Cambridge Assessment International Education

Cambridge International AS & A Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

MARINE SCIENCE **9693/21**

Paper 2 AS Level Data-handling and Investigative Skills **May/June 2025**

1 hour 45 minutes

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You may use a calculator.
- You should show all your working and use appropriate units.

INFORMATION

- The total mark for this paper is 75.
- The number of marks for each question or part question is shown in brackets [ ].

This document has **28** pages. Any blank pages are indicated.

[Turn over

Answer **all** questions.

1 Blue crabs are crustaceans.

Fig. 1.1 shows a blue crab.

Fig. 1.1

(a) (i) On Fig. 1.1, label the carapace on the blue crab. [1]

(ii) State **two other** features of a typical adult crustacean.

1 .....

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2 .....

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[2]

(iii) Fig. 1.2 shows the right claw of the blue crab.

Fig. 1.2

Make a large drawing of the crab claw shown in Fig. 1.2.

Do **not** include markings.

[4]

(b) Blue crabs are harvested by humans in Chesapeake Bay, USA.

A scientist used the Lincoln index to estimate the population of blue crabs in one area of Chesapeake Bay.

The scientist collected the data shown in Table 1.1.

Table 1.1

data collected	number
blue crabs captured in first sample (n_1)	147
blue crabs (both marked and unmarked) captured in second sample (n_2)	139
blue crabs (marked) recaptured in second sample (m_2)	45

The equation for the Lincoln index is:

$$N = \frac{n_1 \times n_2}{m_2}$$

where,

N = estimate of population size
n_1 = number of individuals captured in first sample
n_2 = number of individuals (both marked and unmarked) captured in second sample
m_2 = number of marked individuals recaptured in second sample.

(i) Use the data in Table 1.1 **and** the equation to estimate the population of blue crabs in the area surveyed.

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

Space for working.

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(ii) State **two** limitations of using the mark-release-recapture method to estimate the blue crab population.

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2 .....

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[2]

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(c) Since 1990, scientists have used the mark-release-recapture method and the Lincoln index to monitor the blue crab population in Chesapeake Bay.

In 2008, new rules were introduced to limit the harvesting of blue crabs.

Fig. 1.3 shows the estimated population of blue crabs in Chesapeake Bay from 1990 to 2020.

