

**OXFORD CAMBRIDGE AND RSA EXAMINATIONS**

**Advanced GCE**

**BIOLOGY**

**2806/01**

Unifying Concepts in Biology

Thursday

**22 JANUARY 2004**

Morning

1 hour 15 minutes

Candidates answer on the question paper.

Additional materials:

Electronic calculator

Ruler (cm/mm)

Candidate Name	Centre Number	Candidate Number										
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**TIME** 1 hour 15 minutes

**INSTRUCTIONS TO CANDIDATES**

- Write your name in the space above.
- Write your Centre number and Candidate number in the boxes above.
- Answer **all** the questions.
- Write your answers, in blue or black ink, in the spaces provided on the question paper.
- Read each question carefully before starting your answer.

**INFORMATION FOR CANDIDATES**

- The number of marks is given in brackets [ ] at the end of each question or part question.
- You will be awarded marks for the quality of written communication where this is indicated in the question.
- You may use an electronic calculator.
- You are advised to show all the steps in any calculations.

FOR EXAMINER'S USE		
Qu	Max.	Mark
1	8	
2	12	
3	18	
4	12	
5	10	
<b>TOTAL</b>	<b>60</b>	

**This question paper consists of 15 printed pages, 1 blank page and an insert.**

Answer **all** the questions.

- 1 The body of an insect has a complex system of tubes, containing air, which open to the atmosphere via pairs of holes, called spiracles. The tubes are called tracheae and their finest branches, which are about 2 μm in diameter, are called tracheoles. Each cell of the body is very close to a tracheole. Insect muscle fibres have one or more tracheoles terminating within their cytoplasm. This is shown in Fig. 1.1.

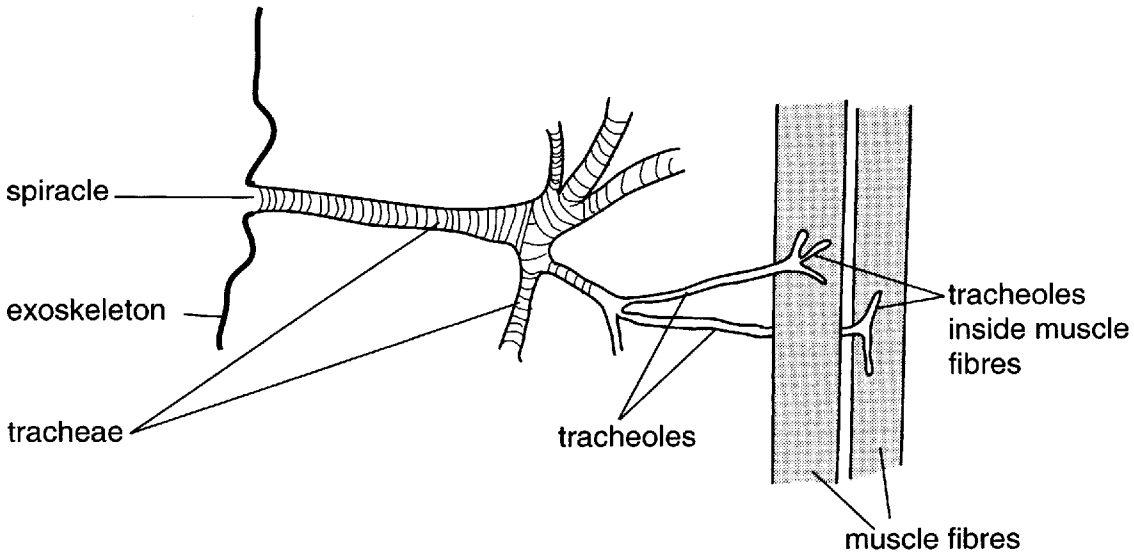


Fig. 1.1

As oxygen is used in aerobic respiration, the concentration of oxygen in an insect's tissues falls. Oxygen molecules diffuse, down a concentration gradient, from the tracheoles into the respiring cells. This reduces the oxygen concentration of the air in the tracheoles, thus setting up a concentration gradient between the tracheoles and the tracheae. Oxygen eventually diffuses into the tracheae from the atmosphere through the spiracles.

