibility and Criteria The 2023 SING Canada Workshop will be held July 16-21, 2023 in Edmonton, Alberta, Canada and is open to Indigenous individuals who would like to learn about the basic of genomic...

I will post a pdf of the full document on Canvas later today > Genetics > Additional Information.

Rory and Brett having Office Hours on Zoom today

Rory (12:30 pm – 2:30 pm today)

- Zoom link is found on our Canvas home page.

Brett Couch (11 am to noon today)

Join Zoom Meeting
https://ubc.zoom.us/j/61973363133?pwd=S1lWVXhGMHlSbHg5WE50WFAvdDViUT09

Meeting ID: 619 7336 3133
Passcode: 888119

Housekeeping

Due this Sunday night @ 11:59 pm:

- Quiz 6 - Evolutionary Mechanisms
- Worksheet #7 - Evolutionary Mechanisms - Natural Selection and Genetic Drift

If not already completed

- Group Project Proposal Survey
- Unofficial Teaching Feedback #1 (1%)

I will be ending lecture early to return midterm #1

- I will say more about the midterm just before returning the exam

I am switching lecture dates:

- Pedigrees (testable on the upcoming midterm) will be moved earlier (March 7th)
- Species Concepts/Speciation will be moved to March 9th (will be tested on final exam)
- why – to reduce the number of concepts tested on midterm #2 due to time concerns

Up to this point in evolution, we have talked about…

The definition of evolution – change in allele frequencies in a population over generations.

Evidence for evolution:

- evidence that all taxa are descendent from an ancient common ancestor (LUCA)
- evidence that species share common ancestry (homologies)
- evidence of evolutionary change

Three of the four mechanisms of evolution (i.e. mechanisms that change allele frequencies).

1. **Mutations** – essential (ultimate source of all genetic variation), but weak evolutionary mechanism by itself; contributes new alleles to a population.

2. **Gene flow** – movement of genes into and out of populations, due to the movement of individuals or the movement of gametes (e.g. pollen); can result in the gain/loss of alleles in a population, and can result in homogenization of allele frequencies between populations.

3. **Natural selection** – environmental and sexual selection (started)

4. **Genetic Drift** – random changes in allele frequencies in a population - Thursday's class.

iClicker Question – Natural Selection

True or false: Natural selection is a random process

A. True

B. False

C. Not sure

Answer

True or false: Natural selection is a random process

A. True

B. False

C. Not sure

The genetic variation that occurs in a population is ultimately due to mutations – a random process

Natural selection is not random.

Natural selection acts on the genetic variation in a population in a non-random way.

Alleles that aid in survival and/or reproduction are more likely to become common in a population than alleles that do not aid in survival and/or reproduction.

iClicker Question – Natural Selection

True or false: Natural selection produces organisms that are perfectly suited to their environment.

A. True

B. False

C. Not sure

Answer

True or false: Natural selection produces organisms that are perfectly suited to their environment.

A. True

B. False

C. Not sure

https://evolution.berkeley.edu/evolution-101/mechanisms-the-processes-of-evolution/misconceptions-about-natural-selection/

- Natural selection can only act on the variation that exists within a population.
- For example, it would be beneficial if our digestive and respiratory tract did not share the same passage at the beginning (eliminate risk of choking); but the gene/developmental pathway for this phenotype do not exist – so evolution in this direction cannot happen.

Sexual selection

- A special case of natural selection (according to Darwin)

- Sexual selection is a process by which individuals compete for access to mates and fertilization opportunities.

- Can lead to the development of extreme adaptations that help organisms obtain mates (that may actually be harmful to an individual's survival, e.g. elaborate tails).

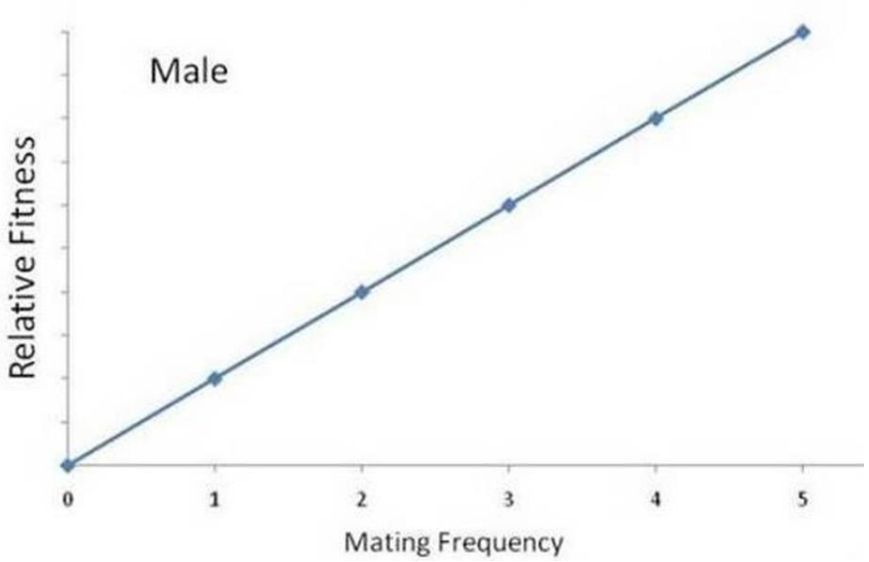
Darwin identified 2 mechanisms of sexual selection:

1. Intrasexual selection – competition between two individuals of the same sex (usually males) for mates.

2. Intersexual selection – where members of one sex (usually females) choose members of the opposite sex.

Males: Fitness linked to the number of mating opportunities

Assuming a male provides little parental care, the more females that a male can mate with the greater his reproductive success and the more alleles he can pass to the next generation (and the higher his fitness).



https://www.nature.com/scitable/knowledge/library/mating-systems-in-sexual-animals-83033427/

https://www.nature.com/scitable/knowledge/library/male-reproductive-strategies-71224983/

So, for a sexually reproducing species where males provide little parental care, males will compete with other males for receptive females (to increase their reproductive success).

Intrasexual selection, e.g. males competing with males

Male-male competition for females (intrasexual selection) has lead to the evolution of differences in body size and shape between males and females in some species (sexual dimorphism).

- Males may be larger than females; and/or
- Males may have armaments to help them signal fighting superiority to other males, or may help the males win in a competition if they combat eat other.

Example: Fork fungus beetles (*Bolitotherus cornutus).* Male (left) and female (right).

- Found in Eastern North America

Source: Gil Wizen, www.gilwizen.com.

This will be the organism of the day, even though it is not found locally.

Male beetles have these orange forward facing horns or “pom poms”, which vary in size. They use these horns to “joust” with other males or dislodge males that are holding on to the females. Function of the orange setae – unknown – perhaps sensory.

Little triceratops ☺

Source: Gil Wizen, www.gilwizen.com.

If you are looking for these beetles – they are typically found on bracket fungi, which the beetles feed upon.

