1. June/2022/Paper_41/No.5

Two subspecies of reindeer, *Rangifer tarandus*, live in North America. Members of the different subspecies belong to the same species but have some morphological differences and are found in different geographical locations.

Fig. 5.1 shows a reindeer.

Fig. 5.1

Table 5.1 compares the features of the two North American reindeer subspecies.

Table 5.1

feature	**woodland subspecies, *R. tarandus caribou***	**barren ground subspecies, *R. tarandus groenlandicus***
habitat	southern woodland (warmer)	northern tundra (colder)
type of food	tree leaves, grass	lichens, moss
summer and winter feeding grounds overlap	yes	no
carry out long migrations	no	yes
body size	large	small
colour of fur	dark	light

(a) During the last ice age an ice sheet separated southern and northern populations of *R. tarandus* in North America.

Explain how this ice sheet affected the evolution of *R. tarandus* to result in the two different subspecies.

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(b) Assess the relative importance of natural selection and genetic drift in producing:

(i) the different colours of fur of the two subspecies of reindeer

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(ii) the different body sizes of the two subspecies of reindeer.

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(c) Hybridisation has occurred between individuals of the two subspecies which now live in the area previously covered by the ice sheet.

Comment on how the hybrid populations compare to the pure subspecies in terms of genetic variation and potential to adapt to climate change.

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(d) Outline how practical techniques could be used to test the hypothesis that migratory behaviour in reindeer has a genetic basis.

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[Total: 14]

2. June/2022/Paper_42/No.5

Bison are a type of large wild cattle. Ancestors of modern bison appeared in Asia 2.5 million years ago. This ancestral bison species increased its range into Europe and North America.

While the ancestral species is now extinct, its descendants include *Bison bonasus*, the European bison, and *Bison bison*, the American bison.

Fig. 5.1 shows an American bison.

Fig. 5.1

(a) After the end of the last ice age, populations of the ancestral bison were separated by sea and by forests that were not suitable as habitats. The separation resulted in the evolution of the European bison and the American bison.

Explain how this separation resulted in the evolution of the two bison species.

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(b) Table 5.1 compares features of European bison and American bison.

Table 5.1

feature	European bison, *B. bonasus*	American bison, *B. bison*
type of food	grass and higher vegetation such as leaves of bushes and trees	grass and low vegetation
height/m	2.1	2.0
maximum mass/kg	1000	1270

Assess the relative importance of natural selection and genetic drift in producing the different heights and masses of the two species of bison.

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(c) The European bison has a nuclear genome that is very similar to that of the American bison. The European bison has a mitochondrial genome that is more similar to that of wild cattle of the genus *Bos* than to the American bison.

Discuss what this implies about the evolutionary history of the European bison.

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(d) Outline how practical techniques could be used to test the hypothesis that farmed cattle are closely related to European bison.

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3. June/2022/Paper_43/No.5

The puma, *Puma concolor*, lives in North and South America.

Fig. 5.1 shows a puma.

Fig 5.2 shows the distribution of the puma species.

