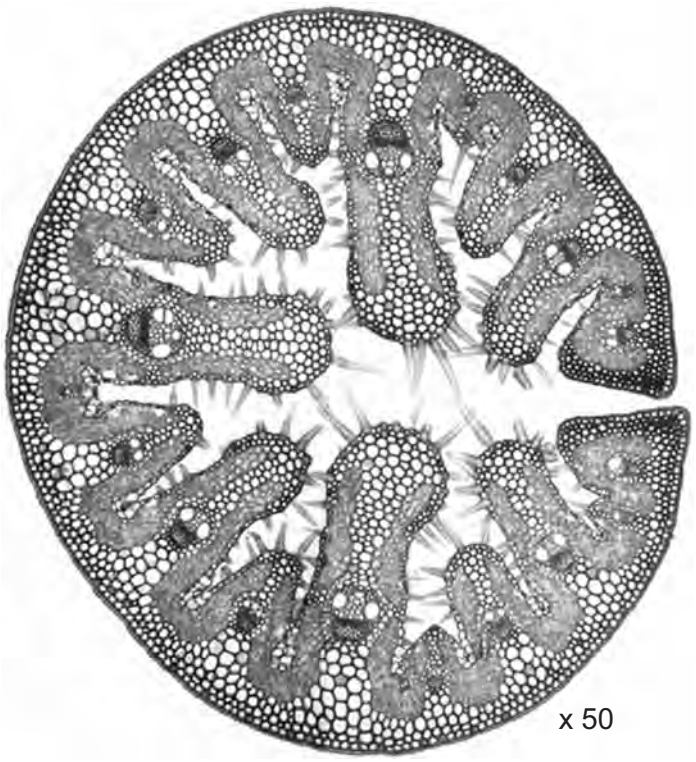
1

Fig. 4.2 shows a cactus plant.

Both plants live in very dry conditions.



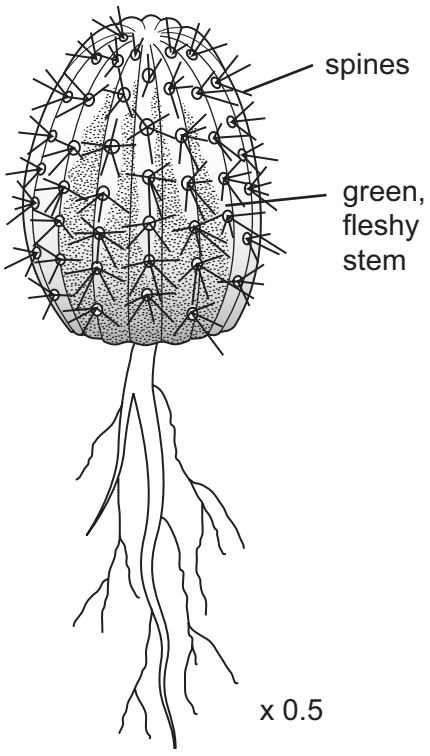


Fig. 4.1 **Fig. 4.2**

(a) Suggest how each of the following adaptations would enable the named plant to survive in very dry conditions.

(i) *Ammophila*

1. rolled leaves with stomata on the inside of the le

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..... [2]

2. thick waxy cuticle on the outside of the le

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..... [1]

(ii) Cactus

1. very long roo

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..... [1]

2. fleshy green st

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..... [2]

(b) Suggest why having only a few, very small leaves could be a disadvantage to a plant.

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..... [2]

(c) Water is involved in a number of processes in plants.

Complete the table by

(i) naming the processes described;

(ii) stating one variable that, if increased, would speed up the process.

description of process	name of process	variable that, if increased, would speed up the process
absorption of water from the soil	.....	....
using water to form glucose	.....	....
movement of water vapour out of leaves	.....	....

[6]

[Total: 14]

2 Cicadas are insects that make a lot of noise.

Fig. 1.1 shows an adult chorus cicada, *Amphipsalta zelandica*, that is only found in New Zealand.

Fig. 1.1

(a) State three features, **visible in Fig. 1.1**, that show that the chorus cicada is an insect.

1 .....

2 .....

3 ..... [3]

(b) Insects are classified in the same group as crustaceans, arachnids and myriapods.

Name the group that contains all these animals.

..... [1]

Evolutionary relationships between different species are investigated by examining DNA.

(c) State precisely where DNA is found in a cell.

.....

..... [2]

Small sections of DNA in 14 species of cicada found in Australia, New Caledonia and New Zealand (**1** to **14**) were examined for similarities and differences.

The results of the DNA examination of these species were used to make a diagram showing how these cicada species may have evolved. Species that are closely related are grouped together on the right of Fig. 1.2.

The brackets show that the cicada species in New Zealand are in two separate groups.