Gil Wizen and a link back to www.gilwizen.com

https://www.publicdomainpictures.net/en/free-download.php?image=bracket-fungus-on-tree-stump&id=364360

These beetles are eaten by nocturnal predators (e.g. mice).

If threatened, they will play dead. If a mammal breathes on the beetle, they will release an obnoxious chemical from glands. (Eisner et al. 2007)

https://www.performance-vision.com/FungusBeetle/

Physical combat can be costly to both males

http://www.youtube.com/watch?v=DU4xW79ASsg

https://www.youtube.com/watch?v=XI8WU9ReFG0

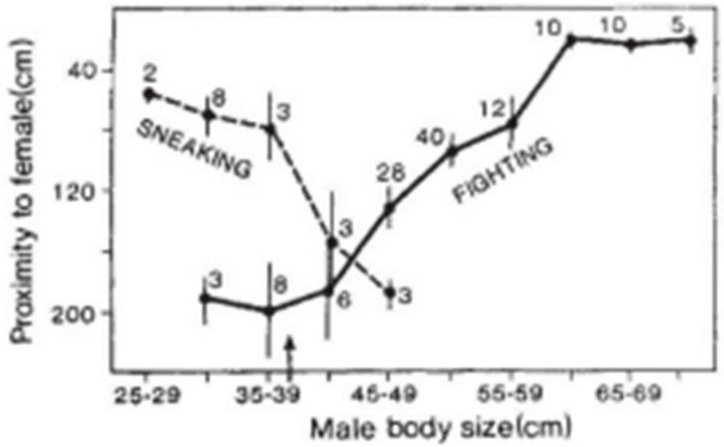
So male-male competition does not necessarily involve direct combat

Examples from the last class:

- Scooped-shaped penis in damselflies and dragonflies
- Copulatory plugs in snakes
- Tiger salamanders mimicking a female's dance in order to destroy competitor's sperm.
- *Drosophila* marking females to make them less attractive
- Beginning sneaky

Evidence – that being a sneaky male is effective

In the last class we also talked about the effect of disruptive selection on the body size of male chinook salmon. The smaller males (jacks) are sneaky.



iClicker Question: Can sneaky male chinook salmon (jacks) fertilize more eggs than dominant males (hooknose)?

A. Yes
B. No
C. Not sure

Ecol Evol. 2013 Dec; 3(15): 4987–4997.
Published online 2013 Nov 11. doi: 10.1002/ece3.869
PMCID: PMC3892362
PMID: 24455130

Sneaker "jack" males outcompete dominant "hooknose" males under sperm competition in Chinook salmon (*Oncorhynchus tshawytscha*)

Brent Young,[1] David V Conti,[2] and Matthew D Dean[1]

Table 1

Paternity under sperm competition

	Hooknose 1:Jack 1	Hooknose 2:Jack 2	Hooknose 3:Jack 3	Hooknose 4:Jack 4	Hooknose 5:Jack 5	Row sum
Female 1	31:55 (0.36:0.64)	31:49 (0.39:0.61)	39:49 (0.44:0.56)	25:44 (0.36:0.64)	17:29 (0.37:0.63)	143:226 (0.39:0.61)
Female 2	26:35 (0.43:0.57)	18:28 (0.39:0.61)	19:27 (0.41:0.59)	32:45 (0.42:0.58)	10:36 (0.22:0.78)	105:171 (0.38:0.62)
Female 3	47:44 (0.52:0.48)	37:47 (0.44:0.56)	14:28 (0.33:0.67)	27:41 (0.40:0.60)	39:29 (0.57:0.43)	164:189 (0.46:0.54)
Female 4	42:35 (0.55:0.45)	38:8 (0.83:0.17)	32:14 (0.70:0.30)	7:39 (0.15:0.85)	23:45 (0.34:0.66)	142:141 (0.50:0.50)
Female 5	28:17 (0.62:0.38)	22:47 (0.32:0.68)	31:14 (0.69:0.31)	10:59 (0.14:0.86)	39:50 (0.44:0.56)	130:187 (0.41:0.59)
Column sum	174:186 (0.48:0.52)	146:179 (0.45:0.55)	135:132 (0.51:0.49)	101:228 (0.31:0.69)	128:189 (0.40:0.60)	684:914 (0.43:0.57)

Number of embryos sired by hooknose:jack (proportions in parentheses).

Answer

A. Yes
B. No
C. Not sure

Sneaky males were 1.35X more likely to fertilize the eggs than the dominant fish

Table 1

Paternity under sperm competition

	Hooknose 1:Jack 1	Hooknose 2:Jack 2	Hooknose 3:Jack 3	Hooknose 4:Jack 4	Hooknose 5:Jack 5	Row sum
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Number of embryos sired by hooknose:jack (proportions in parentheses).

Young et al. 2013

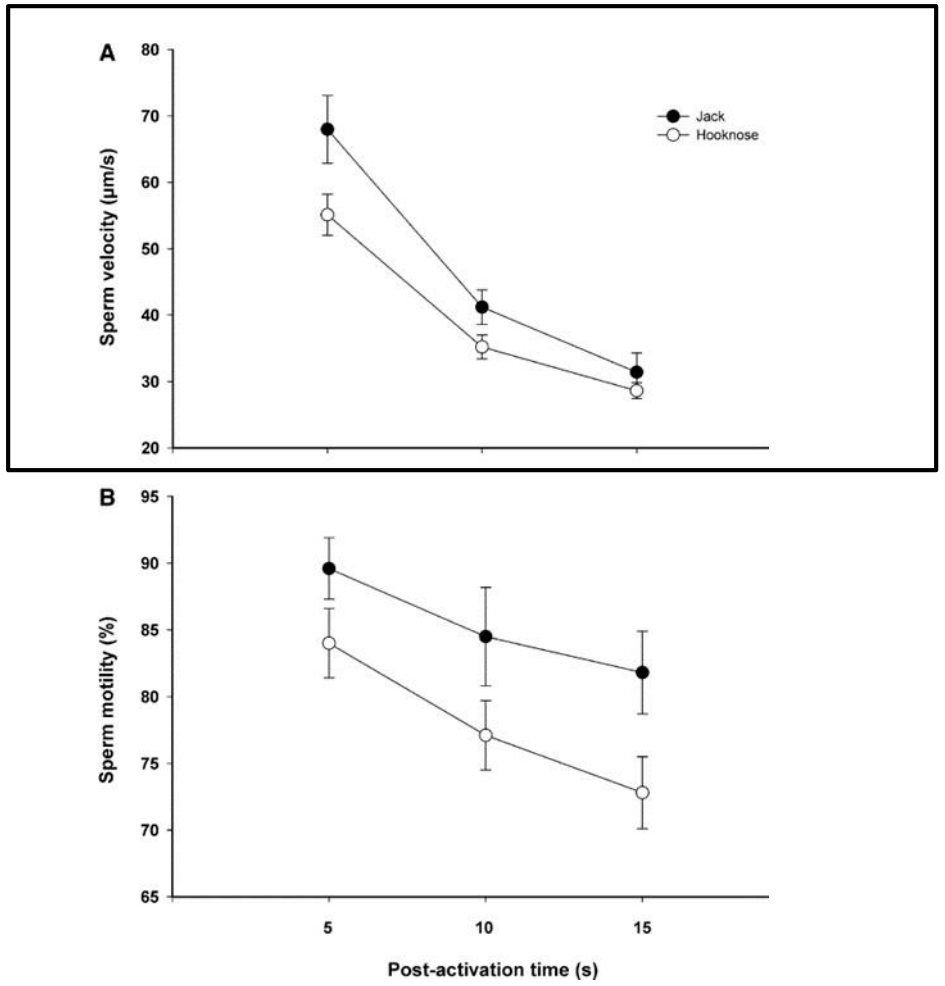
iClicker Question

Do the sneaky (jack) males produce sperm that move faster than the dominant (hooknose) salmon?