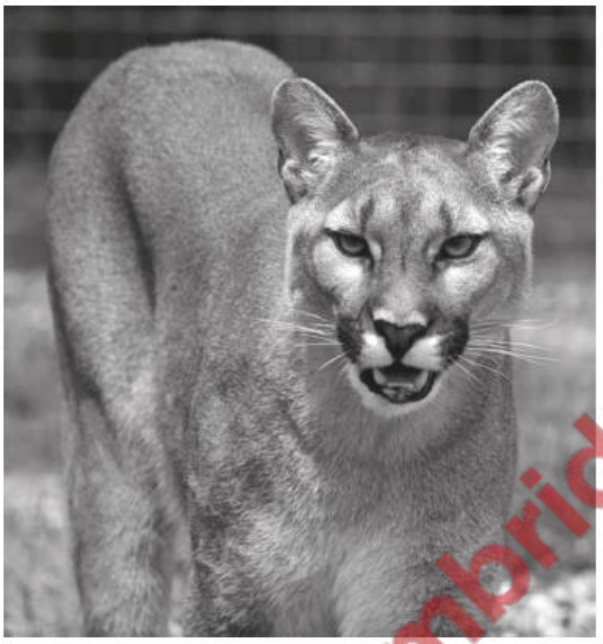

Fig. 5.1

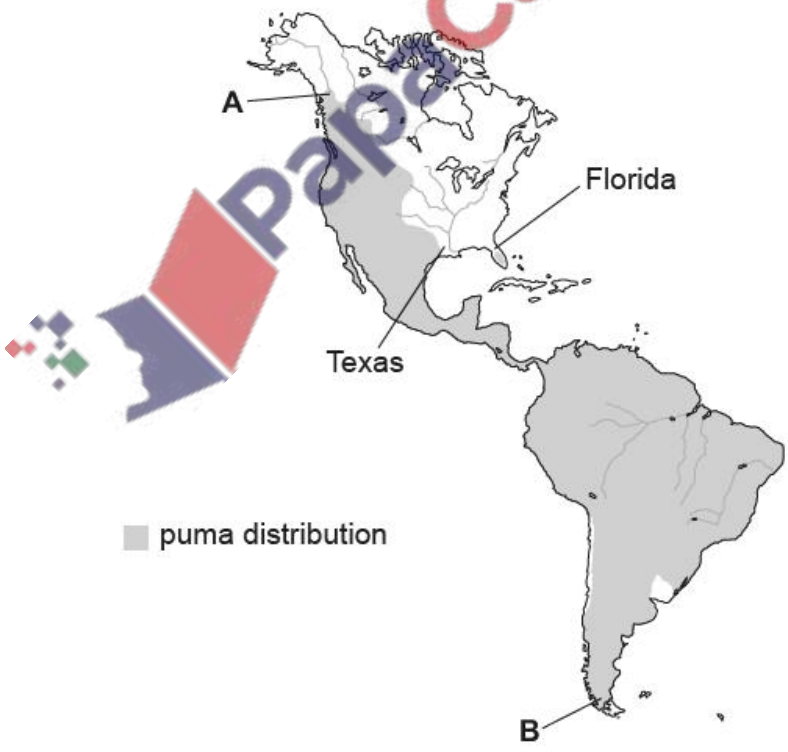

Fig. 5.2

(a) Members of different subspecies belong to the same species but have some morphological differences and are found in different geographical locations.

In the past the puma has been divided into 32 subspecies. The subspecies of puma varied in body size, coat colour and behaviour to adapt each population to its environment.

Explain how the different subspecies of puma evolved.

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In 2016, genetic analysis concluded that there are only two genetically distinct subspecies of puma, one in North and Central America and one in South America.

(b) Outline how practical techniques could be used to conduct a genetic analysis of the puma species.

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(c) Fig. 5.2 shows the location of an isolated puma population in Florida. In 1990, the size of this population was very small, with fewer than 30 individuals.

Three phenotypic features that vary in pumas are the shape of the tail, the pattern of hair growth on the back and the position of the testes in male pumas.

Variant forms of these phenotypic features that are normally rare occur at a high frequency in the small Florida population. These variant forms are:

- bent tail
- abnormal pattern of hair growth on the back
- testes remain in abdomen (undescended) in some male pumas.

(i) Predict, with reasons, whether these phenotypic features show a continuous or a discontinuous pattern of variation.

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(ii) Explain how the small size of the Florida population resulted in a high frequency of these normally rare variant forms.

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(iii) In 1995, eight puma females from Texas were introduced to Florida to increase the breeding success and future size of the puma population in Florida. In the next 20 years the population grew substantially.

Suggest why the introduced females were taken from Texas and not from points **A** or **B** on Fig. 5.2.

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