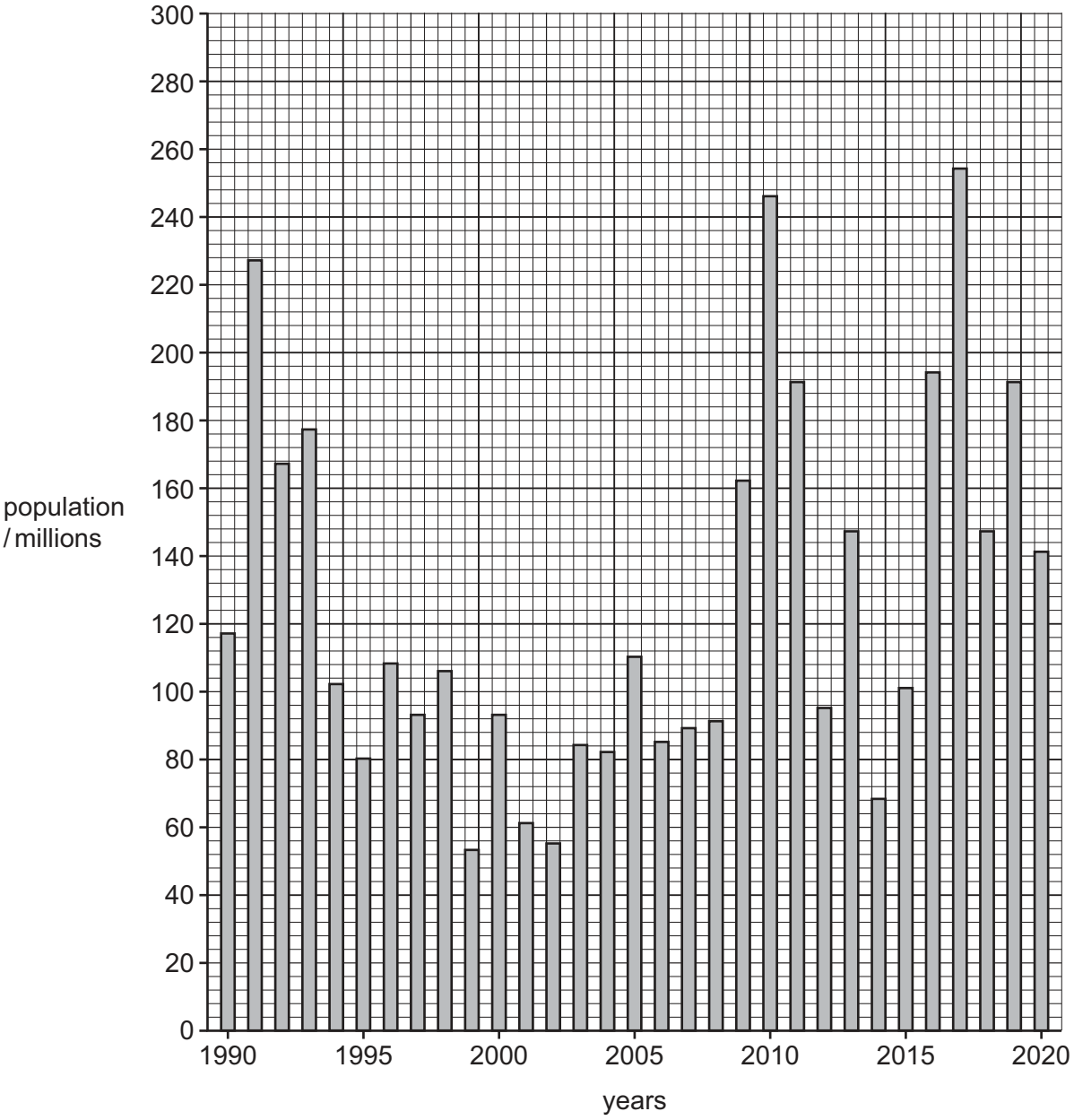

Fig. 1.3

Use Fig. 1.3 to evaluate the effect of the new harvesting rules on the population of blue crabs.

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..... [4]

[Total: 16]

2 Nitrate ions (NO_3^-) are a source of nitrogen for marine producers such as seagrass.

(a) Define the term ion.

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..... [1]

(b) A student designed an experiment to investigate the relationship between the concentration of nitrate ions in sea water and the growth of seagrass.

The student was provided with a solution of nitrate ions at a concentration of 40 μmol dm^{-3}.

Fig. 2.1 shows the equipment the student used.

