Populations and sustainability – 2021/20 GCE Biology A Component 02

1. Nov/2021/Paper_H420/02/No.20

Charles Darwin visited the Galapagos Islands in the 1820s. The organisms living on the Galapagos Islands provided Darwin with evidence that helped him to develop his theory of evolution by natural selection.

(a) Finches are small birds that are common on the Galapagos Islands.

The variation in the sizes of beak of the various Galapagos finch species provided evidence for evolution by natural selection.

Scientists recently studied the beak sizes of two species of Galapagos finch living on the same island, *Geospiza fuliginosa* and *Geospiza fortis*.

Beak size is an overall measurement that includes length, depth and width. The arbitrary units are relative to the average of all of the individual birds measured.

Some of the scientists' results are shown in **Fig. 20.1**.

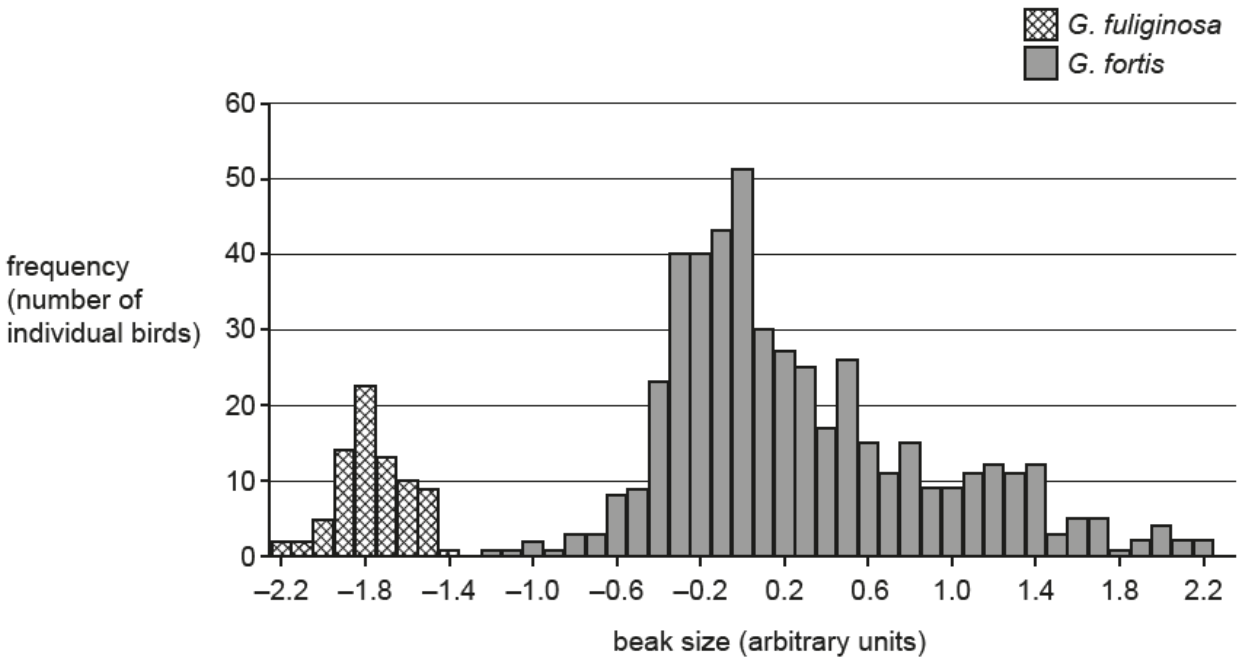

Fig. 20.1

(i) Identify the modal beak size of *G. fuliginosa*.

Size = ... arbitrary units **[1]**

(ii) Calculate the range of *G. fuliginosa* beak size as a proportion of the range of *G. fortis* beak size.

Give your answer to **2** significant figures.

Proportion = ... **[2]**

(iii) The scientists concluded that the data showed evidence of disruptive selection in the population of *G. fortis*. In disruptive selection, extreme phenotypes are selected for and average phenotypes selected against.

Evaluate the conclusion that disruptive selection is occurring in *G. fortis*.

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..... **[3]**

(b) The *G. fortis* all live in the same location. If disruptive selection is occurring in the *G. fortis* population, it is possible that speciation might occur.