A. Yes

B. No

C. I am not sure



Biol J Linn Soc, Volume 108, Issue 1, January 2013, Pages 99–108, https://doi.org/10.1111/j.1095-8312.2012.01980.x

Answer

Do the sneaky (jack) males produce sperm that move faster than the dominant (hooknose) salmon?

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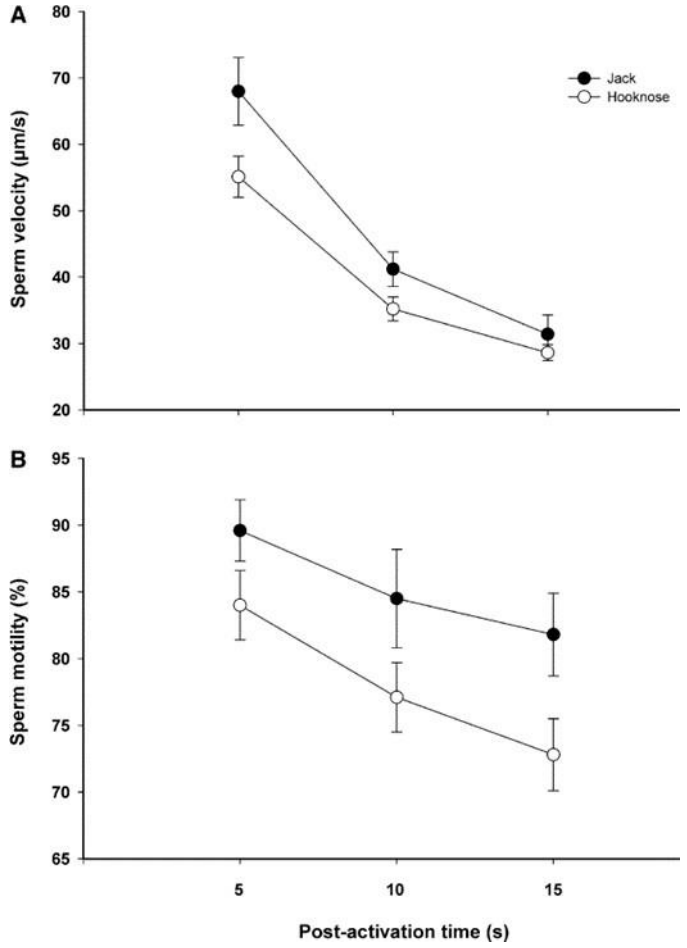


Biol J Linn Soc, Volume 108, Issue 1, January 2013, Pages 99–108, https://doi.org/10.1111/j.1095-8312.2012.01980.x

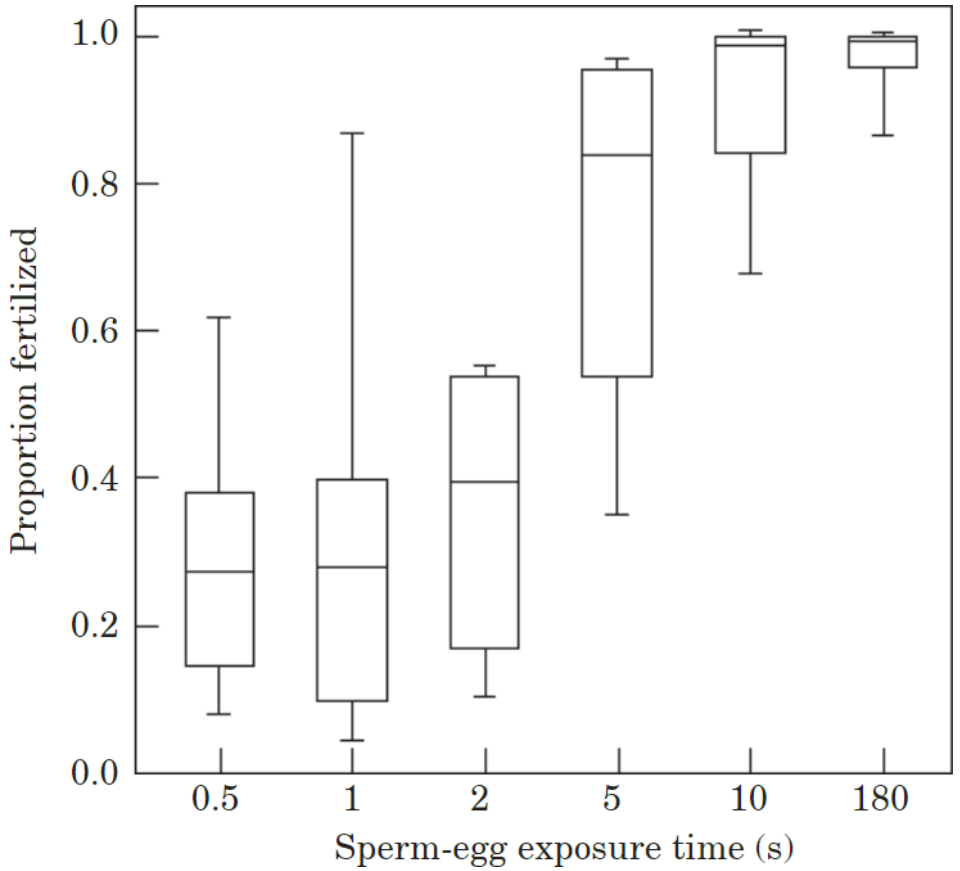
iClicker Question

Is the speed at which a sperm can find an egg important in Chinook salmon?