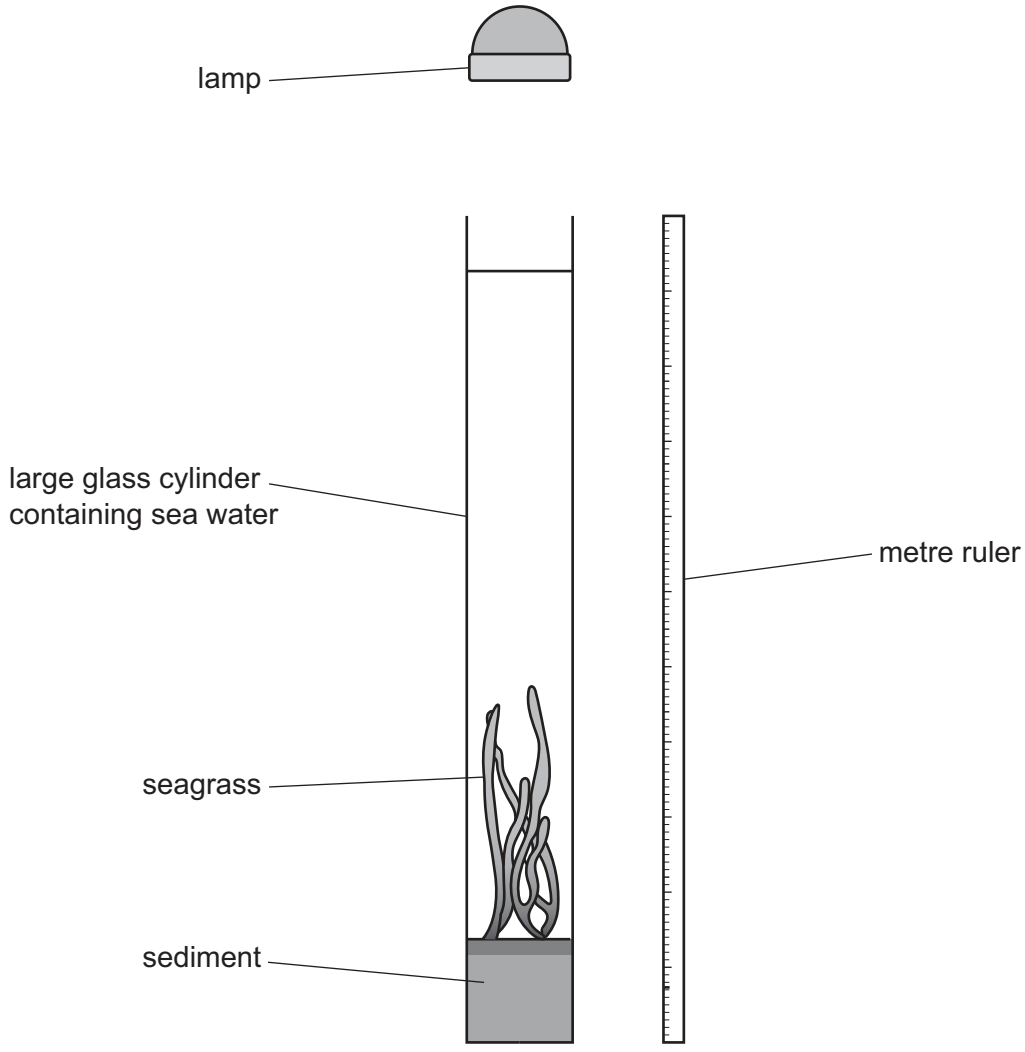

Fig. 2.1

(i) Suggest how the student used the equipment shown in Fig. 2.1 to investigate the growth of seagrass at different concentrations of nitrate ions.

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..... [5]

(ii) Draw a table that could be used to record the results from the investigation in **(b)(i)**.

Include a suitable unit for the dependent variable.

Do **not** write in any results.

[2]

(iii) Predict the relationship you would expect to find between nitrate ion concentration and growth rate of seagrass.

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..... [1]

(c) State **two** uses of nitrogen for producers such as seagrass.

1 .....

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2 .....

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[2]

(d) Fig. 2.2 shows a pair of pipefish.

Seagrasses provide pipefish with food and are ideal breeding grounds.

Fig. 2.2

Many pipefish species are in decline.

A scientist investigated whether the survival of newborn pipefish depends on the prey species available.

Three tanks containing seagrass were set up in controlled conditions and newborn pipefish were placed into each tank.

Each tank contained different prey species:

tank 1 – prey species **R** only

tank 2 – prey species **S** only

tank 3 – prey species **R** and **S**.

The percentage of newborn pipefish surviving each day was monitored for seven days.

Fig. 2.3 shows the results.

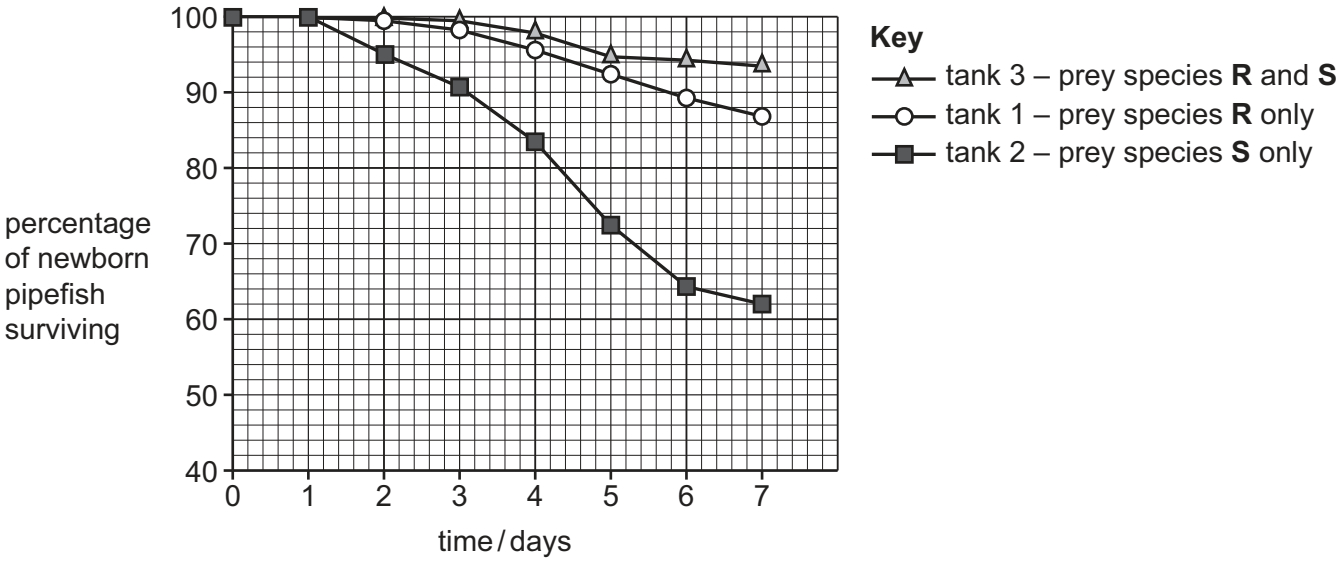

Fig. 2.3

(i) Suggest **two** biotic factors which would need to be standardised in this investigation.

1 .....

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2 .....

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[2]

(ii) The starting number of newborn pipefish in tank 2 was 150.