(i) Name the type of speciation that occurs when two populations live in the same location.

..... **[1]**

(ii) Suggest how *G. fortis* with large beaks could become reproductively isolated from *G. fortis* with small beaks despite living in the same location.

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..... **[1]**

(iii) Comparing anatomy between species such as beak size in finches can be used to provide evidence to support the theory of evolution by natural selection.

Describe how DNA can be used to provide evidence to support the theory of evolution by natural selection.

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..... **[2]**

(c)* In the 1970s, another group of scientists studied beak sizes in one species of finch on Daphne Island, one of the Galapagos Islands. The study lasted three years. The results are shown in **Fig. 20.2**.

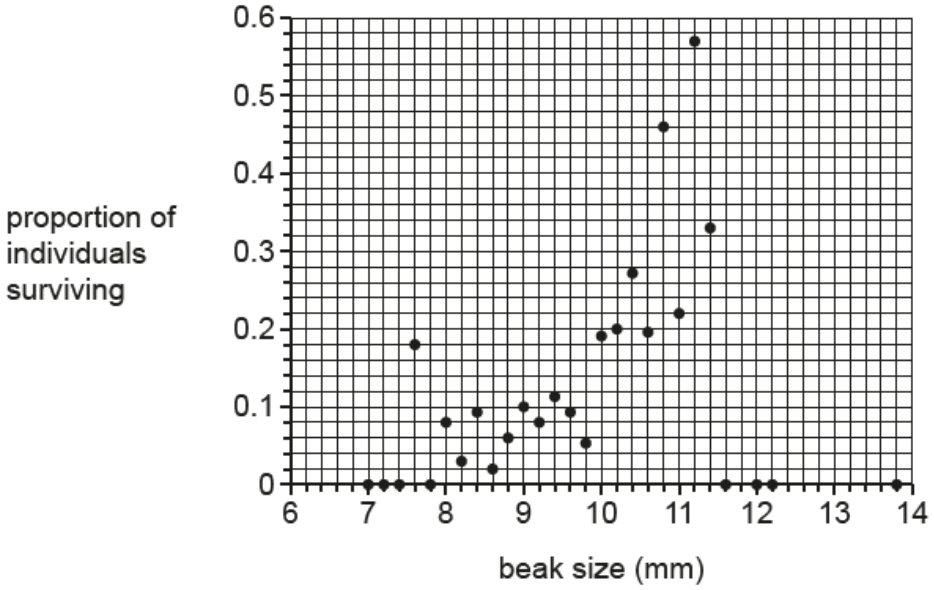

Fig. 20.2

The results suggested that stabilising selection was occurring within this population of finches.

With reference to **Fig. 20.2**, explain the effect of stabilising selection on beak size on Daphne Island. **[6]**

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(d) Alfred Russel Wallace is another important figure in the understanding of evolution.

Outline the way in which Wallace contributed to the acceptance of Darwin's theory of natural selection by the wider scientific community.

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..... **[2]**

2. Nov/2020/Paper_H420/02/No.13

The nitrogen cycle involves a range of reactions and microorganisms.

Which of the following processes, **A** to **D**, usually occurs under anaerobic conditions?

A conversion of amino acids to ammonium compounds

B conversion of urea to ammonium compounds

C nitrification

D nitrogen fixation

Your answer ☐ **[1]**

3. Nov/2020/Paper_H420/02/No.14

Which of the following bacteria, **A** to **D**, convert ammonium compounds to nitrites?

A *Azotobacter*

B *Nitrobacter*

C *Nitrosomonas*

D *Rhizobium*

Your answer ☐ **[1]**

4. Nov/2020/Paper_H420/02/No.15

Ash trees are common throughout the UK. They often grow in dense woodland.

Which of the following, **A** to **D**, is an abiotic factor that is likely to affect the growth of young ash trees?

A the availability of light underneath larger trees in the wood

B the availability of oxygen in the air

C the presence of a pathogen that causes ash dieback disease

D the species of bacteria present in the soil

Your answer ☐ **[1]**

5. Nov/2020/Paper_H420/02/No.18

Individuals within populations vary. Much of this variation is under genetic control.