A. Yes

B. No

C. I am not sure



Hoysak and Liley 2005, a UBC study

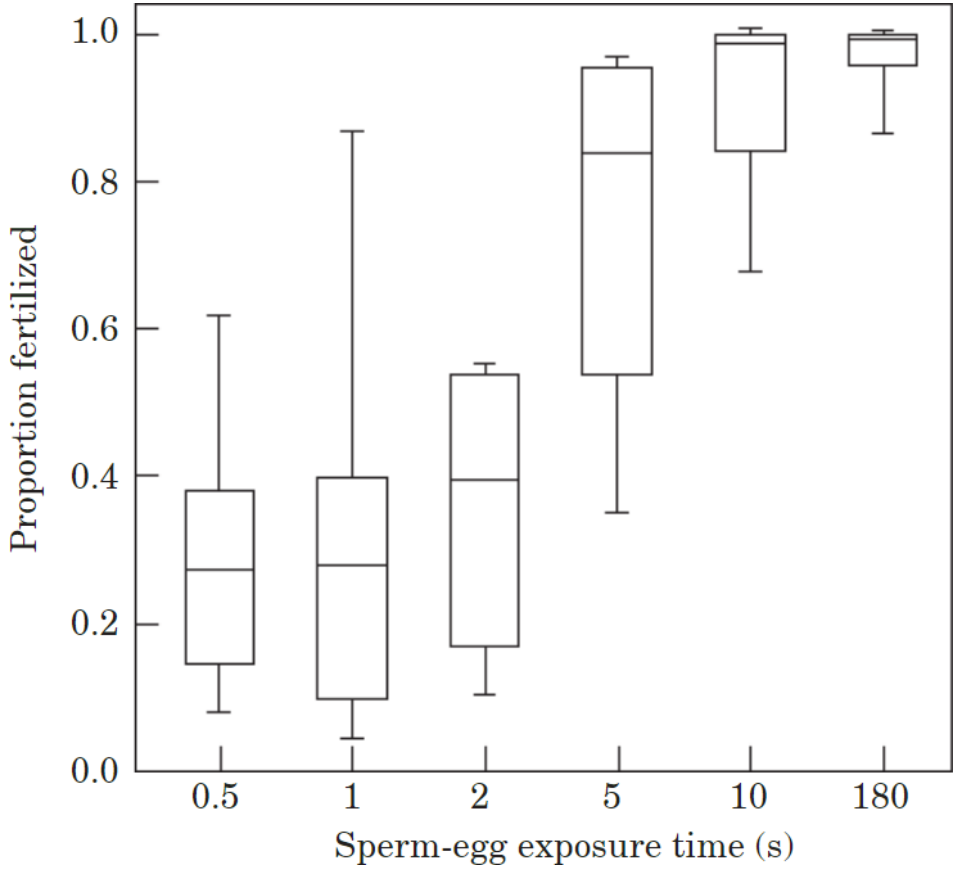
Answer

Is the speed at which a sperm can find an egg in Chinook salmon important?

A. Yes
B. No
C. I am not sure

Most (>80%) eggs are fertilized within 5 seconds.

Also – not shown here – most sperm die within one minute of activation



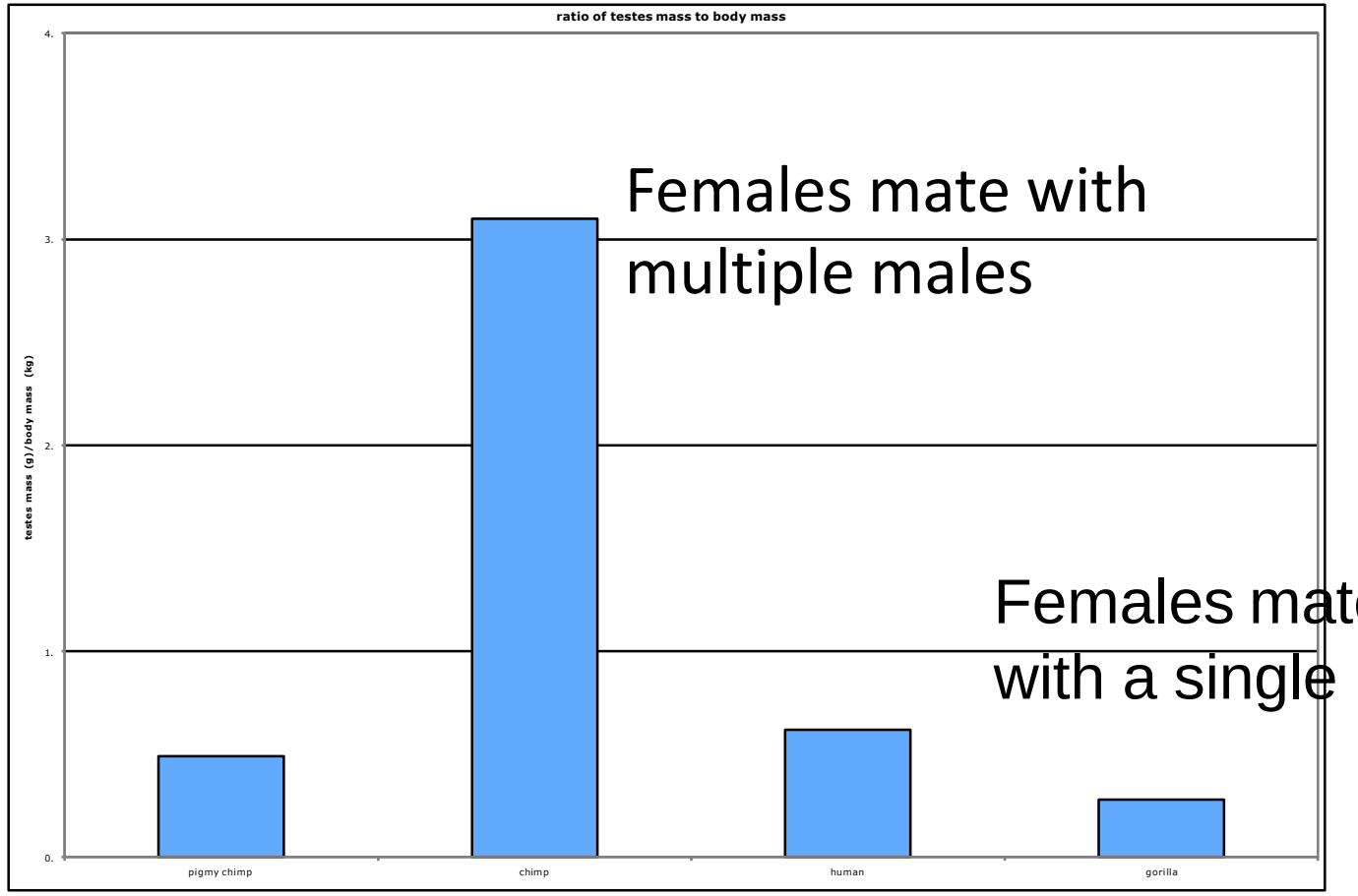
Hoysak and Liley 2005, a UBC study

Another indirect option for males – invest heavily in sperm (e.g., more lottery tickets)

Male chimpanzees have the largest testes of all the great apes.

-Female chimps typically mate with all of the males in their troop.

Testes/body mass ratio



Pygmy Chimp

Chimp

Human

Gorilla

From Dr. Rosie Redfield, UBC

Not testable – female-female interactions

From Dr. Irene Ballagh (UBC, BIOL155) – in mice raised for research purposes, if a male has fertilized multiple females at the same time, the alpha-female can delay implantation of her eggs by a few days.

