Bio 325: Introductory Ecology
First Exam: Fall Semester 2009

Name:_____
ID:_____

True/False Questions (5 points each): Circle the correct answer.

1. **True or False?** Bill width in African finches is an example of disruptive selection.

2. **True or False?** Under the hypotheses of allopatric speciation and peripatric speciation, the populations in question are geographically isolated from one another.

3. **True or False?** In the F_2 generation of *M. cardinalis* X *M. lewisi* hybrid monkeyflowers, all individuals had flower phenotypes that were intermediate to those of the two parent species.
   The key word here is, *all*. Although most F_2s are intermediate to the parent species for one or more traits, some F_2s resembled the parent species in all 4 traits.

4. **True or False?** Epistasis refers to nonadditive interactions between alleles within one gene.

5. **True or False?** The slope of the regression line of fitness versus phenotype is called the selection differential, S.

6. **True or False?** When a population is above its carrying capacity, birth rate is greater than death rate.

   If a population is at its carrying capacity, if N=K, then birth rate equals death rate, b=d. From that, one can infer that if the population is below its carrying capacity that birth rate is greater than death rate (i.e. if N<K, b>d), and that if the population is above its carrying capacity that death rate is greater than birth rate (i.e. if N>K, b<d).

   This question is not asking what birth and death rates were prior to the point in time that we are asking this question. Rather, it's asking what the relative birth and death rates are *now*, *when* a population finds itself above its carrying capacity, K. Regarding events preceding this point in time, the population in question could have been even further above its K and in the process of decreasing in size.

   There were several who asked whether population size, N, could ever be greater than its carrying capacity, K, if the birth rate, b, weren't greater than the death rate, d? Yes. There are 3 ways that can give rise to N>K. 1. The environment can change and lower K, such as a drought lowering plant biomass lowering food for herbivores, and thus lowering their K. 2. A population can migrate to a new habitat whose K is lower than the number of

migrants. 3. A population can overshoot its carrying capacity. In this case, the overshoot begins when N<K and b>d, and results in N>K. Even in this case, once N>K, b<d.

7. **True or False?** In tarweeds, the number of nonsynonymous point mutations was less than the number of synonymous point mutation in both structural and regulatory genes.

8. **True or False?** Disruptive selection gradients are concave down.
   I mentioned these shapes, concave up or down, when I lectured on these selection gradients. You would have most likely first been exposed to them when you learned about parabolas in middle school or high school math.

9. **True or False?** Narrow sense heritability, h^2, can be estimated by dividing the selection response, R, by the selection differential, S.

10. **True or False?** In monkeyflowers, inserting the carotenoid genotype of *M. cardinalis* into the genetic background of *M. lewisii* resulted in an increase in pollinator visits by bees and a reduction in pollinator visits by hummingbirds.

Short Essays (10 points each): Answer each question with one to five sentences.

1. In the breeder's equation, why is the selection response usually less than the selection differential?

   The breeder's equation is $R = h^2 S$, where R is the selection response, h^2 is narrow sense heritability, and S is the selection differential. Because $0 \leq h^2 \leq 1$(because $h^2 = V_A/V_P$ and $V_A \leq V_P$), $R \leq S$. Because heritabilities are usually less than 1, R is usually less than S.

2. What is meant by the term, ***interaction***, in biology, and how can we detect or measure such interactions?

   In ***biology***, the term interaction refers to whenever "the whole is other than the sum of its parts" in the sense of Aristotle (Metaphysica). We covered examples of this across the levels of biological organization, e.g. organs consist of interacting tissue types, organ systems consist of interacting organs, communities consist of interacting species, two individuals each affecting the other's behavior, etc. One way to detect an interaction between two parts in making up a whole is to fit the following linear model to our data:

   $$Y = aX_1 + bX_2 + cX_1X_2 ,$$

   where Y is the whole, X_1 and X_2 are parts, and a, b and c are coefficients that are estimated by fitting this model to our data. Coefficient c tells us if there is an interaction. If $c = 0$, then there is no interaction; whereas, if $c \neq 0$, then there is a nonadditive, multiplicative interaction between parts X_1 and X_2 in determining the whole, Y.

3. What can the relative rates of evolution of regulatory versus structural genes tell us about macroevolution in an adaptive radiation?

   One hypothesis for the macroevolution of new phenotypes is that evolution of regulatory genes can lead to the evolution of new ways to network structural genes that already exist, and in the process, create new patterns of phenotypic development. If this hypothesis were true, then it predicts that within an adaptive radiation that regulatory genes will be observed to have evolved faster than structural genes, and that when comparing an adaptive radiation to a closely related species group that has not undergone an adaptive radiation, that regulatory genes will be observed to have evolved faster within the adaptive radiation than outside the radiation.