Use Fig. 2.3 to calculate the number of newborn pipefish surviving after seven days.

..... [2]

(iii) Give **one** conclusion that can be made from the results in Fig. 2.3.

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..... [1]

(iv) Describe **two** limitations of the data collected in this investigation.

1 .....

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2 .....

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[2]

[Total: 18]

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3 Hydrothermal vents occur close to plate boundaries.

(a) State the type of plate boundary where ocean floor spreading occurs.

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..... [1]

(b) Scientists investigated whether the rate of ocean floor spreading affects the number of hydrothermal vents along the length of an ocean ridge.

Table 3.1 shows the data collected by the scientists.

Table 3.1

rate of ocean floor spreading /mm per year	mean number of hydrothermal vents per 100 km
39	1.8
55	2.5
67	3.1
88	3.6
100	4.0
115	4.8
140	6.2

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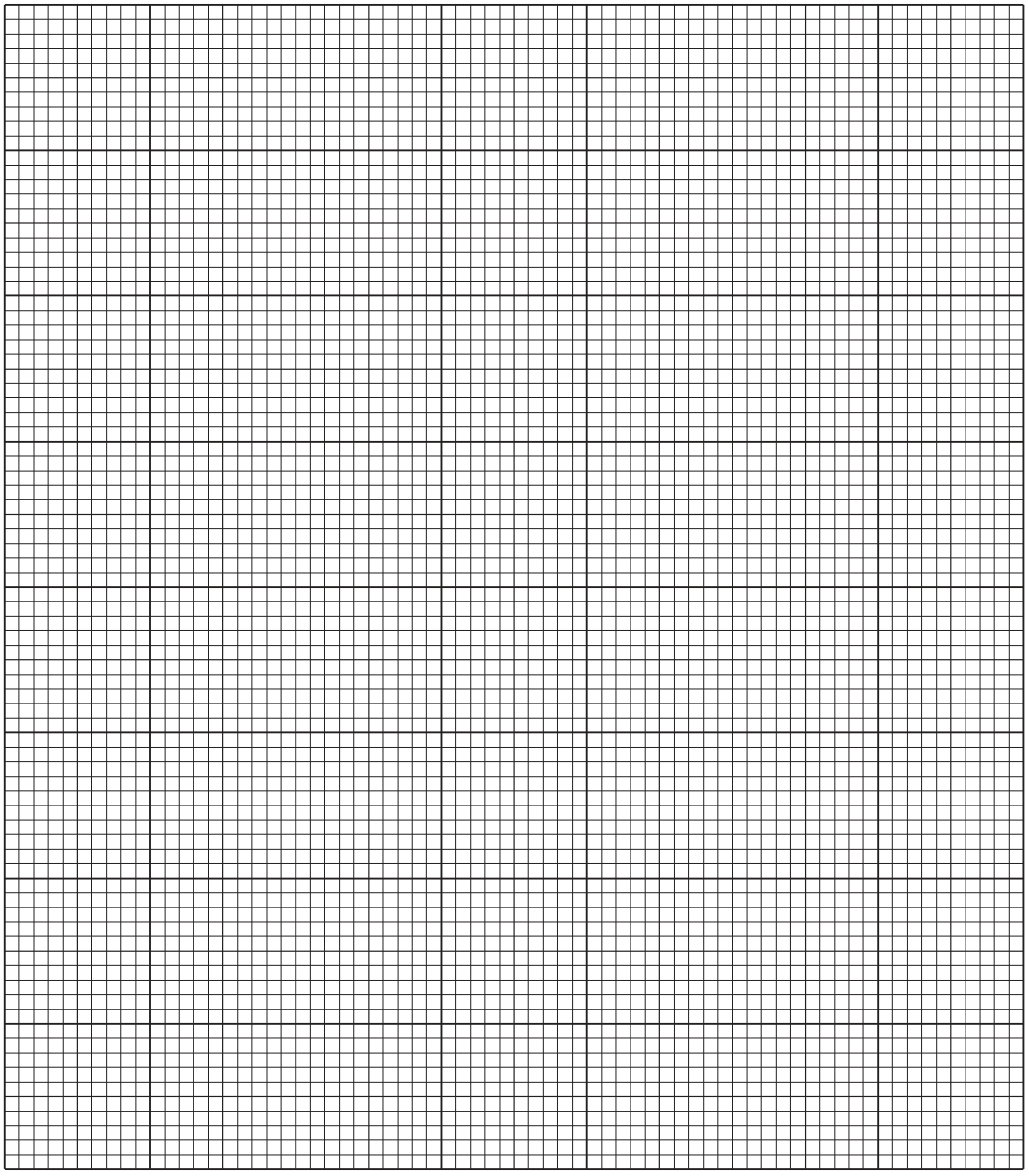
(i) Plot a line graph showing the relationship between the rate of ocean floor spreading and the mean number of hydrothermal vents.