- outcome of this delay is the other females give birth a few days earlier
- the alpha female will kill these offspring before giving birth to her own pups
- the females without pups, who are lactating, will then help to feed the alpha female's pups.

5- minute break

Then, intersexual selection (female mate choice)

https://www.youtube.com/watch?v=VQr8xDk_UaY

iClicker Question

Is a female's fitness also primarily determined by the number of times she mates (during one mating season; assuming no multiple paternity)?

A. Yes

B. No

C. Unsure

Answer

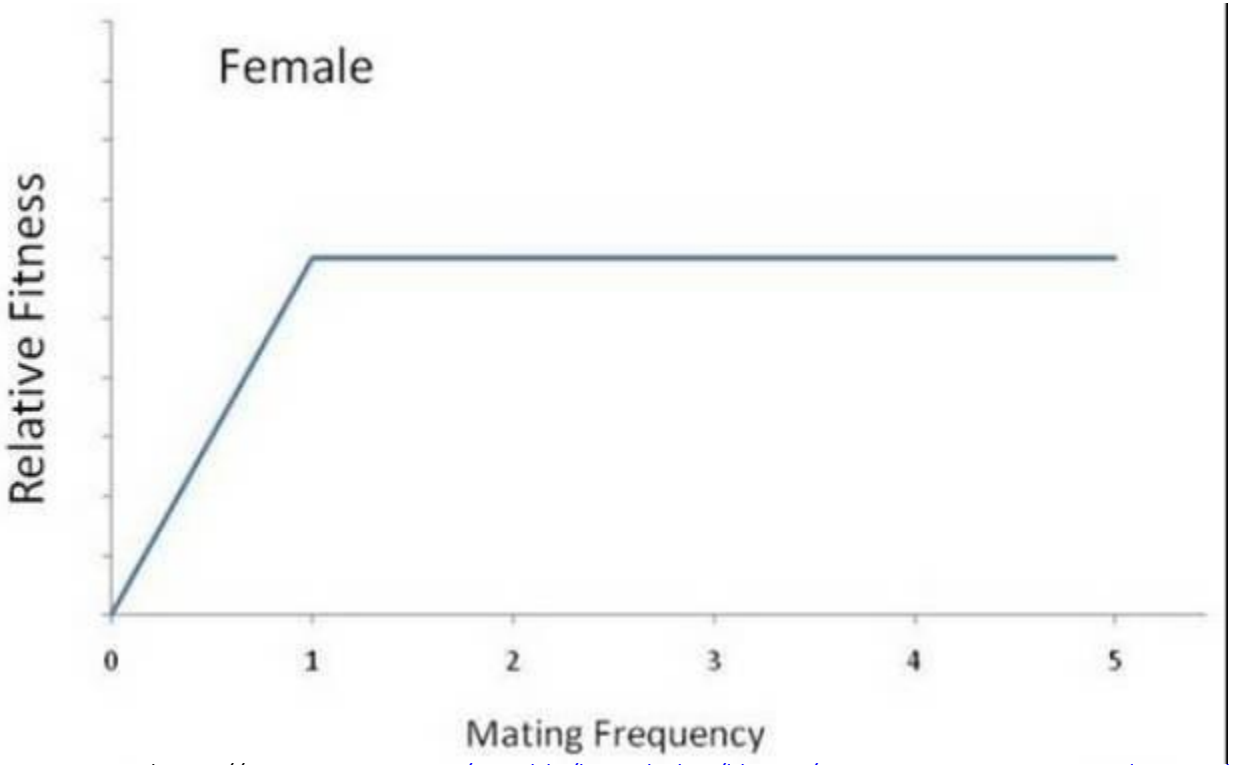
Is a female's fitness also primarily determined by the number of times she mates (during one mating season, assume no multiple paternity)?

A. Yes

B. No

C. Unsure

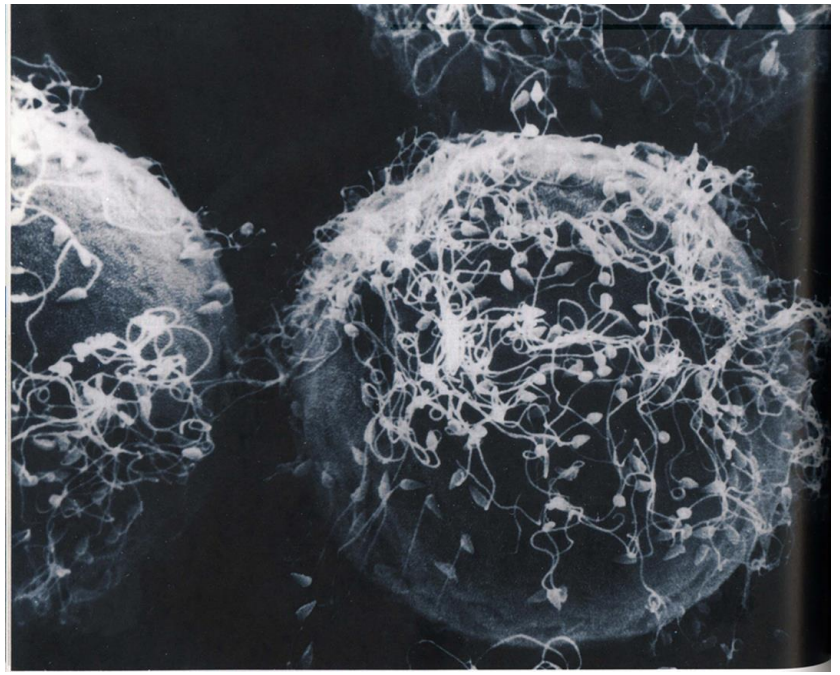
Mating with ONE male should potentially be enough to fertilize of all a female's eggs



https://www.nature.com/scitable/knowledge/library/mating-systems-in-sexual-animals-83033427/

Asymmetric costs of reproduction

Figure 24-5 Biological Science, 2/e



For a broad array of species (e.g. some species of invertebrates, reptiles, amphibians, fishes, birds and mammals):

- Females produce fewer gametes than males.
- And, the females may invest more in each gamete (e.g. eggs are larger, and contain the nutritional reserves for development)

iClicker Question

Given that a female's egg/s could potentially be fertilized by one male; and given the asymmetric costs of reproduction would you expect a female to be choosy about which males to mate with?

A. Yes
B. No
C. Unsure

Answer

Given that a female's egg/s could potentially be fertilized by one male; and given the asymmetric costs of reproduction would you expect a female to be choosy about which males to mate with?

A. Yes - choose a male that will result in healthy, high quality offspring
B. No
C. Unsure

Bateman's principle (not testable):

- In species where females invest more in their offspring than do males, females are expected to be more selective in mate choice

The production of eggs and the caring of offspring is energetically expensive (relative to the cost of sperm). So, females should choose a mate that will maximize the fitness of her offspring.

A mother elephant investing time

Intersexual selection - Female mate choice

https://news.yale.edu/2018/01/09/evolved-illusion-blackest-black-gives-bird-paradise-edge

What would make one male more enticing to a female than another male?