- (a) (i) State **three** ways in which the oxygen supply to an insect muscle fibre is **different** from the way in which oxygen is supplied to a mammalian muscle fibre.

1 .....

.....

2 .....

.....

3 .....

.....[3]

- (ii) State **one** way in which the oxygen supply to the muscle fibres of insects and mammals is **similar**.

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

- (b) The number, position, size and structure of spiracles varies greatly in different species of insect. In diving beetles, the spiracles are covered by the folded wings. When the beetle dives, it carries down an air bubble that is trapped under its wings. The spiracles open into this trapped air and gas exchange can take place during the dive.

In an investigation of the effect of temperature on diving beetles, three of the animals were placed in thermostatically-controlled water baths. The beetles were watched and the number of times each surfaced to renew its air bubble was counted during a 30 minute period. The observations were repeated at different temperatures. The data are recorded in Table 1.1.

**Table 1.1**

diving beetle	number of times air bubble was renewed during 30 minutes		
	10 °C	20 °C	30 °C
<b>A</b>	5	9	22
<b>B</b>	6	11	24
<b>C</b>	4	9	19

Describe **and** explain the trends shown by the data in Table 1.1.

.....  
 .....  
 .....  
 .....  
 .....  
 .....  
 .....[4]

[Total: 8]

2 Isle Royale is an island 544 km<sup>2</sup>, in Lake Superior, between the USA and Canada. The island is about 25 km from the Canadian shore. During exceptionally cold winters, ice bridges have been observed connecting the island to Canada but the climatic conditions needed for this to happen are extremely unusual.

The island is mostly covered by climax forest. It is a national park where hunting and logging are prohibited.

Shortly after 1900, moose colonised Isle Royale for the first time. Moose are a large species of deer which feed on shrubs and the lower branches of trees.

The population of moose on the island has been estimated at frequent intervals since 1915 and has been surveyed accurately every year since 1957.

In 1948, wolves arrived on the island and the wolf population has also been monitored. Wolves hunt and feed on moose as well as on other prey species.

Fig. 2.1, provided as an insert, shows estimated numbers of both species between 1915 and 1995.

(a) Using Fig. 2.1, calculate the **population density** of moose in 1928. Give your answer to the nearest whole number per km<sup>2</sup>. Show your working.

Answer .....per km<sup>2</sup> [2]

(b) Suggest **two** reasons to explain the rapid fall in the moose population between 1928 and 1936.

- 1 .....
- .....
- 2 .....
- .....[2]

(c) In 1936, a fire destroyed about 20% of the forest on Isle Royale. Suggest how the fire may have helped the recovery of the moose population.

- .....
- .....
- .....[2]

- (d) The crash in the wolf population between 1965 and 1967 was the result of an outbreak of a disease caused by canine parvovirus.

Explain how a viral disease may act on a population as a density dependent limiting factor.

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

- (e) Biologists have argued that the Isle Royale wolf and moose populations are an example of a predator-prey relationship in which the population of prey is controlled by the population of predators.

Explain how the data in Fig. 2.1 support this hypothesis.

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

- (f) Explain how the data in Fig. 2.1 do **not** support the hypothesis that a shortage of moose limits the wolf population.

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

[Total: 12]

- 3 Three samples of hemp seeds, each sample with a mass of **exactly 105 grams**, were taken from one packet of seeds.

**Sample 1** was **not** allowed to germinate.

**Sample 2** was allowed to germinate and grow for **7** days on moist filter paper in darkness.

**Sample 3** was allowed to germinate and grow for **10** days on moist filter paper in darkness.

All three samples were then dried and analysed using methods that were accurate to within 1%. The results of the investigation are shown in Table 3.1.

**Table 3.1**

sample	dry mass / g						
	lipid	starch	protein	cellulose	other organic compounds	minerals	total
<b>1</b>	33	0	25	17	21	4	100
<b>2</b>	17	9	24	17	26	4	97
<b>3</b>	15	5	25	18	27	4	94

- (a) Using the results shown in Table 3.1, explain

- (i) why all the samples were dried before analysis;

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

- (ii) the change in total **dry mass** of the samples.