[4]

(ii) Name the statistical test that could be used to test if there is a correlation between the two variables.

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..... [1]

(c) A probe was moved at a fixed depth into the vent plume over a total distance of 6 km, as shown in Fig. 3.1.

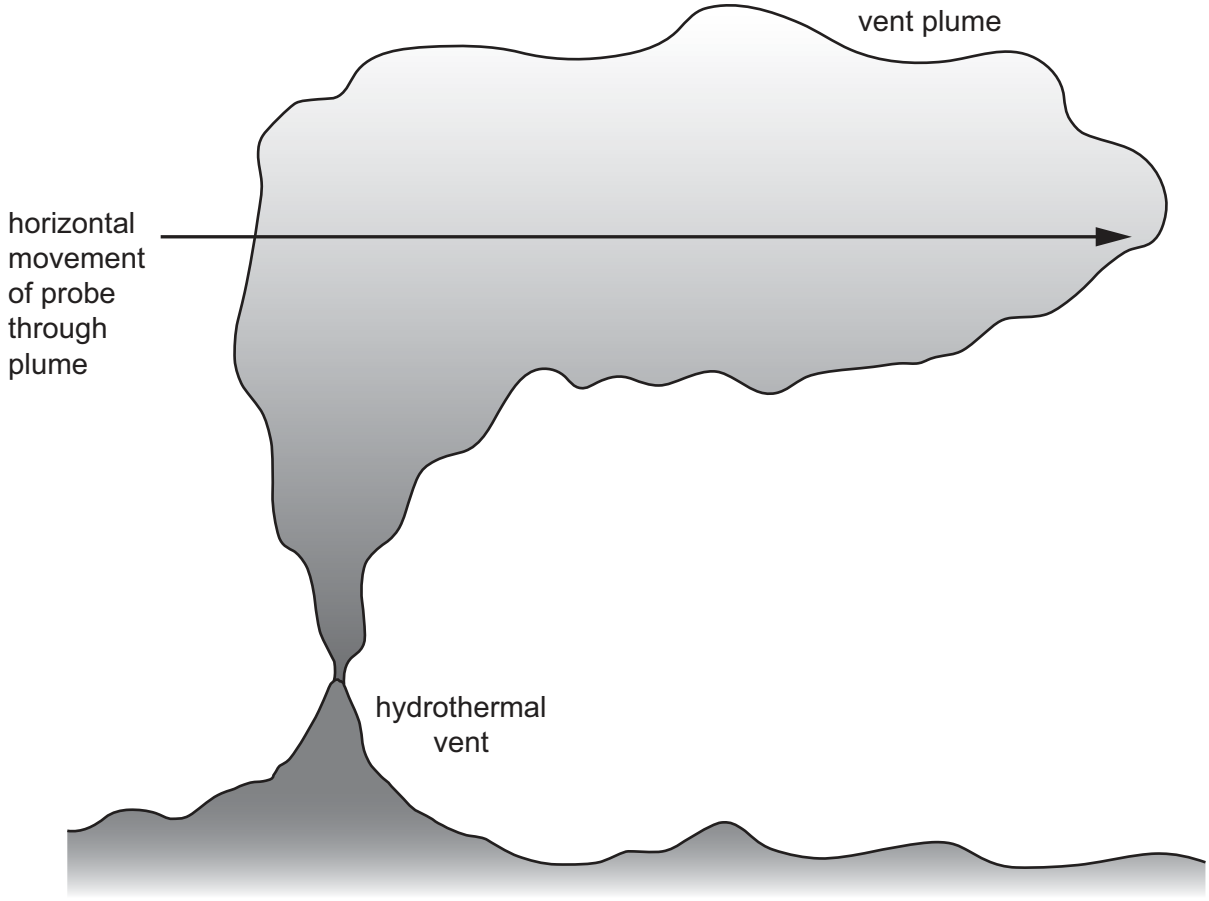

Fig. 3.1

Fig. 3.2 shows the concentration of hydrogen sulfide and the turbidity of the water recorded by the probe across the hydrothermal vent plume.