Two hypotheses:

1. A male that signaled to the female that they were better at providing direct benefits to a female than another male would be more enticing.

2. A male that signaled to the female that they would provide better indirect benefits (i.e. good genes), that would maximize the fitness of the female's offspring.

1) Direct benefit

Males can signal that they would provide benefits such as:

- Resources (e.g. food, shelter)
- Protection
- Parental care
- Parasite avoidance
- Fertility

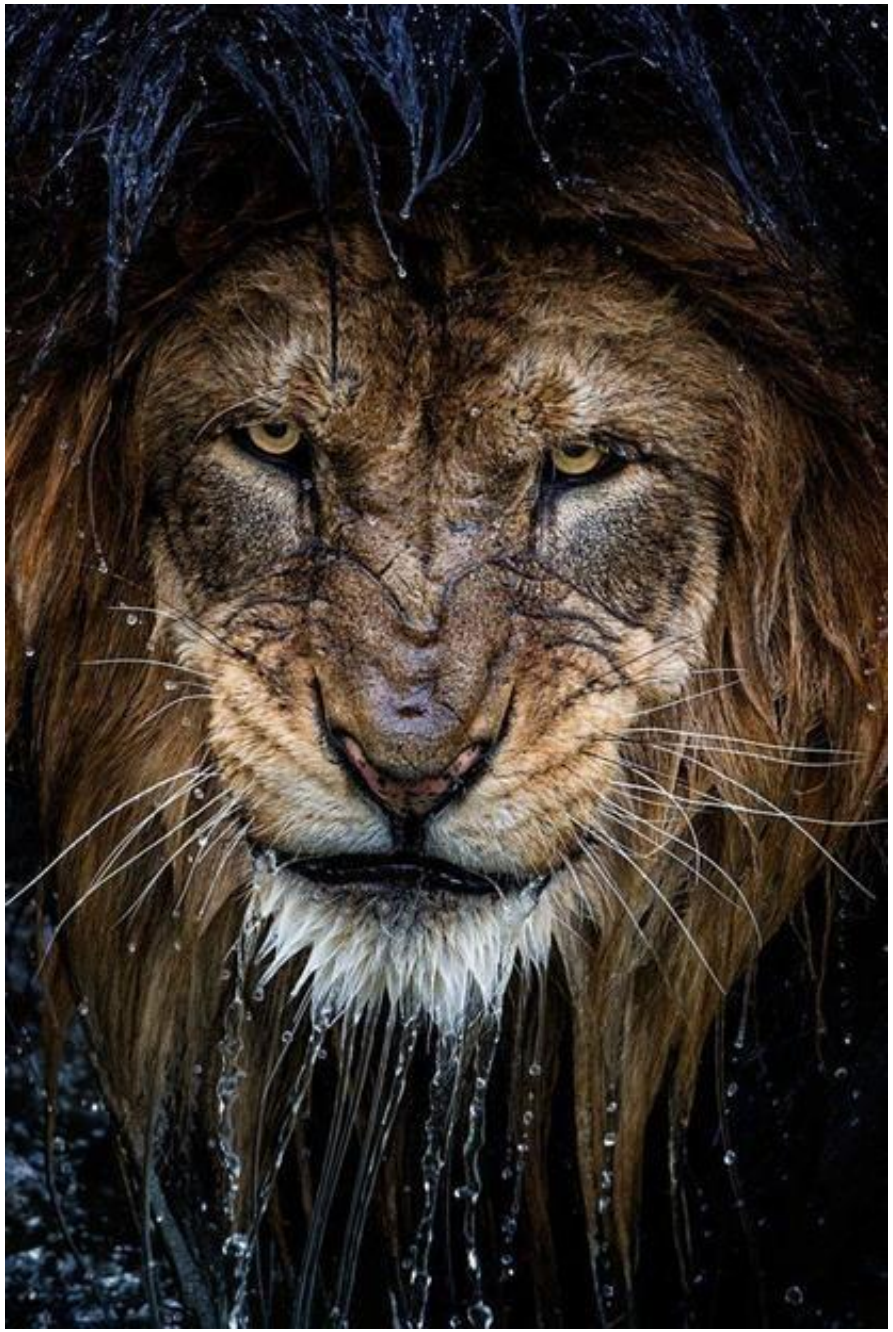
Males demonstrate that they can provide resources to the female by bringing gifts (nuptial gift)

Female lions preferentially mate with males with dark manes:

Dark manes in lions indicate:

> older age (survivor)

>higher testosterone levels (more aggressive, fighting ability)
- good protector



Source
?

2) Indirect benefit (e.g. good genes hypothesis)

- The male's phenotype is an indicator or advertisement for good genes/high fitness that can be pass to the female's offspring.
- This usually means the signal has to bear some cost (e.g. energetics) to the male.

https://sonurai.com/bingwallpapers/166

Display their good genes, e.g. look fabulous!

- Healthy – no parasites
- Good immune system
- Non-damaged DNA, etc.

Good genes - dance ☺

https://www.youtube.com/watch?v=nPhVOZiPokA

https://www.youtube.com/watch?v=xYIUFEQeh3g

https://www.youtube.com/watch?v=BnLE-G1hVAE

Another tactic for demonstrating good genes: loss of the baculum

- Baculum from the latin word for stick or staff.
- Found in most mammals, including all primates, exceptHumans

- Lossof the baculum in human males possibility due tosexual selection by females looking for signs ofgood health in mates.
- What systems must be in good working order to function without a baculum?

Questions?