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

(b) The researchers concentrated their analysis on lipid, starch, protein and cellulose. All other organic compounds were grouped together.

(i) Explain, with the help of examples, the difference between organic compounds and minerals.

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

(ii) Suggest **two** organic compounds or classes of organic compound, **other than lipid, starch, protein and cellulose**, which you would expect to occur in seeds.

1 ..... 2 .....[2]

(iii) Use the data in Table 3.1 to provide evidence for the view that little cell division occurs during the first 10 days of development of hemp.

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

(iv) Suggest which compound was used by the germinating seeds for starch synthesis **and** explain how the data provide evidence for your suggestion.

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

(c) In this question, one mark is available for the quality of written communication.

The germination of seeds involves the action of many different enzymes.

Outline some of the **functions** of enzymes in the metabolic processes **inside** plant and animal cells.

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.....[7]

Quality of Written Communication [1]

[Total: 18]





Male rhesus monkeys of similar age and body mass, were used to investigate the effect of diet on the development of atherosclerosis. The diets provided similar amounts of energy and nutrients but the energy came from different sources, as shown in Table 4.1.

**Table 4.1**

diet	% of total energy in the diet	
	carbohydrates	lipids – including cholesterol
<b>A</b> – rich in starch	77	4
<b>B</b> – rich in corn oil	45	40
<b>C</b> – rich in egg yolk which contains cholesterol	43	41

(b) Explain why the percentages of energy in diets **A**, **B** and **C** do not reach 100%.

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

(c) Suggest **one** reason why only male monkeys were studied.

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

**Question 4 continues on page 12**

(d) The following treatments were given to groups of monkeys:

- diet **A** only for 57 months
- diet **C** only for 57 months
- diet **C** for 17 months followed by diet **A** for 40 months
- diet **C** for 17 months followed by diet **B** for 40 months.

The effect of varying the diet was assessed by analysis of blood samples for cholesterol and by measuring the cross sectional area of the lumen of the coronary arteries of each monkey at the end of the investigation.

The results are shown in Table 4.2.

**Table 4.2**

diets received by groups of monkeys	mean blood cholesterol concentration / mg per 100 cm <sup>3</sup> of blood			relative cross sectional area of coronary arteries at 57 months
	start of the investigation	at 17 months	at 57 months	
diet <b>A</b> only for 57 months	143	140	135	100
diet <b>C</b> only for 57 months	138	701	740	40
diet <b>C</b> for 17 months followed by diet <b>A</b> for 40 months	142	712	136	83
diet <b>C</b> for 17 months followed by diet <b>B</b> for 40 months	140	703	138	75

Explain whether each of the following hypotheses is either:

- **supported,**
- **not supported,**
- **needs further investigation.**

In your answers, use data from Tables 4.1 and 4.2, together with the other information provided.

(i) 'Coronary arteries become diseased if the diet is relatively low in carbohydrate.'

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(ii) 'A change in diet can produce an improvement in the health of coronary arteries.'

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(iii) 'Cholesterol in the diet is the cause of coronary heart disease.'

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[7]

[Total: 12]

- 5 Achondroplasia is a condition which affects the human skeleton. It affects about one in every 25 000 births and it occurs in all races and in both sexes. People with achondroplasia have unusually short arms and legs but the rest of the body is relatively unaffected. Mental development and life expectancy are also unaffected.

Fig. 5.1 shows part of a pedigree (also called a family tree) for a family where some of the individuals have achondroplasia.