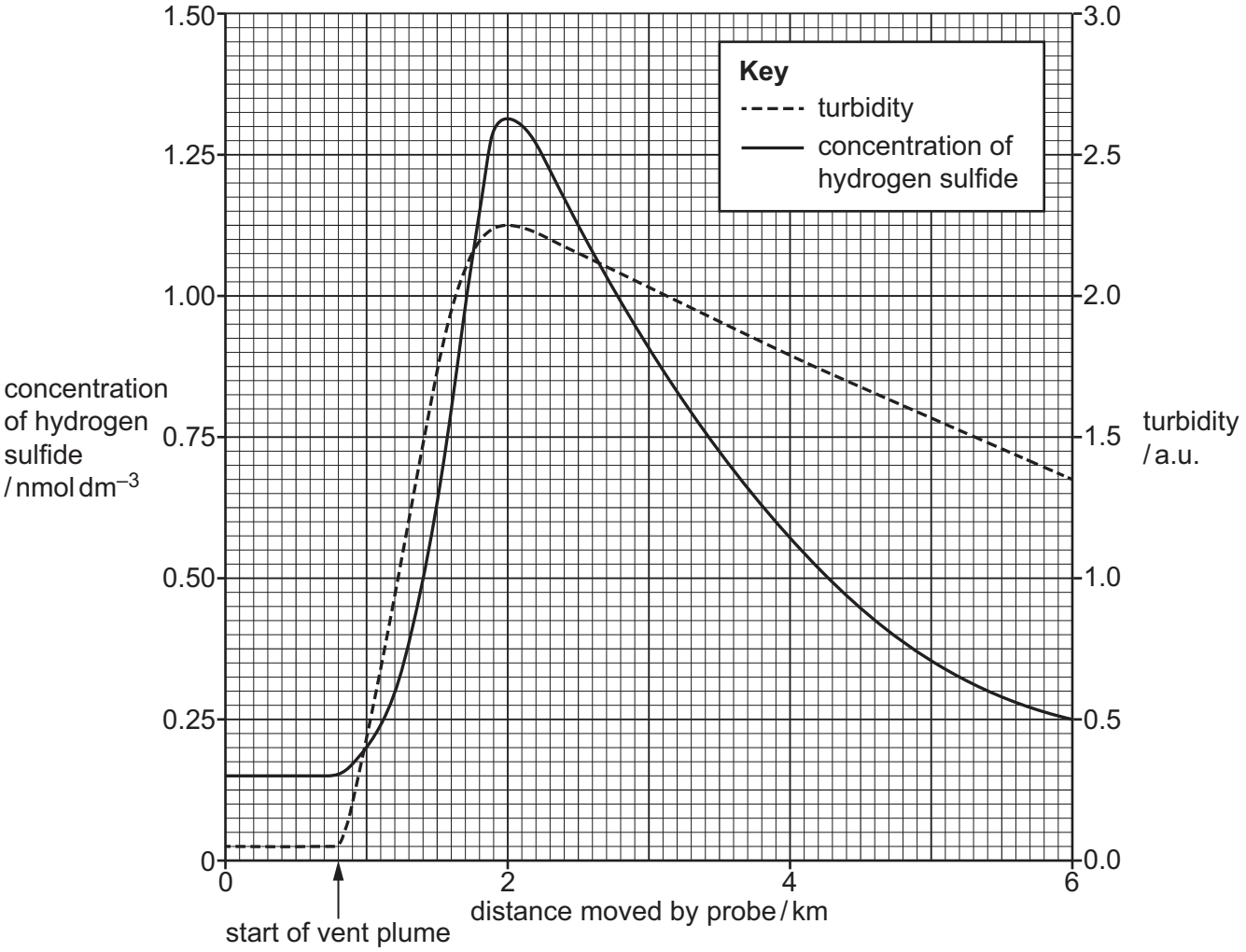

Fig. 3.2

(i) Compare the trends for the concentration of hydrogen sulfide and the turbidity of the water shown in Fig. 3.2.

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..... [3]

(ii) Use Fig. 3.2 to calculate the range in turbidity recorded by the probe.

..... a.u. [1]

(iii) State **two other** conditions in the sea water that are affected by the hydrothermal vent plume.

1 .....

2 .....

[2]

(iv) Suggest how conditions caused by the hydrothermal vent plume affect the organisms in the surrounding water.

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..... [3]

[Total: 15]