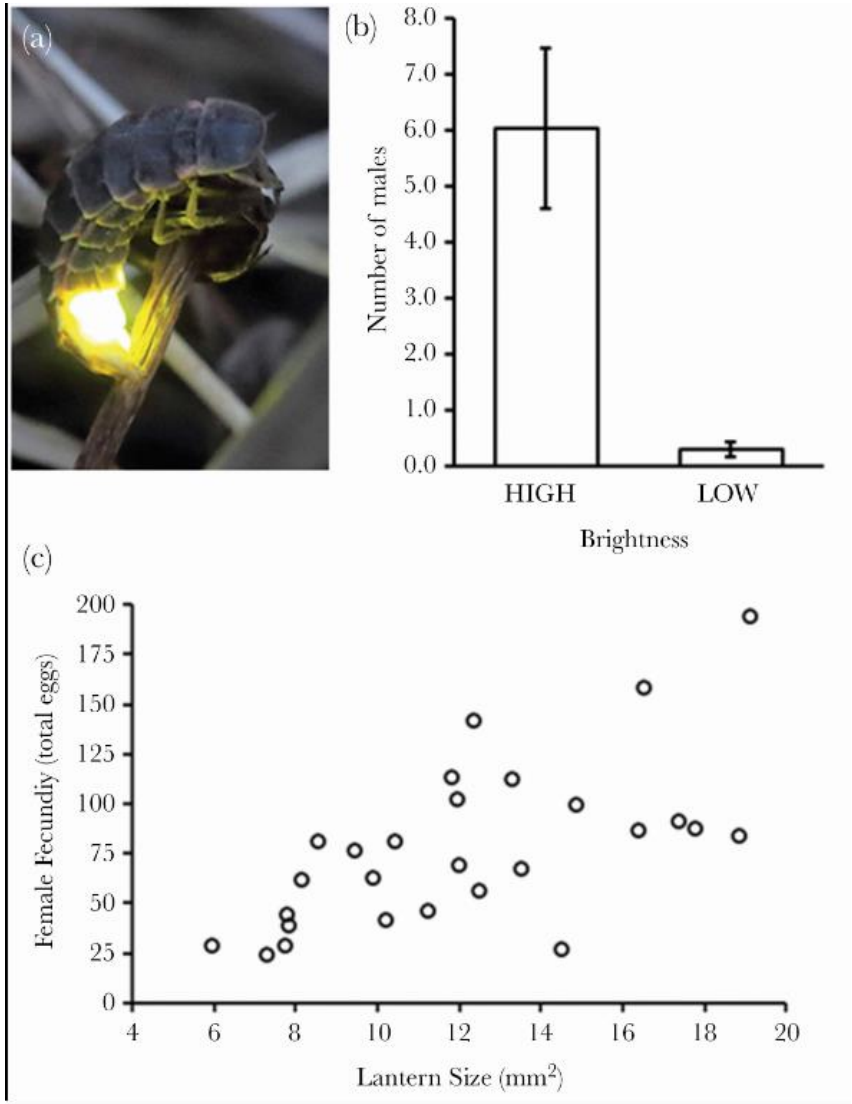
Female competition and male mate choice

The common glowworm, *Lampyris noctiluca* – a type of beetle (found in Europe, Asia & Africa).

In this species, the females attract males by glowing for several hours a night (for up to 10 consecutive nights).

(b) Experimental evidence that males are attracted to a brighter glow = bigger female.

(c) Light producing organism is called a lantern. Evidence that females with a bigger lantern produce more eggs. So, males are attracted to brighter glow = bigger female = more eggs for males to fertilize.



JOURNAL ARTICLE

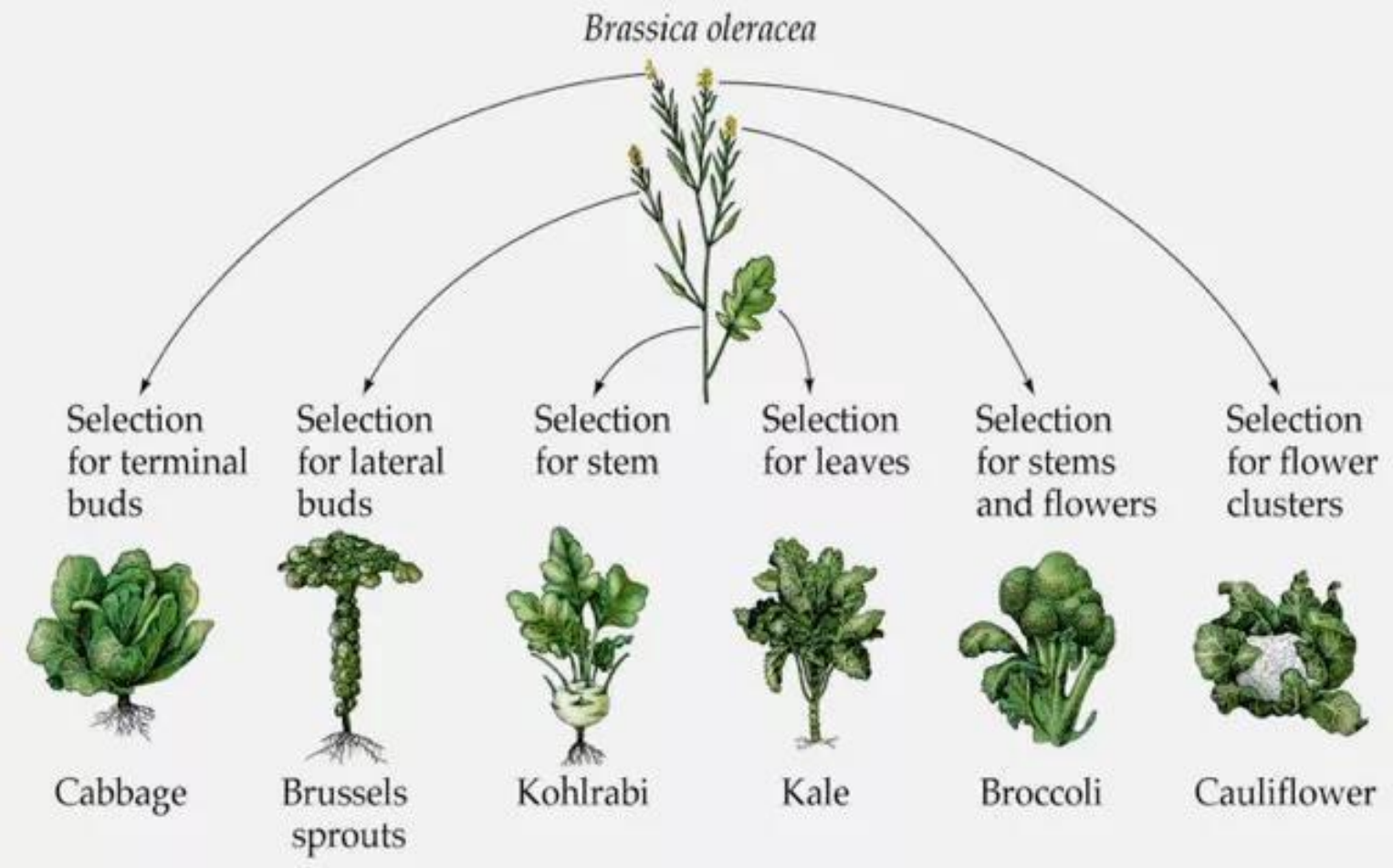
The definition of sexual selection

David M Shuker ✉, Charlotta Kvarnemo

Behavioral Ecology, Volume 32, Issue 5, September/October 2021, Pages 781–794,

Artificial Selection

People, instead of nature, select which individuals get to reproduce and pass their alleles onto the next generation (i.e. there is a goal unlike in natural selection).



4 Evolutionary Mechanisms

#1 Mutations ☑

#2 Gene flow ☑

#3 Natural selection ☑

Sexual selection: a type of non-random mating ☑

#4 Genetic Drift (Thursday)

Darwin’s unsung teacher

The contribution of many people to science/evolution are hidden by history.

An example of such a person is **Mr. John Edmonstone**

- In the 1700’s, Mr. Edmonstone was born enslaved in a timber plantation in Guyana (South America). The owner of the plantation was a Charles Edmonstone.
- A naturalist, Mr. Charles Waterton, would visit the plantation during his travels.
- John Edmonstone would accompany Waterton on his collecting expeditions, and learned how to preserve bird skins.