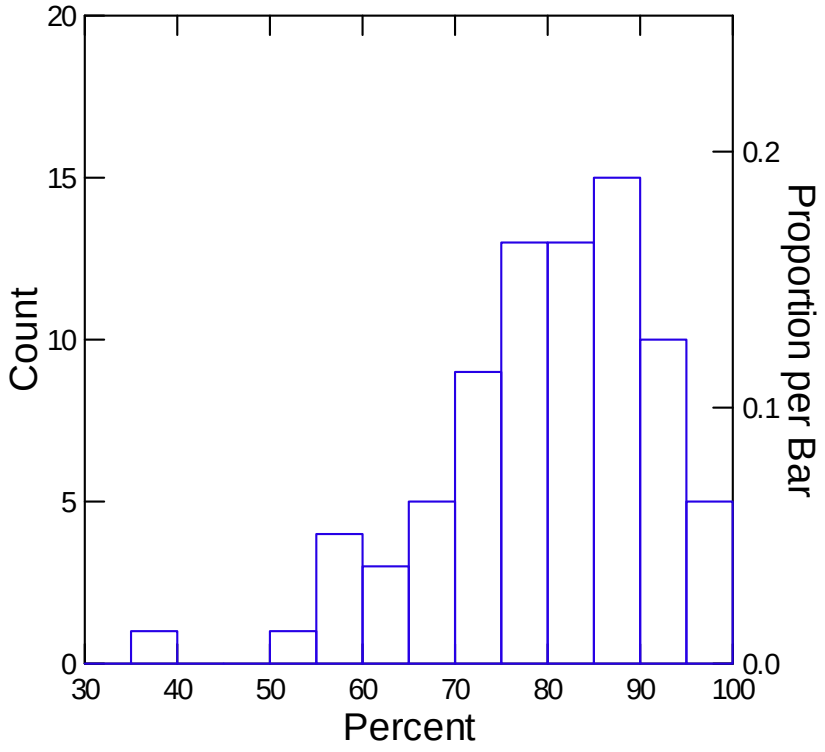
4. Consider the two closely related species of monkeyflowers we studied in class. For these two species, give an example of a prezygotic reproductive isolating mechanism, and an example of a postzygotic reproductive isolating mechanism.

   Several people put down habitat isolation as a prezygotic isolating mechanism. I gave partial credit for this, but it is more than simple geographic separation. From Sinervo's website, he writes, "Barriers are not merely geographic, but have a biological origin and arise during the process of speciation." Technically, habitat isolation refers to two species being biologically adapted to different habitats, and because of this, they do not encounter one another to interbreed. To have gotten full credit for habitat isolation, you needed to include the biological component of local adaptation in addition to the geographic or spatial separation.

   From what we covered in class, an example of a prezygotic isolating mechanism is different flower morphology for each flower species that attracts different species of pollinators. Hummingbirds are attracted to the large nectar loads of *M. cardinalis*, and bees are attracted to the larger flower size and broader flower shape of *M. lewisii*. An example of a postzygotic isolating mechanism is that hybrids are about 50% less fit than the parentals due to lower seed sets, lower seed mass, lower pollen viability, and lower germination rate in the hybrids.

5. What is the difference between *hypothesis* and *theory*, as we use these terms in science?

   An hypothesis is an educated guess of cause and effect to explain a phenomenon; whereas, a theory is a conceptual framework within which a hypothesis is framed.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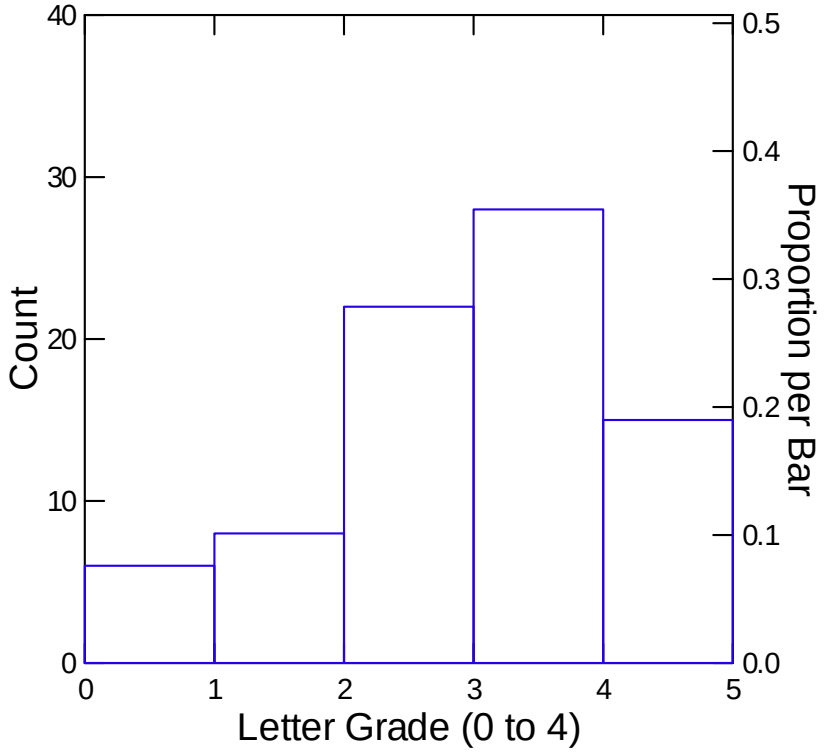
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