

4 The wolf, *Canis lupus*, lives in North America. Wolves may have a grey or a black coat colour. The colour of an individual wolf depends on the DNA it inherits at the *CPD103* gene locus.

- Wolves inherit two copies of *CPD103*, one from each parent.
- Wolves that inherit one copy of the black form of the *CPD103* gene have a black coat.

(a) State the term used to describe:

- an organism that has two copies of each gene
- a form of a gene
- a form of a gene that gives a phenotypic effect in a heterozygote.

[3]

In addition to producing black coat colour, the protein coded for by the *CPD103* gene also defends against infectious lung disease.

Canine distemper virus (CDV) causes serious lung disease in wolves. Wolves that have been previously infected by CDV have antibodies against CDV (anti-CDV antibodies) in their blood.

(b) CDV can be passed from domestic dogs to wolves.

- Domestic dogs are more numerous in the southern part of the area occupied by wolves.
- Domestic dogs are less numerous in the northern part of the area occupied by wolves.
- The relative frequency of black wolves compared to grey wolves increases from the north to the south of the area they occupy.

Explain how natural selection causes this trend in the distribution of black wolves.

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(c) Several different populations of wolves were compared.

Fig. 4.1 shows the relationship between the percentage of wolves in a population that have anti-CDV antibodies in their blood and the percentage of wolves in that population that are black. The line of best fit was calculated after comparing the different populations of wolves.

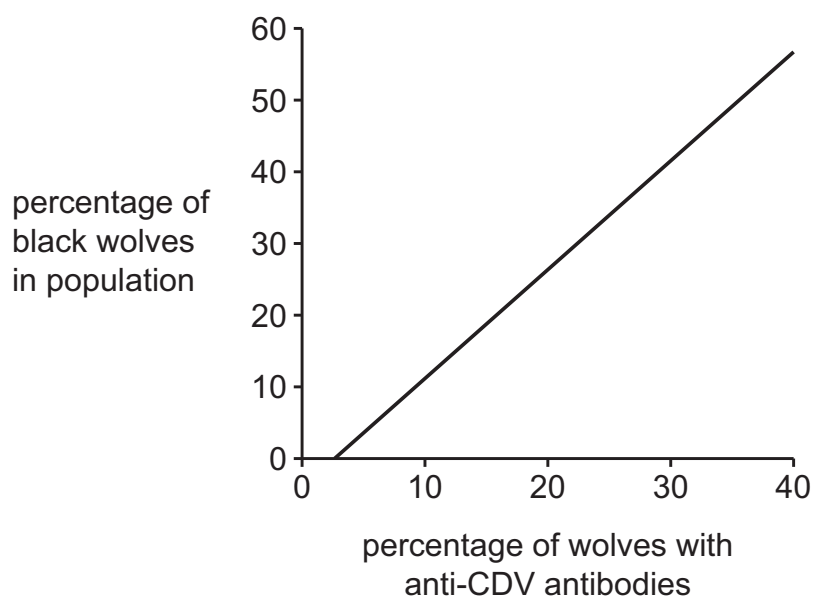


Fig. 4.1

With reference to Fig. 4.1, state the relationship between the percentage of wolves with anti-CDV antibodies and wolf coat colour, **and** suggest reasons for this relationship.

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[Total: 11]

4 The evolution of antibiotic resistance in bacteria has occurred as a result of natural selection.

(a) Name **two** ways in which a bacterium can become resistant to an antibiotic.

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(b) The World Health Organisation regularly analyses bacterial DNA sequence data.

Suggest **one** way in which this contributes to solving the problem of antibiotic resistance in bacteria.

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(c) Some infectious bacterial diseases are treated with the antibiotic streptomycin.

If a person does **not** finish the prescribed course of streptomycin, bacteria are more likely to become resistant to the antibiotic.

Explain why a streptomycin-resistant strain of bacteria is more likely to develop as a result of natural selection when a person does **not** complete the prescribed course of antibiotics.

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[Total: 6]

Question 5 starts on page 12.

5 The Galápagos is a group of islands with a high biodiversity.

- (a) *Geospiza fortis* is one of the many species of finch that live on the Galápagos islands. On one of the Galápagos islands, Daphne Major, scientists measured the bill size (length, width and depth) of individuals in a population of *G. fortis* over several years.

Fig. 5.1 shows a *G. fortis* female.



Fig. 5.1

G. fortis feed on seeds. Seed size and bill size vary. It is easier for *G. fortis* with smaller bills to eat small seeds and for *G. fortis* with larger bills to eat large seeds.

In 1977, a drought occurred on Daphne Major, which resulted in a large decrease in the availability of seeds, particularly small seeds.

Scientists observed an increase in the mean bill size in the *G. fortis* population on Daphne Major after the drought.

- (i) State the type of natural selection that occurred in the *G. fortis* population on Daphne Major as a result of the drought.

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- (ii) Fig. 5.2 shows the distribution of bill size in the *G. fortis* population before the drought in 1977.