- In 1817, John Edmonstone travelled to Scotland with the plantation owner.
- Slavery was banned in Scotland; so, John became a free man.
- By 1824, he had set up a successful taxidermy business close to the University of Edinburgh
- In 1825, at the age of 17, Darwin went to Edinburgh (initially to pursue medicine); and apparently an acquaintance recommended John to Darwin.
- Darwin hired John to give him private lessons how to preserve birds.
- This skill helped Darwin preserve the birds that he collected.
- Darwin did write about John Edmonstone in his memoirs; apparently they spent many hours in conversation (presumably at least some of those conversations involved the plant and animal life if in South America).
- We can only speculate about the effect of John Edmonstone on young Darwin, but many historians think he was very influential.

Specimens of Galapagos mockingbirds, collected by Charles Darwin

https://www.nhm.ac.uk/discover/john-edmonstone-the-man-who-taught-darwin-taxidermy.html

Next class (Thursday)

- Genetic Drift (last evolutionary mechanism).
- Hardy-Weinberg Equilibrium

  - equation that can be used to determine if evolution may be acting on a specific gene in a population or not.

Midterm #1

Mr. Michael Jordan (G.O.A.T! Some argue, MJ is even greater than Mr. LeBron James ☺).

- Did not make his High School Varsity Basketball team.
- He was placed on the Junior Varsity team instead – to develop more
- His high school basketball coach said:

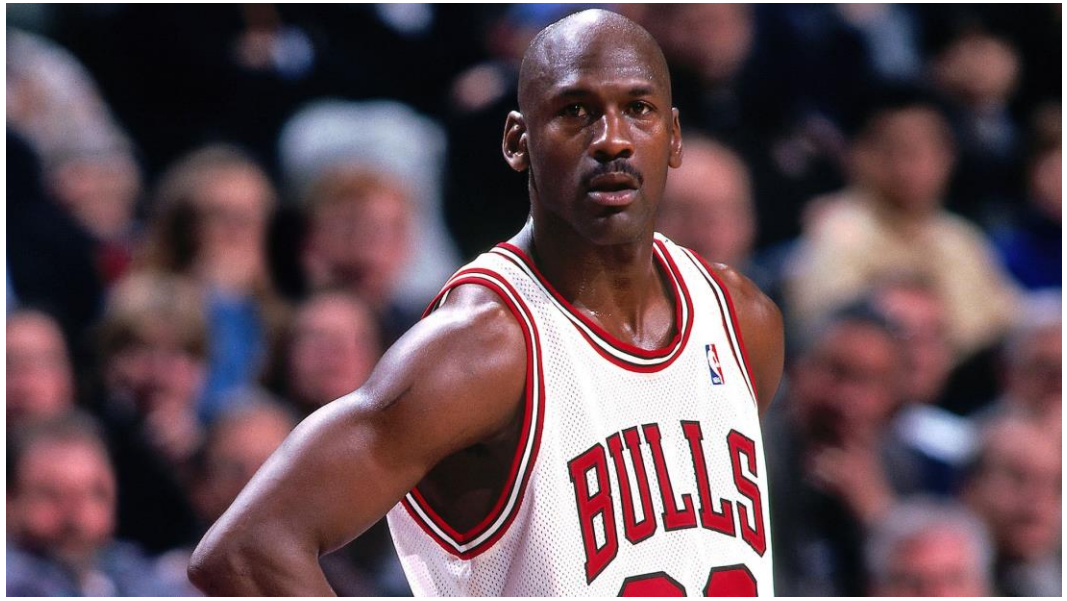
"There was no doubt that Mike Jordan could handle the ball, but his shooting was merely good and his defense mediocre…… If Jordan distinguished himself at all during the tryout, it was through his supreme effort." (Clifford Herring).

So, Michael Jordan just needed time.

Your exam marks do NOT define who you are!!

It is how you respond to challenges that is important

Dr. Angela Duckworth has found that GRIT
- a combination of passion and perseverance is the hallmark of high achievers



https://www.nba.com/news/history-nba-legend-michael-jordan

Midterm #1 Stats

Course average (all sections) ~ 60%
Min ~15%
Max 105%

An Answer Guide will be posted on Canvas by tomorrow (Wednesday) afternoon. Brett is currently write this guide.

Exam marks will also be posted on Canvas by tomorrow (Wednesday) afternoon.

Regrade Policy

You can request a regrade. To do this you must:

- drop off your exam with me (Lynn) for a few days
- provide a reasonable argument based on the answer key for why your answer(s) deserve a different marks.
- you must use the Claim, Evidence, Reasoning Model
- the entire exam may be regraded, your grade may go up, down or remain the same.

- only exams written entirely in non-erasable pen with no whiteout will be regraded.

If you notice an addition error, please submit to me indicating where the error occurred.

24 HOUR RULE – you must wait 24 hours from when the marking guide is released before you can submit regrade requests; so, starting on Thursday.

Changes to exam total mark and weighting

TOTAL MARK:

- I am reducing the total mark for this exam to 33 (not 34).
- The main reason – in hindsight, I believe the pedigree assumptions question (worth 1 mark) was not entirely fair as I did discuss the definition of assumption.

WEIGHTING (all sections).

- For students who do better on the final exam than midterm #1….
- I will transfer 15% of midterm #1 to the final exam
- New midterm #1 weight = 5%
- New final grade weight = 50% (for students who will benefit).
- The genetics component of the final exam will be increased (not sure what the final breakdown will be yet; normally genetics is worth about 15-20% of the final exam)
- Reason - we want to encourage and reward improvement in students that found this midterm difficult.

Some common mistakes

A. Misreading questions

For example:

i) For Q1.4, we asked how many different genotypes a cell could produce by multiple MITOTIC DIVISIONS.
   - but many people used the 2^n equation – which is for meiosis

ii) For Q2.2 (cell drawn an metaphase I).
   - drawing the cell at Metaphase II (i.e. drawing the cell as haploid)

Some common mistakes

B. Incomplete answers for explanation questions

- Question 3 – crosses, e.g.
  - Not quantifying observed values
  - Not explicitly comparing observed and expected values (as requested in the scenario).

- Question4 - pedigrees
    - e.g. not providing genotypes

C. Incorrect answers

- Q-3.4 linked genes, no crossing-over (same question as tomato worksheet)
- Q4.4 pedigrees
    - Correctly identifying the correct mode of inheritance (autosomal recessive), then calculating probability using X-linked mode of inheritance.

Picking up exams

- If you cannot stay to pick up your exam today:
    - I will bring exams to class on Thursday too.
    - I will bring exams to my office hours on Wednesday and Thursday (2-3 pm in 1114C)
    - You can drop by my office (BIOL2103) – if my door is open, I can return your exam
    - You can email me to set up a time to drop by

Pick up exams (alphabetical by last name)

Marks on back

A, B, C

D-F, G-I

J-K, L, M-N

Instructor's Desk/Podium

O-R, S, T-V, W-X, Y-Z