family pedigree showing achondroplasia

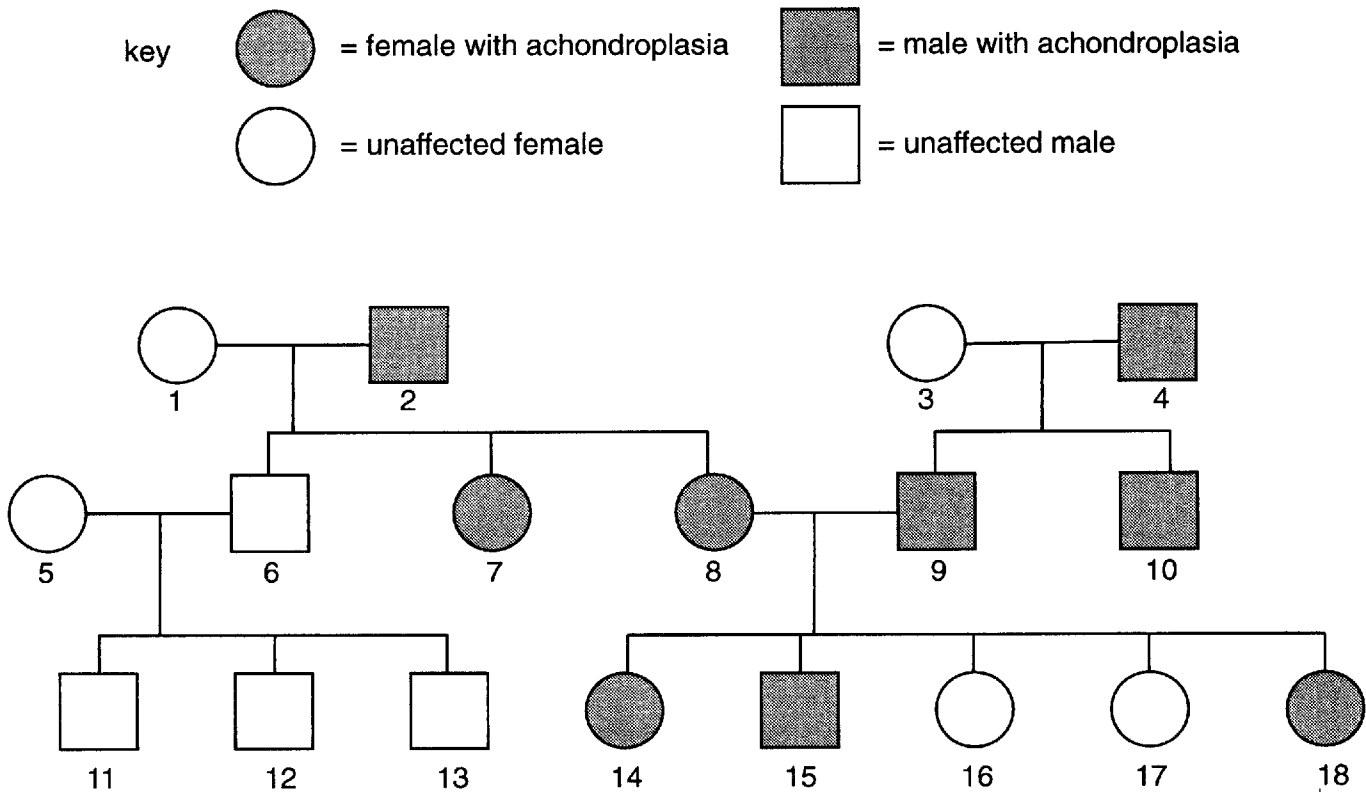


Fig. 5.1

- (a) By referring to numbered individuals **and** the relationships shown in the pedigree, explain why

(i) the allele that determines achondroplasia must be dominant;

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

(ii) the gene concerned is **not** sex linked.

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

Achondroplasia is controlled by **one** gene. The presence of the dominant allele, **A**, results in achondroplasia. Unaffected individuals are homozygous recessive, **aa**.

**(b)** Draw a genetic diagram to explain why two people, **both** with achondroplasia, can produce a child unaffected by the condition.

*genotypes of parents* .....

*gamete genotypes* .....

*possible genotypes of children* .....

*possible phenotypes of children* ..... [2]

**(c)** Achondroplasia can spontaneously appear in a child of unaffected parents. There is no previous history of the condition in the family of **either** of the parents. Such children have a 50% chance of passing on the condition.

Explain these observations.

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

**(d)** Explain why vitamin D and calcium supplements in the diet would not prevent achondroplasia.

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

[Total: 10]

**END OF QUESTION PAPER**

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*Copyright Acknowledgements:*

Q.4 Fig. 4.1 © Philip Harris Biological Ltd.

OCR has made every effort to trace the copyright holders of items used in this Question Paper, but if we have missed any, we apologise.

