

1) Pollination by birds occurs at a higher frequency in Hawaii than in continental tropical habitats, suggesting that it is an adaptation to relatively few insect pollinators. Which of the following observations would **refute** this hypothesis?

- a) the continental relatives of Hawaiian plant species are bird pollinated
- b) there are fewer species of insects in the Hawaiian archipelago than nearby continental areas
- c) the nectar rewards of Hawaiian species are larger than their continental relatives
- d) the flowers of Hawaiian species are red, while those of continental species are blue or purple
- e) the bills of Hawaiian birds are slender and often deeply curved
- f) the corolla of Hawaiian species is deeply tubular, while those of continental species are shallow
- g) Hawaiian birds are derived from three independent colonization events

2) In most species of cacti, the leaves have become modified into spines. The genus *Opuntia*, which includes prickly pears, displays considerable variability: some species are densely spined, other have relatively few spines, and still others are spineless. Within a particular region, however, all species of *Opuntia* will have similar amounts of spines. Which of the following is an *evolutionary* hypothesis to explain why spine density varies geographically.

- a) cacti exposed to higher temperatures produce longer spines
- b) cacti exposed to lower humidity produce longer spines
- c) spines are a defense against vertebrate herbivores
- d) cacti exposed to lower soil moisture produce longer spines
- e) it takes more energy to make spines than to be spineless
- f) cacti that are spineless contain poisonous compounds
- g) cacti that are spineless benefit from herbivory

3) Although mimicry often involves a palatable mimic and a poisonous model, in parts of South America several species of poisonous butterflies have evolved to resemble each other. One particular pair of species, *Heliconius melpomene* and *Heliconius erato*, displays considerable geographic variation over the entire range of the species. But at any specific location, the two species closely resemble each other (i.e., at a given site individuals of *H. erato* and *H. melpomene* will more closely look like each other than two populations of *H. erato* from different areas). Color pattern is determined by 8-12 different genes which are not closely linked. In the lab, you can cross individuals of the same species from different populations and produce viable progeny. On the basis of this information, which of the following statements is most likely to be **false**?

- a) visual predators have difficulty telling the two species apart
- b) courtship is likely to involve visual cues
- c) the two species are likely to fly in similar parts of the forest
- d) the two species are likely to fly at similar times of day
- e) each species has higher survival where it co-occurs with the other
- f) hybrids between the two species may not resemble either parent
- g) the primary predators of these species hunt visually

4) Male dragonflies defend territories against other males. Female dragonflies mate with a male and then lay their eggs on aquatic vegetation within his territory. During copulation, the male

removes any sperm already in the female's sperm storage organ. After copulation, the male guards the female, while she is ovipositing, preventing other males from mating with her. Females typically mate many times during their lifetime. Based on the male's behavior, which of the following is most likely to be **false**?

- a) the female will mate with multiple males
- b) the offspring that develop on the male's territory will be his
- c) the female chooses mates on the basis of territory quality
- d) the female receives a direct benefit from mate choice
- e) selection will favor males that can completely remove previously deposited sperm
- f) the male benefits from mate-guarding behavior via higher fertilization success
- g) the female benefits from mate-guarding via higher quality offspring

5) Mallard Ducks are sexually dimorphic: males have a bright green head and a grey and white body pattern while females are a drab, mottled brown. The most closely related species to Mallards, the Black Duck, is sexually monomorphic: both males and females are drab, mottled brown. This pattern occurs repeatedly among the Anseridae (the duck family): among pairs of sister taxa, one species is sexually dimorphic, and the other is monomorphic with "female" coloration. In mallards, females choose mates on the basis of the intensity of the green color of the head (the basis of mate choice in the other species is unknown). Male ducks provide no parental care (in any species). Duck offspring are precocial (they can move and feed on their own), the period of female parental care is relatively brief compared to other species of birds, and the energetic cost to females is lower. Based on the above information, which statement is most likely to be **true**?

- a) females of all species prefer brightly colored males
- b) females of all species will accept a brown male if there are no other choices
- c) females of species where males are brightly colored prefer bright males, females of sexually monomorphic species do not have a preference
- d) brightly colored males will display more vigorously than brown males
- e) brightly colored males will display longer than brown males
- f) brightly colored males confer indirect benefits, brown males do not
- g) brightly colored males confer direct benefits, brown males do not

6) Woodfrogs develop in vernal pools, which are temporary structures that occur in the spring as a result of heavy spring rainfall. Because the ponds eventually dry out, tadpoles that develop rapidly are more likely to survive; thus development rate is likely to be an adaptation to an ephemeral environment. In order to confirm that development rate is an adaptation using an experiment you could:

- a) mark all the woodfrogs in the population
- b) add tadpoles to some vernal pools to increase the population density
- c) add food to some vernal pools to make the tadpoles grow more slowly
- d) add food to some vernal pools to make the tadpoles grow bigger
- e) add water to some vernal pools to make them last longer
- f) conduct a breeding study to determine the genetic covariance between growth rate and size
- g) grow the tadpoles in the laboratory under different temperatures

7) Which of the following is unlikely to be a form of male-male competition?

- a) infanticide in lions
- b) displacement of sperm in dragonflies
- c) guarding of female basking territories in iguanas (a type of lizard)
- d) the lek display of male sage grouse
- e) prolonged copulation in bruchid beetles
- f) transient female mimicry in cuttlefish
- g) repeated copulation in thirteen-lined ground squirrels
- h) the territorial song of a red-winged blackbird

8) The figure below shows an extended pedigree or family tree. For which pair of individuals is the coefficient of relatedness = 0.125?

- a) A and K
- b) A and R
- c) E and S
- d) B and P
- e) J and O
- g) H and R
- h) M and O
- i) N and J