4 Fig. 4.1 shows a Southern flounder, a species of fish that lives and reproduces in estuaries.

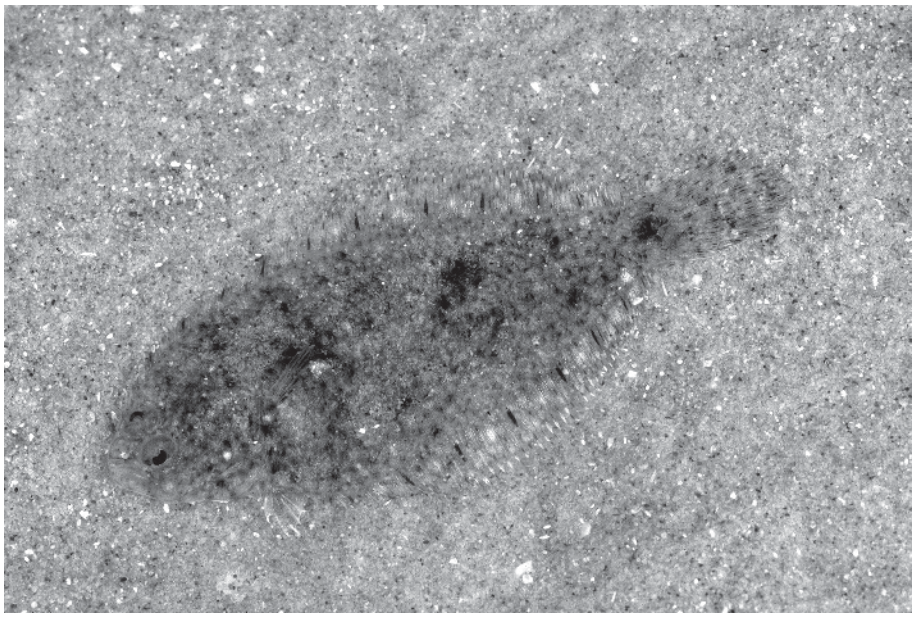

Fig. 4.1

(a) Scientists investigated the effect of the size of sediment in an estuary on the distribution of Southern flounder.

Samples of sediment were taken from three locations, **A**, **B** and **C**, in the estuary.

Each sediment sample was then analysed. The sediment types found were:

clay (smallest particle size)

silt

sand

stones (largest particle size).

The percentage of the different sediment types in each location was calculated.

The results are shown in Fig. 4.2.

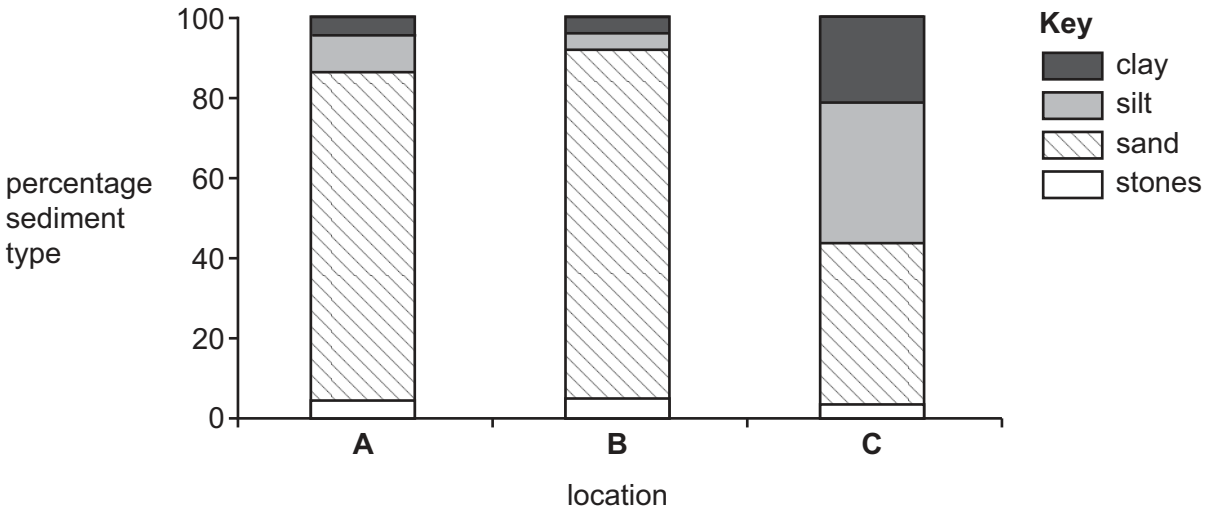

Fig. 4.2

(i) Use Fig. 4.2 to compare the permeability of samples from locations **A**, **B** and **C**.

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..... [2]

(ii) Suggest why particle size affects the permeability of sediment types found in locations **A**, **B** and **C**.

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..... [2]

(b) Southern flounders were caught using nets dragged along the bottom of the estuary at each location.

The mean population density of Southern flounder was recorded.

Fig. 4.3 shows these results.

