(1, 5 pts) SEX CHANGES. Imagine that human evolution had proceeded much the same as it did, but that humans evolved one of the mechanisms of sex change described in class (i.e., like the wrasse or clownfish). Thinking about what you know about human life histories and/or sexual selection, which mode of sex change would you expect to have evolved if it did and why? Be sure to provide both the technical term and support your answer.

The most likely mode would be PROTOGYNOUS for several reasons.

Possible reasons include:

Since males are able to reproduce later in life it is more advantageous to switch to male rather than to female to maximize overall reproductive time.

Since females are attracted to older males and males are attracted to younger females already, protogyny is advantageous from the perspective of the mate choices that we see in modern humans (i.e., younger males and older females are less sexually selected).

With male-male competition for females based on status or resources (i.e., direct benefit is important) as seems to be in humans, it is advantageous to delay the male strategy until older when more resources have been acquired to allow success in these competitions.
(2, 10 pts) STUDY METHODS. Describe the observational and comparative methods for pursuing the adaptationist program and one of the examples given in class for each.

OBS: In the observational method we observe nature and collect data to see whether certain traits appear to be related to higher fitness - i.e., are under selection. This then supports proposals that these traits evolved for these reason.

Examples from class included: giraffe necks, mammal jaw/ear bones,

COMP: With the comparative method we look for repeated patterns of association between a proposed selective force and the evolution that occurred in species subjected to that force.

Examples from class included: primate testes, bird coloration

(3, 10 pts) SPECIATION. Provide the definitions for and describe the examples given in class for both the allopatric and sympatric modes of speciation.

Allopatric: Allopatric speciation occurs when two populations are separated by a physical barrier and diverge to the point at which they are so distinct that when rejoined they are reproductively isolated from one another.

This was seen in the shrimp isolated by the formation of the Panama land bridge.

Sympatric: Sympatric speciation occurs when two subpopulations in the same area diverge (due to use of different microhabitats or behaviors) to the point at which they are so distinct that even though in the same place they are reproductively isolated from one another.

This was seen in the apple maggot flies which have begun to specialize on different fruit.

Abstract:
Benefits accruing to females who exercise mate choice have been defined to be either 'direct' or 'indirect'. We suggest an alternative distinction: benefits can be considered 'fixed', meaning they are on average equal to all females mating with the same male (e.g. good genes' benefits) or 'dilutable', meaning they are shared between females mating with the same male, so that the more mates a male has, the lower the average benefit to each (e.g. fertility benefits or many forms of direct benefit). Using a simple model, we show that this distinction has a major effect on the form of female preference. We predict that mating skew will be far greater in species where the benefits are fixed when compared with those where the benefits are dilutable.

(a, 4 pts) Would the handicap principle mechanism aspect of female choice provide a "fixed" or "dilutable" benefit? Support your answer.

**FIXED.** This would be because the handicap principle also indicates superiority of genetic factors (but in a more general sense than the "good genes" model) and these would not be diluted by multiple matings.

(b, 4 pts) Would the hybridization avoidance aspect of female choice provide a "fixed" or "dilutable" benefit? Support your answer.

**FIXED.** This would be because the avoidance of hybridization is also based on genetic factors that would not be diluted by multiple matings by the male.

(c, 4 pts) List the 2 aspects of female choice we discussed, aside from the handicap principle and hybridization avoidance, not mentioned explicitly or implicitly in the abstract.

_____pre-existing bias__________ & _____Runaway selection__________

(d, 4 pts) What do the authors mean by the phrase "mating skew"?

They mean the level of female choosiness as reflected by numbers of mating for each male. Their result is that fixed benefits will result in stronger selection for preferences since the females always get the full benefit from the best choice whereas with the diluted benefits having the strong preference means that even when choosing the best male, it may not be that much more beneficial since his benefits are diluted.
(5) EXPERIMENTAL DESIGN. Imagine a scenario in which researchers are studying a bird species that lives along the entire West Coast of the US that they think may be undergoing parapatric speciation along the North-South cline. The researchers collect a number of birds from several different sites all along the coast and bring them back to the lab to conduct an experiment to see if this is the case. Potentially useful or useless facts about the birds:
- The Birds in Canada are light in color while the birds in Mexico are dark.
- The Birds at higher altitudes are larger than birds near the ocean.
- The Birds mate well in captivity and offspring are easily counted.
- The Birds eat insects and seeds, but not fruit.

You will design an experiment and make predictions about the pattern of the data that would help determine if their hypothesis is true or not. In the two blanks plots below you will illustrate data (i.e., just show general trend lines of data, not data points) that come from an experiment the researchers can perform to test their hypothesis.

(a, 4 pts) Briefly describe an experimental design to test their hypothesis.