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**INSERT**

**2806/01**

Thursday

**22 JANUARY 2004**

Morning

1 hour 15 minutes

**INSTRUCTIONS TO CANDIDATES**

- This insert contains Fig. 2.1.

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**This insert consists of 2 printed pages.**



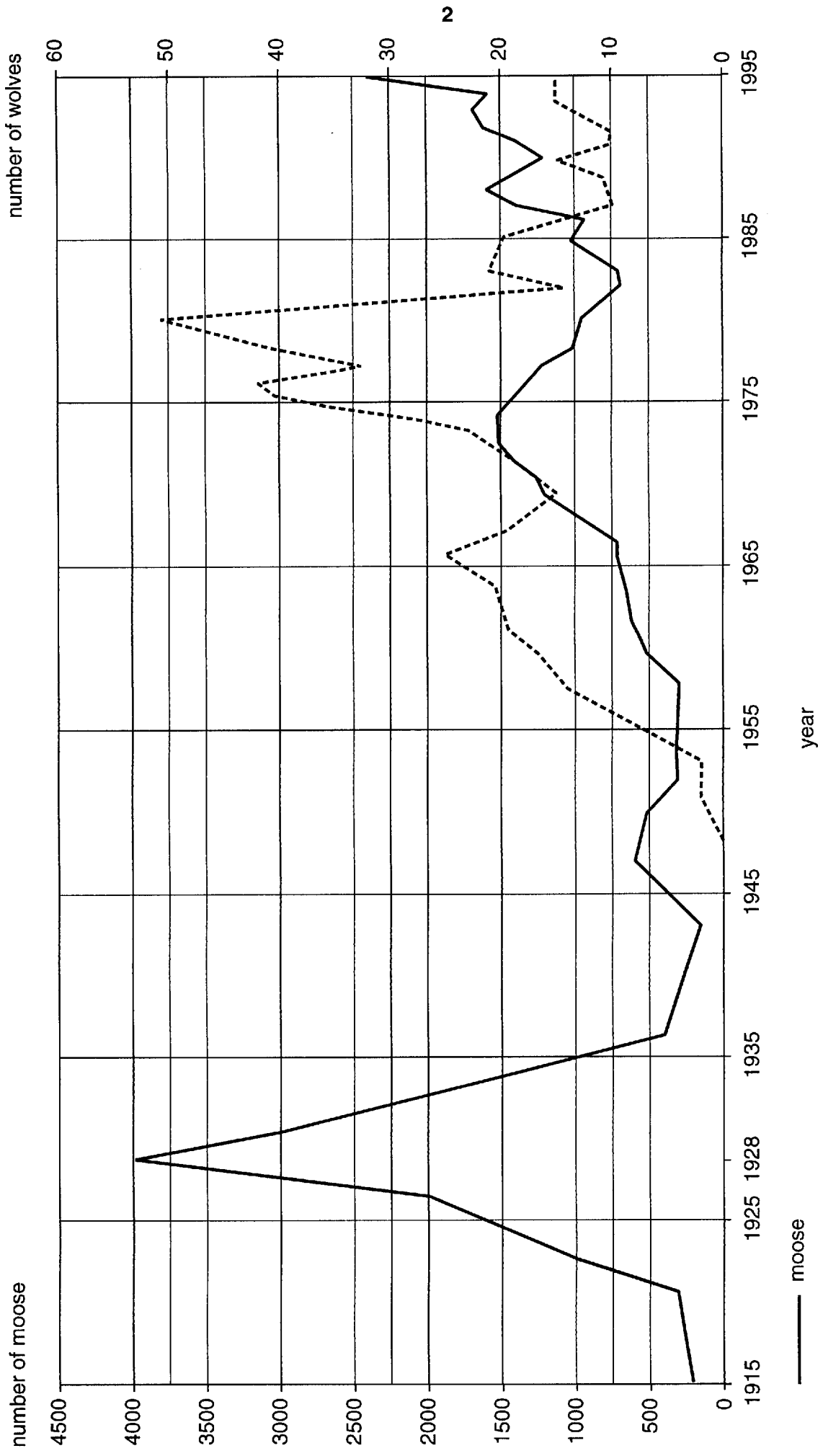


Fig. 2.1