Past-paper walk-through

Variations in Populations ▪ 7.11

eXercise

Questions in this set

- 2015 Q6
- 2014 Q1
- 2014 Q4

Reading the mark scheme

- **B1** a mark that stands on its own – the point is either made or not.
- **M1** a *method* mark: the right approach, even if the number is wrong.
- **A1** an *answer* mark, and it usually needs its M mark first.
- **C1** a working mark on the way to the answer.
- // separates answers the examiner accepts equally.
- **ecf** = error carried forward: a later part is marked on your own earlier answer.
- **owtte** = "or words to that effect" – the wording need not match.

Question 6

2015 ▪ Q6

In an attempt to rescue a small isolated population of snakes from decline, a few male snakes from several larger populations of the same species were introduced into the population in 1992. The snakes reproduce sexually, and there are abundant resources in the environment.

The figure below shows the results of a study of the snake population both before and after the introduction of the outside males. In the study, the numbers of captured snakes indicate the overall population size.

Question 6

[Bar graph; y-axis "Number of Snakes Captured" from 0 to 35; x-axis "Year" from 1989 to 1999 (odd years labeled: 1989, 1991, 1993, 1995, 1997, 1999). Two bars per year: light gray "Total Snakes Captured" and dark gray "Juvenile Snakes Captured". An arrow labeled "Males from Outside Populations Introduced" points up to the 1992 position on the x-axis. Approximate bar values by year:

Year	Total Snakes Captured	Juvenile Snakes Captured
1989	19	5
1990	17	3
1991	15	4
1992	9	2
1993	6	0
1994	7	1
1995	4	0
1996	8	4
1997	12	5
1998	20	12
1999	32	19

Question 6

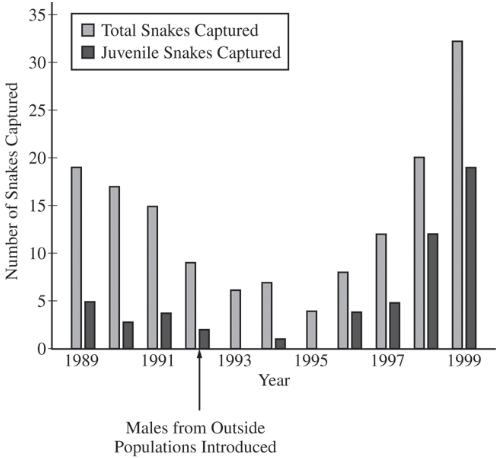
]

(a) Describe ONE characteristic of the original population that may have led to the population's decline in size between 1989 and 1993.

(b) Propose ONE reason that the introduction of the outside males rescued the snake population from decline.

(c) Describe how the data support the statement that there are abundant resources in the environment.

Question 6


Total Snakes Captured
Juvenile Snakes Captured
Number of Snakes Captured
0
5
10
15
20
25
30
35
1989
1991
1993
1995
1997
1999
Year
Males from Outside
Populations Introduced

Solution 6

(a)

Mark scheme

- 1 point for any ONE plausible characteristic of the original (declining) population, e.g.: it lacked genetic diversity/variation; it was an aged/post-reproductive population with not enough young snakes; it had an unfavorable sex ratio/too few males; or it possessed a harmful mutation/disease.

Solution 6

(b)

Mark scheme

- 1 point for any ONE reason the introduction of outside males rescued the population from decline, e.g.: increased genetic diversity in the population; increased reproductive success; established a beneficial sex ratio/sufficient proportion of males for reproduction; or introduced resistance to a disease that was affecting the original population.

Solution 6

(c)

Mark scheme

- 1 point. The data show the (total and juvenile) snake population size increasing/growing after the introduction of outside males (visible in the bar graph from the early-to-late 1990s); a population can only grow this way if resources are abundant — if resources were limited, the population would not be able to grow.

Question 1

2014 ▪ Q1

Trichomes are hairlike outgrowths of the epidermis of plants that are thought to provide protection against being eaten by herbivores (herbivory). In a certain plant species, stem trichome density is genetically determined.

To investigate variation in stem trichome density within the plant species, a student counted the number of trichomes on the stems of six plants in each of three different populations. The student used the data to calculate the mean trichome density (numbers of hairs per square centimeter) for each population. The results are provided in the table below.

TRICHOME DENSITY IN THREE PLANT POPULATIONS (number of trichomes/cm^2)

Question 1

Population	Plant 1	Plant 2	Plant 3	Plant 4	Plant 5	Plant 6	Mean	Standard Error of the Mean (SEM)
I	8	11	9	10	8	6	9	1
II	12	6	15	9	13	8	11	1
III	13	17	9	14	12	16	14	1

[Below the parts is a blank graph grid (approximately 18 columns $\times$ 22 rows) with no axis labels provided, for the student to create their own labeled graph.]

(a) On the axes provided, **create** an appropriately labeled graph to illustrate the sample means of the three populations to within 95

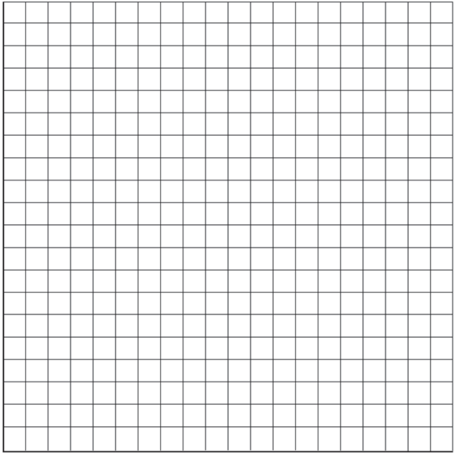
(b) Based on the sample means and standard errors of the means, **identify** the two populations that are most likely to have statistically significant differences in the mean stem trichome densities. **Justify** your response.