The most straightforward technique would be to mate birds from different ends of the distribution with one another. Birds from farther away should be less interfertile than ones close to each other. A plot of distance between collection sites and number of offspring produced would test this.

(b, 6 pts) Label the axes on the blank plots and show linear trendlines that support the researchers’ hypothesis (left plot) or fail to support their hypothesis (right plot).

This data would support hypothesis

This data would NOT support hypothesis

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(6) ITEROPARITY/SEMPARITY. Cole (and Charnov and Schaffer) modeled the factors that influence the likelihood for an evolutionary switch between different types of reproductive strategies; a similar approach can model other types of adaptations. For the questions below show all the steps in your work & provide 3 significant figures in all terms.

(a, 4 pts) Using the equations we used for these models, consider a situation in which the birth rate, juvenile survival probability and adult survival probability values are 6.3, 8% and 60% respectively. Is the population growing or declining and by how much each generation?

The population is **declining** / increasing (circle one) by _10.4_ % per generation.

(b, 3 pts) Now consider a slightly different population in which the birth rate and juvenile survival probability are 7.0 and 10% respectively. What must the adult survival probability be in order for the population to remain stable and not go extinct? (express this as a percentage)

Prob = _30_ %

(c, 3 pts) Now consider a mutation that causes individuals to produce fewer offspring, but the offspring experience an increase of 30% in their juvenile survival probability. Producing fewer offspring also reduces the adult mortality by 10% compared to the wildtype adult mortality rate. How much lower could this mutant's birth rate (b_m) be and still experience total fitness equal to the normal wildtype individuals? Express b_m in terms of b_w, P_w and C_w where these terms represent the values in the wildtype individuals. Put your final answer in the box below.

\[ b_m = 0.769b_w +/\ - 0.077P_w/C_w \]

-3 pts for a single major algebra error, otherwise correct
(1) Individuals with a higher number of CAG repeats in their Huntington gene appear to have more offspring than those with lower numbers of repeats. These individuals suffer from a neurodegenerative disorder however. Which of the following terms is the best one to use to describe the evolutionary constraint that prevents the evolution of whatever mechanism these individuals use to increase their number of offspring?
   (A) Conflict (C) Functional (E) Selective
   (B) Developmental (D) Pleiotropic

(2) We represent the probability of an allele in one individual also being in another by the use of the value of "r" which is called which of the following?
   (A) Coefficient of relatedness (C) Index of relationship (E) Relation skew
   (B) Correlation coefficient (D) Relationship index

(3) The term _______ describes selection that is imposed by individuals of the same sex.
   (A) Fecundity (C) Intersexual (E) Viability
   (B) Fertility (D) Intrasexual

(4) The term _______ is the best one to describe a mating system in which one male mates with multiple females.
   (A) Multigamous (C) Polyandrous (E) Polygynous
   (B) Nulligamous (D) Polygamous

(5) The mammalian ear bones, the incus and the malleus evolved from the _____ and the _____ jaw bones in our ancestors.
   (A) articular ; quadrate (C) quadrate ; articular (E) squamosal ; articular
   (B) articular ; squamosal (D) quadrate ; squamosal

(6) Which of the following species definitions is the best one to use to understand the phenomenon of cryptic species in which two groups that appear identical in all physical ways nevertheless shows signs of being distinct genetically?
   (A) Biological (C) Nomialist (E) Typological
   (B) Essentialist (D) Phenetic

(7) Plato would have used which of the following species definitions?
   (A) Biological (C) Phenetic (E) Typological
   (B) Nomialist (D) Phylogenetic

(8) When considering the overall fitness of a gene, the portion that comes from reproduction by relatives is termed _______ fitness.
   (A) Altruistic (C) Hamiltonian (E) Indirect
   (B) Direct (D) Inclusive
For the last questions on this page consider the pair of pedigrees shown below.

(9) Consider an allele in individual A; what is the probability that this allele is also in individual D?
(A) 0.75  (B) 0.5  (C) 0.25  (D) 0.1875  (E) 0.125

(10) Consider an allele in individual C; what is the probability that this allele is also in individual D?
(A) 0.25  (B) 0.1875  (C) 0.125  (D) 0.0625  (E) 0.03125

(11) Consider an allele in individual G; what is the probability that this allele is also in individual H?
(A) 0.75  (B) 0.5  (C) 0.25  (D) 0.1875  (E) 0.125

(12) Consider an allele in individual E; what is the probability that this allele is also in individual F?
(A) 0.75  (B) 0.5  (C) 0.25  (D) 0.1875  (E) 0.125

(13) Consider an allele in individual H; what is the probability that this allele is also in individual J?
(A) 0.75  (B) 0.5  (C) 0.25  (D) 0.1875  (E) 0.125