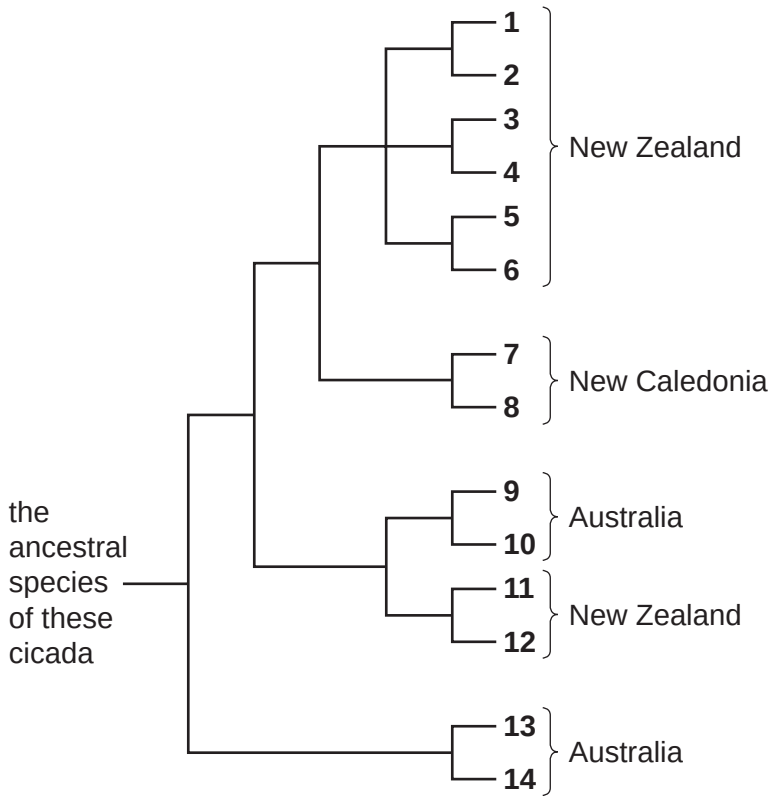

Fig. 1.2

(d) It is suggested that the eight cicada species in New Zealand originated from two migrations, **A** and **B**, from Australia as shown in Fig.1.3.

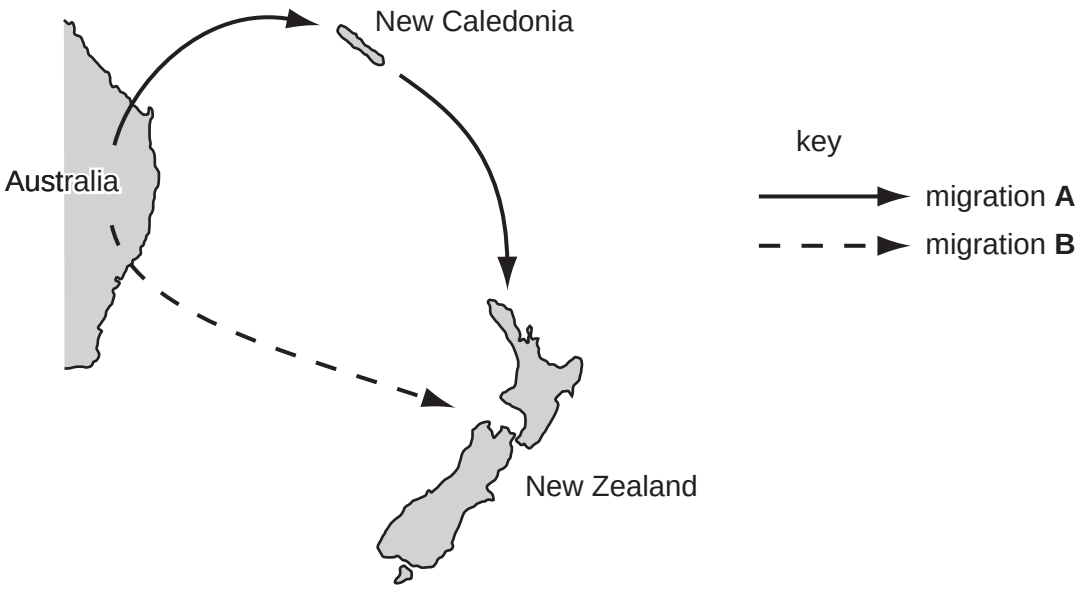

Fig. 1.3

Explain how the results in Fig. 1.2 support the idea that the eight cicada species in New Zealand originated from two migrations of cicadas as shown in Fig. 1.3.

You can use the numbers from Fig. 1.2 in your answer.

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..... [3]

Islands in the Pacific have been colonised by populations of animals that have migrated from Australia, mainland Asia and the Americas. Over many generations these populations have changed. Now they are unable to breed with animals of the original populations in Australia, mainland Asia and the Americas.