(a) Two groups of scientists were studying genetic polymorphism in fruit flies.

They extracted DNA from two different species of fruit fly, A and B.

The first group of scientists studied 26 gene loci from species A. They calculated the genetic polymorphism of species A to be 0.35.

The second group of scientists studied 32 gene loci from species B. They found that 13 of the gene loci were polymorphic.

(i) Calculate the proportion of genetic polymorphic gene loci of species B.

proportion = ... **[2]**

(ii) Evaluate the conclusion that species B shows greater genetic polymorphism than species A.

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..... **[3]**

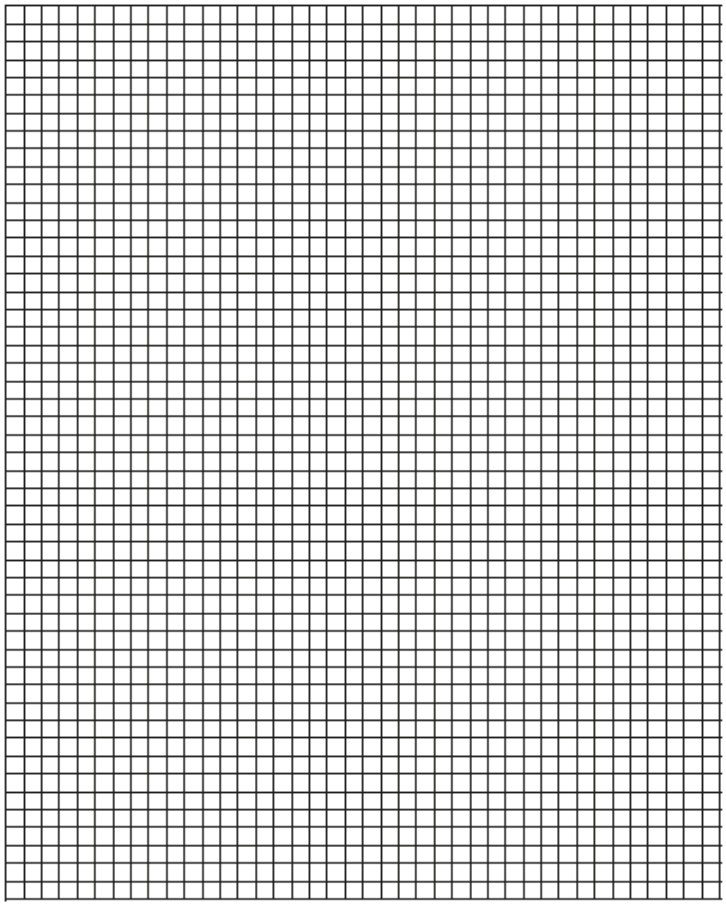
(b) When studying variation, it is sometimes impractical to analyse DNA.

A student was investigating variation between a number of students in their school. They recorded the frequency of students that could and could not roll their tongue.

The results are shown in the table.

Phenotype	Frequency	
	Females	Males
Tongue-rolling	83	88
Non tongue-rolling	43	34

(i) Represent the data in the table as a bar chart on the grid provided below.



[4]

(ii) Since 1940, people have believed that the ability to roll the tongue is caused by a single gene with two alleles.

R is dominant and allows tongue-rolling.

r is recessive and does not allow tongue-rolling.

The genotype of students who can roll their tongue could be either RR or Rr.

In the results shown in the table opposite

- the total number of students who could roll their tongue = **171**
- the total number of students who could not roll their tongue = **77**.

The Hardy–Weinberg principle allows us to estimate the proportion of each genotype.

Use the Hardy–Weinberg principle to estimate the proportion of heterozygous individuals in the school survey in the table.

Use the equations:

$p^2 + 2pq + q^2 = 1$

$p + q = 1$

proportion = ... **[3]**

(iii) The Hardy–Weinberg principle might not give an accurate estimate of the proportion of genotypes for the results of the student's investigation.

The population of students varies from year to year and so cannot be said to be stable.

State **two other** reasons why it might be inappropriate to use the Hardy–Weinberg principle to estimate allele frequencies for the results in the table.

1 .....

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2 .....

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[2]