(c) **Describe** the independent and dependent variables and a control treatment for an experiment to test the hypothesis that higher trichome density in plants is selected for in the presence of herbivores. **Identify** an appropriate duration of the experiment to

Question 1

ensure that natural selection is measured, and **predict** the experimental results that would support the hypothesis.

Question 1



Question 1

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Solution 1

(a)

Mark scheme

- Construct a bar graph (or modified bar graph) plotting the sample mean trichome density for each population — Population I $= 9$, Population II $= 11$, Population III $= 14$ trichomes/cm^2 — with error bars extending ± 2 SEM (each SEM $= 1$, so bars span mean-2 to mean$+2$). Full credit (3 points) requires: (1) axes correctly labeled and scaled with proper units (trichome density in trichomes/cm^2; Populations I, II, III); (2) a bar graph or modified bar graph with the means correctly plotted; (3) error bars showing $2\times$SEM above and below each mean.

Solution 1

(b)

Mark scheme

- Identification (1 point): Populations I and III. Justification (1 point): the 95% confidence intervals (mean $\pm$ 2 SEM) for Populations I and III do not overlap — Population I's upper bound ($9 + 2 = 11$) is less than Population III's lower bound ($14 - 2 = 12$), i.e. (sample mean + 2 SEM of Population I) $<$ (sample mean $-$ 2 SEM of Population III).

Solution 1

(c) Mark scheme

- Present independent variable, dependent variable, control, duration, and prediction consistently — points are earned in a single row only (5 points max). Accepted row 1: Independent variable = presence of herbivores (1 pt); Dependent variable = trichome density (1 pt); Control = absence of herbivores (1 pt); Duration = more than one generation (1 pt); Prediction = increased trichome density relative to control (1 pt). Accepted row 2: Independent variable = trichome density in the presence of herbivores; Dependent variable = reproductive success OR number of plants; Control = plants with lower trichome density; Duration = more than one generation; Prediction = size of the population with higher trichome density will be larger than the control population.

Question 4

2014 ▪ Q4

Adult male guppies (*Poecilia reticulata*) exhibit genetically determined spots, while juvenile and adult female guppies lack spots. In a study of selection, male and female guppies from genetically diverse populations were collected from different mountain streams and placed together in an isolated environment containing no predators.
The study population was maintained for several generations in the isolated area before being separated into two groups. One group was moved to an artificial pond containing a fish predator, while a second group was moved to an artificial pond containing no predators. The two groups went through several generations in their new environments. At different times during the experiment, the mean number of spots per adult male guppy was determined as shown in the figure below. Vertical bars in the figure represent two standard errors of the mean (SEM).

Question 4

[Line graph titled "Mean Number of Spots per Adult Male Guppy" vs. "Time (months)"; y-axis from ~8 (with a break symbol) to 14 in increments of 1; x-axis from 0 to 20, tick marks at 0, 10, 20. A vertical dotted arrow labeled "Population Separated into Groups" points to approximately month 6. Two data series with error bars (± 2 SEM): "Predator present" (dashed line) starting at (0,10) with a very large error bar (from about 8.2 to 11.9), rising to a peak at (6,11.8), then declining to (10,10.5) and (20,9.3). "Predator absent" (solid line) starting at (0,10) with the same large error bar, rising to (6,11.8), continuing to rise to (10,12.5) and (20,13.2). Both lines coincide from month 0 to month 6, then diverge after separation into groups.]

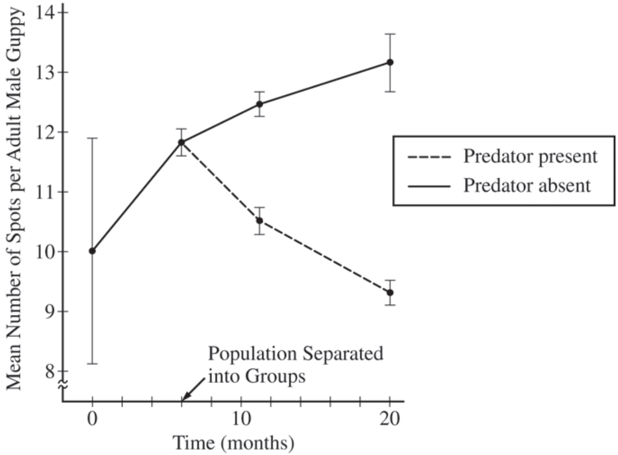
(a) Describe the change in genetic variation in the population between 0 and 6 months and **provide** reasoning for your description based on the means and SEM.

Question 4

(b) Propose ONE type of mating behavior that could have resulted in the observed change in the number of spots per adult male guppy between 6 and 20 months in the absence of the predator.

(c) Propose an evolutionary mechanism that explains the change in average number of spots between 6 and 20 months in the presence of the predator.

Question 4



Mean Number of Spots per Adult Male Guppy
14
13
12
11
10
9
8
0
10
20
Time (months)
Population Separated into Groups
Predator present
Predator absent

Solution 4

(a)

Mark scheme

- Describe change (1 point): genetic variation is decreasing between 0 and 6 months. Provide reasoning (1 point): the SEM (standard error of the mean) gets smaller over this interval.

Solution 4

(b)

Mark scheme

- 1 point for proposing a plausible mating behavior, e.g.: sexual selection for individuals with more spots, OR random mating behavior resulted in an increased number of spots by chance.

Solution 4

(c)

Mark scheme

- 1 point for proposing a plausible evolutionary mechanism, e.g.: directional selection against individuals with large numbers of spots / directional selection for individuals with fewer spots (natural selection used in context), OR genetic drift resulting in several generations of decreased numbers of spots.