(e) Explain how natural selection has resulted in changes in the populations of animals on islands in the Pacific.

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..... [4]

[Total: 13]

3 Two species of beetle, *Tribolium castaneum* and *T. confusum*, can infest and eat stored flour.

In an investigation these two species were kept together in containers of flour under different environmental conditions.

Many identical containers were set up, each with the same mass of flour.

Equal numbers of male and female flour beetles of the two species were put into each container at the start.

The numbers of beetles were counted regularly.

The containers were left until only one species survived.

Table 5.1 shows the percentage of containers in which *T. castaneum* or *T. confusum* were the only survivors.

Table 5.1

environmental conditions	percentage of containers in which only *T. castaneum* survived / %	percentage of containers in which only *T. confusum* survived / %
A hot and wet	100	0
B hot and dry	10	90
C warm and wet	86	14
D warm and dry	13	87
E cold and wet	29	71
F cold and dry	0	100

(a) Compare the survival of the two species of flour beetle in different temperatures and humidities.

Use data from Table 5.1 to illustrate your answer.

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..... [4]

(b) Suggest why only one species survived in each container.

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..... [2]

There is a gene in *T. confusum* which controls body colour.

A represents the dominant allele for red-brown body colour.

a represents the recessive allele for black body colour.

(c) Complete the genetic diagram below to show the colour of beetles produced when heterozygous beetles are crossed with beetles that are homozygous recessive for this gene.

parental phenotypes ..... × .....

parental genotypes ..... × .....

gametes  +

offspring genotypes .....

offspring phenotypes .....

ratio of phenotypes .....

[4]

The eyes of *Tribolium* species are usually black. A very small number of flour beetles have white eyes.

(d) Explain how this happens and why they are so rare.

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..... [2]

(e) Insect pests, such as flour beetles, eat the flour and deposit nitrogenous waste in urine and faeces into the flour. This leads to the growth of bacteria and fungi in the flour.

Suggest **and** explain what happens to the nitrogenous waste and the faeces released by the flour beetles.

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..... [4]

[Total: 16]

4 **(a** Define the term *gene*.

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..... [1]

The medical condition sickle cell anaemia is widely distributed in Africa, parts of Asia and the Americas. People with sickle cell anaemia have red blood cells with an abnormal form of haemoglobin.

The gene for haemoglobin exists in two forms:

$\mathbf{H^N}$ = allele for normal haemoglobin
$\mathbf{H^S}$ = allele for abnormal haemoglobin

(b) Complete the genetic diagram below to show how two people who are heterozygous for this gene may have a child who has sickle cell anaemia.

Use the symbols H^N and H^S in your answer.

parental phenotypes	normal	x	normal
parental genotypes	…….	x	…….
gametes	…….	+	…….

child's genotype	…….
child's phenotype	sickle cell anaemia

[3]

(c) Describe the effects of sickle cell anaemia on the body.

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..... [4]

(d) Fig. 5.1 is a map that shows the distribution of the allele for the abnormal form of haemoglobin ($\mathbf{H^S}$) and malaria in Africa.

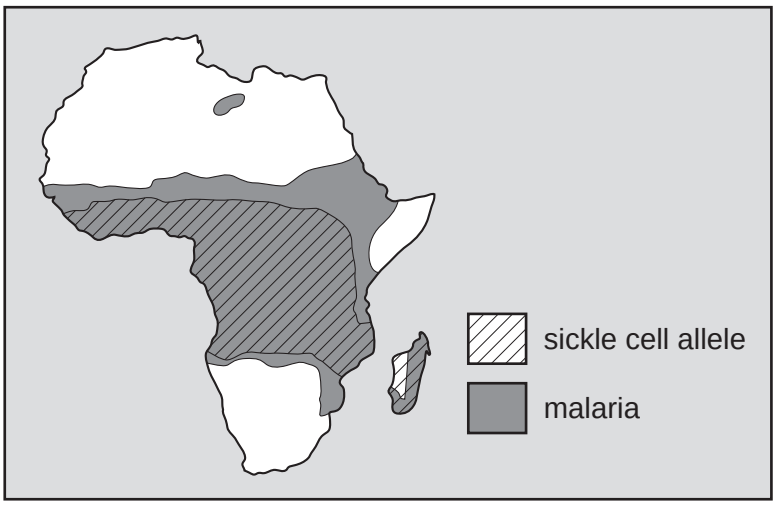

Fig. 5.1

Explain how natural selection is responsible for the distribution of the allele for the abnormal form of haemoglobin ($\mathbf{H^S}$).

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..... [5]

(e) Sickle cell anaemia is an example of the variation that exists in the human population. It is a form of discontinuous variation.

Explain why sickle cell anaemia is a form of discontinuous variation.

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..... [3]

[Total: 16]