RLP-BIOB · RLP Biology B — Ecosystems, Evolution and Human Impact

Unit 4: Behavior, Populations and Population Genetics

Practice Workbook. The same problems, in the same order, as the Practice sections of the online lessons.

Name _____ Period _____

Lesson 4.1 — Phenomenon: The Booming Grounds of Missouri's Prairie-Chickens

FLUENCY

1. A population of 50 grows exponentially with a per-capita rate of 0.05 per year (continuous). Estimate its size after 3 years.

2. A population of 1000 grows exponentially with a per-capita rate of 0.2 per year (continuous). Estimate its size after 8 years.

3. Define a population bottleneck and give the Missouri example from this unit.

APPLICATION

4. MDC estimated about 1,000 prairie-chickens in Missouri in 1998 and about 200 in 2006. Estimate r and the halving time.

5. MDC's estimate for the 1940s ranges from 5,000 to 13,000 birds. Estimate r from 1944 to 1998 (about 1,000 birds) using each end of the range. How sensitive is r to the starting figure, and how does either rate compare with 1998-2006?

6. In an illustrative spring, 60 hens mate on leks attended by 50 males; 10 top-ranked males mate with 48 of the hens and the other 40 males share the remaining 12. Compare the average number of matings per top male and per other male.

CHALLENGE

7. Using the previous problem, explain how the prairie-chicken lek mating system affects both natural selection on males and the loss of genetic variation.

REVIEW

8. Producers in an ecosystem capture 50,000 kJ of energy. Using the 10% rule, about how much energy reaches the tertiary consumers?

Lesson 4.2 — Pill Bug Choices: Investigating Behavior

FLUENCY

1. In 100 observations, 30 pill bugs were on the dry side and 70 on the damp side. Calculate χ^2 against a 50 : 50 expectation.

2. In 100 observations, 58 were on one side and 42 on the other. Calculate χ^2.

3. For each result above, decide at the 0.05 level (critical value 3.84) whether there is evidence of a preference.

APPLICATION

4. A three-way choice chamber (damp leaf litter, damp paper, dry paper) gives 40, 35 and 25 of 100 observations. Test for a preference (critical value 5.99 for 2 degrees of freedom).

5. Explain how a kinesis can bring pill bugs to damp places even though they do not move directly toward moisture.

6. Why does clustering help pill bugs survive in dry conditions, and how could you test this?

CHALLENGE

7. A student counts the same 10 pill bugs every 30 seconds for 5 minutes and treats the 100 counts as independent observations. Explain why this can overstate the evidence, and suggest a better design.

REVIEW

8. In fruit flies, where normal wings (A) are dominant to vestigial wings (a), and in a trait where A (dominant) masks a (recessive), cross Aa × aa. Give the genotype ratio and the probability of the dominant phenotype.

Lesson 4.3 — Alarm Calls and Helpers: When Does Group Behavior Pay?

FLUENCY

1. What is the average relatedness (r) between full siblings? Between a parent and child? Between first cousins?

2. State Hamilton's rule and what each letter means.

3. Give one benefit and one cost of schooling for a gizzard shad.

APPLICATION

4. An alarm call costs the caller 0.05 in extra risk of death and gives each of three sisters a 0.3 better chance of survival. Is the call favored by kin selection?

5. The same call benefits four first cousins (r = 0.125) by 0.1 each, with the same cost of 0.05. Is it favored?

6. Belding's ground squirrel males usually leave the area where they were born, while females stay. Use this to explain why females give more alarm calls.

CHALLENGE

7. Acorn woodpecker helpers feed nestlings that are not their own. Describe two different evolutionary benefits helpers may gain, and the data a researcher would need to tell them apart.

REVIEW

8. (Unit 3) 1% of bacteria are resistant and an antibiotic kills 90% of susceptible ones. What fraction of survivors is resistant after one treatment?

Lesson 4.4 — Hardy-Weinberg and Genetic Drift: Is This Population Evolving?

FLUENCY

1. In a population in Hardy-Weinberg equilibrium, 12.25% show a recessive phenotype. Find the allele frequencies and the proportion of carriers (heterozygotes).

2. In a population in Hardy-Weinberg equilibrium, 9.00% show a recessive phenotype. Find the allele frequencies and the proportion of carriers (heterozygotes).

3. In a population in Hardy-Weinberg equilibrium, 1.44% show a recessive phenotype. Find the allele frequencies and the proportion of carriers (heterozygotes).

4. In a population in Hardy-Weinberg equilibrium, 1.00% show a recessive phenotype. Find the allele frequencies and the proportion of carriers (heterozygotes).

APPLICATION

5. A population has 490 AA, 420 Aa and 90 aa individuals. Find p and q, and decide whether the genotypes fit Hardy-Weinberg proportions.

6. A sample has 30 AA, 10 Aa and 10 aa. Test whether it is in Hardy-Weinberg equilibrium (1 degree of freedom, critical value 3.84).

7. A breeding population has 10 individuals. On average, what fraction of its heterozygosity is kept after one generation and after five generations of drift?

CHALLENGE

8. Compare the heterozygosity kept after 10 generations by a population of 50 breeders with one of 20 breeders. Use the result to explain why conservation plans for rare species try to keep breeding populations large.

REVIEW

9. (Biology A) An ear of 200 kernels from Pp × Pp has 140 purple and 60 yellow. Test the 3 : 1 model with chi-square.

Unit 4 checkpoint

1. Which best explains why only a few male prairie-chickens mate each spring?
   A. Most males are too young to breed
   B. Males display and compete on the lek, and hens choose among them
   C. Females choose randomly
   D. Hens mate before males arrive on the lek
2. In 100 choice-chamber observations, 72 on the damp side and 28 on the dry side give χ² = _____.
3. True or false: Group behavior always benefits every individual in the group.

4. Kin selection predicts that an alarm call is most likely when:
   A. The caller has close relatives nearby
   B. The caller is alone
   C. The predator is far away
   D. The caller is unrelated to everyone

5. If 16% of a population shows a recessive trait, q = _____ and the carrier frequency 2pq = _____.

6. A population in Hardy-Weinberg equilibrium has p = 0.8. What fraction is homozygous AA?
   A. 0.16
   B. 0.32
   C. 0.64
   D. 0.80

7. True or false: A population that is not in Hardy-Weinberg equilibrium is undergoing some evolutionary force, such as selection, drift, migration, mutation or non-random mating.

8. Genetic drift has the greatest effect in:
   A. Very large populations
   B. Small populations
   C. Populations under strong selection only
   D. Populations with many migrants

9. With 20 breeding individuals, the fraction of heterozygosity kept per generation by drift alone is 1 − 1/(2 × 20) = _____.

10. Why did Illinois's prairie-chickens lose genetic variation when their numbers crashed?
    A. They mutate very quickly
    B. They descend from a few survivors, and alleles lost in the bottleneck return only slowly unless birds arrive from other populations
    C. They migrate too much
    D. They are in Hardy-Weinberg equilibrium

11. A sample has 50 AA, 20 Aa and 30 aa. What is p?
    A. 0.50
    B. 0.60
    C. 0.70
    D. 0.40