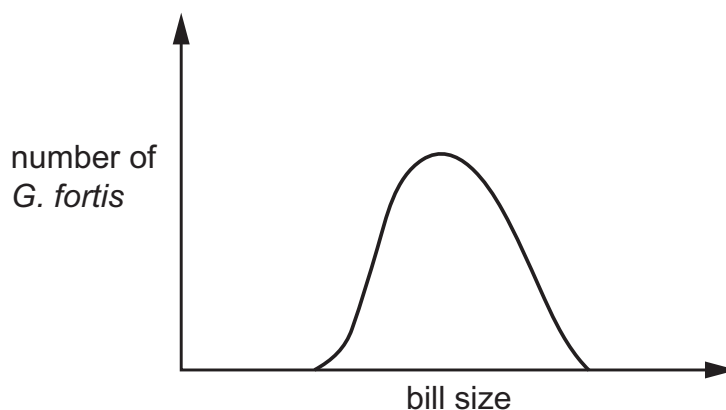


Fig. 5.2

Sketch a new curve on Fig. 5.2 to show the distribution of bill size in the *G. fortis* population after the drought.

(b) *G. fortis* also lives on Santa Cruz, another island in the Galápagos.

Most of the seeds available for *G. fortis* to eat on Santa Cruz are either small or large. There are few intermediate sizes of seed.

Fig. 5.3 shows the distribution of bill size in the *G. fortis* population on Santa Cruz.

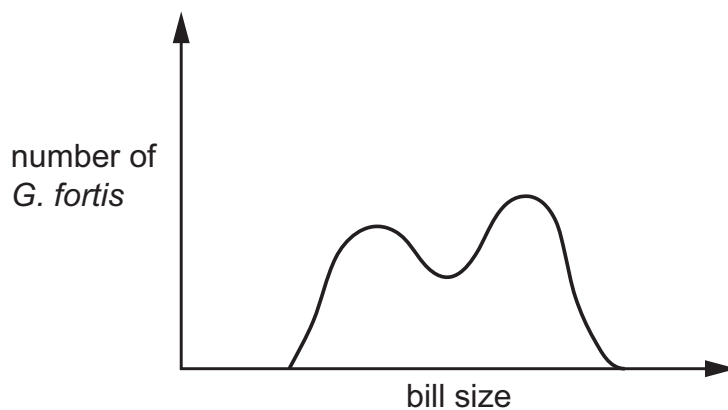


Fig. 5.3

Explain how natural selection in the *G. fortis* population on Santa Cruz has resulted in the distribution in bill size shown in Fig. 5.3.

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- (c) Scientists studied the effect of an increase in the number of tourists each year on the number of invasive alien species present in the Galápagos islands.

The scientists recorded the number of invasive alien species present each year in the Galápagos islands over many years. The scientists also recorded the number of tourists visiting the islands each year.

Fig. 5.4 shows a graph of the data for five different years during the study.

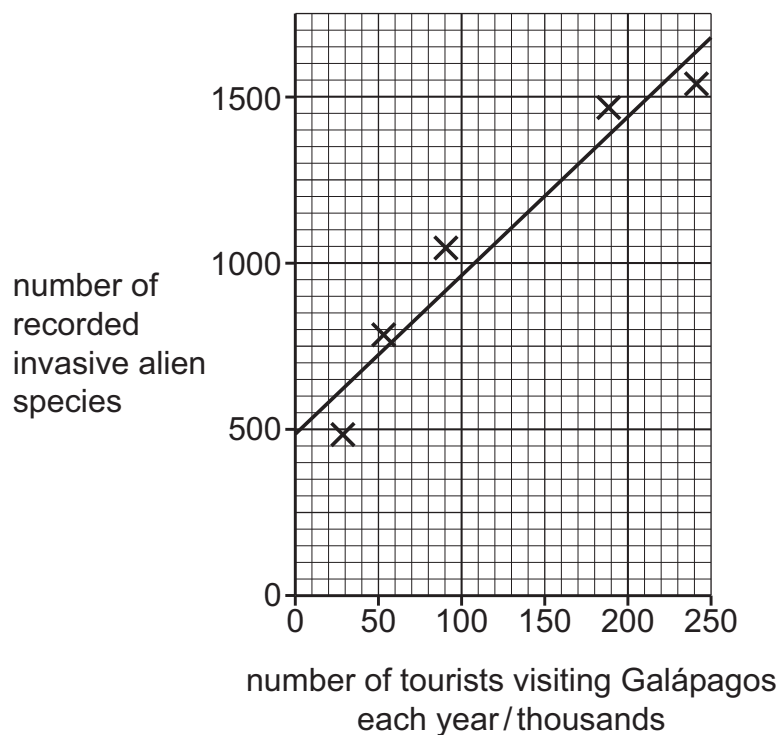


Fig. 5.4

- (i) The scientists carried out a Pearson's linear correlation calculation for the data in Fig. 5.4.

The scientists calculated an r value of 0.930.

The scientists concluded that there is a significant correlation between the number of tourists visiting the Galápagos islands each year and the number of invasive alien species present.

Table 5.1 shows a probability table of critical values for Pearson’s linear correlation.

Table 5.1

number of observations	probability level (<i>p</i>)	
	0.05	0.01
3	0.997	1.000
4	0.950	0.990
5	0.878	0.959
6	0.811	0.917
7	0.754	0.875

With reference to Table 5.1, explain why the *r* value of 0.930 indicates that there is a significant correlation between the number of tourists and the number of invasive alien species.

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(ii) Invasive alien species are thought to have contributed to extinctions recorded in the Galápagos islands.

Discuss the negative effects of introducing invasive alien species to an ecosystem.

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(iii) State **two** factors, other than competition and the introduction of invasive alien species, that can cause extinction.

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