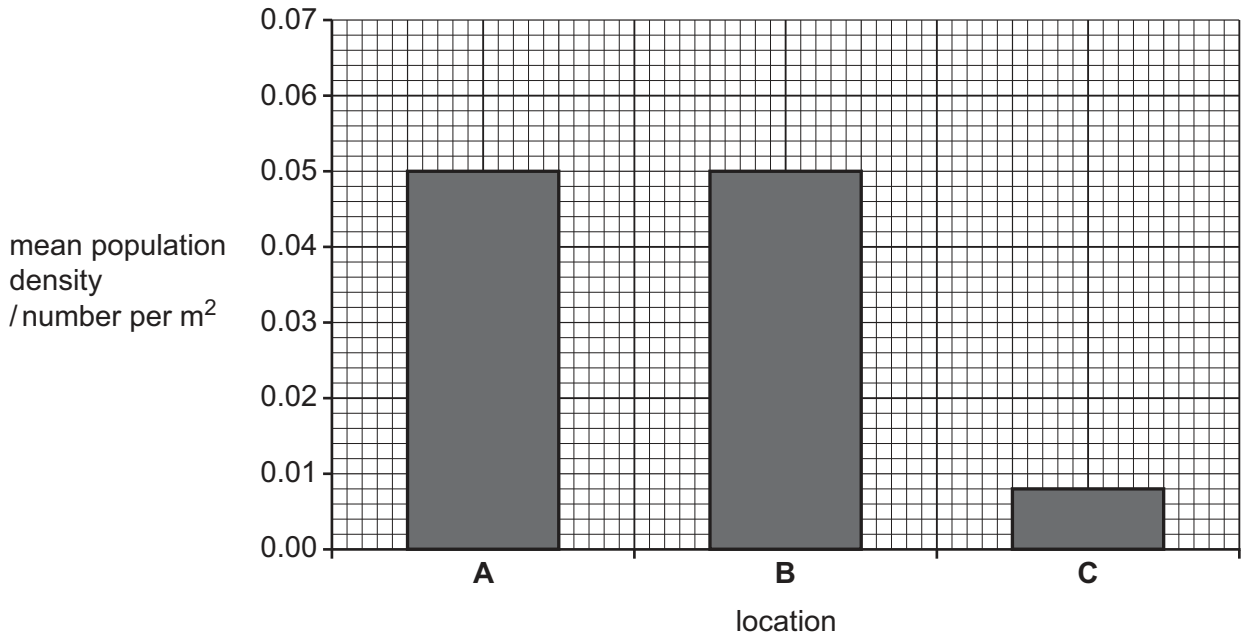

Fig. 4.3

(i) Compare the effect of sediment type on the distribution of Southern flounder at locations **A**, **B** and **C**.

Use the bar charts in Fig. 4.2 **and** Fig. 4.3 to support your answer.

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..... [4]

(ii) Suggest **three** reasons why the type of sediment found in locations **A**, **B** and **C** may affect the distribution of Southern flounder.

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2 .....

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3 .....

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[3]

(c) Particle size affects the permeability of sediments.

Fig. 4.4 shows apparatus that could be used to find the permeability of sediment samples.

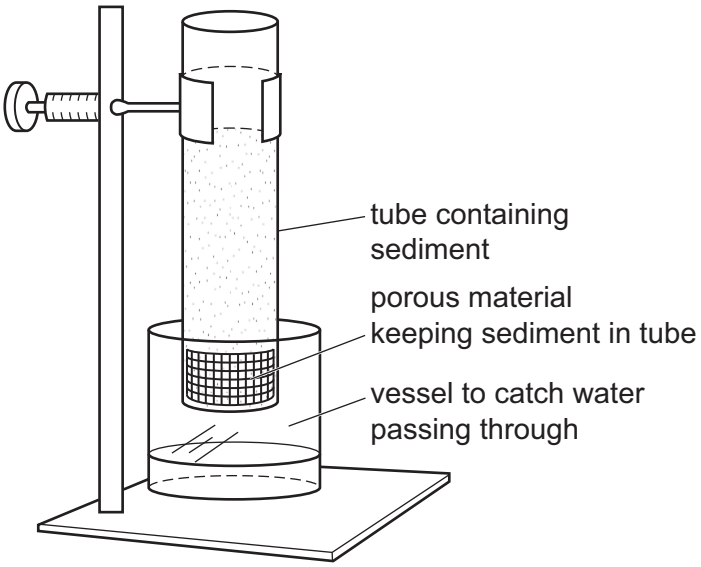

Fig. 4.4

Describe how the apparatus in Fig. 4.4 can be used to determine the permeability of sediment samples from locations **A**, **B** and **C**.

Include any additional laboratory equipment that may be needed.

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..... [3]

[Total: 14]

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5 Some copepods are parasites of marine fish.

(a) Describe the meaning of the term parasitism.

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..... [2]

(b) Gobies are small fish that compete with each other for hiding spaces in coral reefs. These spaces provide shelter from predators.

Fig. 5.1 shows two gobies on a coral reef.

Fig. 5.1

Scientists investigated whether the presence of copepod parasites affected the behaviour of gobies.

Observations were made of goby behaviour with and without copepod parasites.

Fig. 5.2 shows the relationship between the mean number of gobies competing for each hiding space and the maximum distance travelled by gobies from the hiding space.

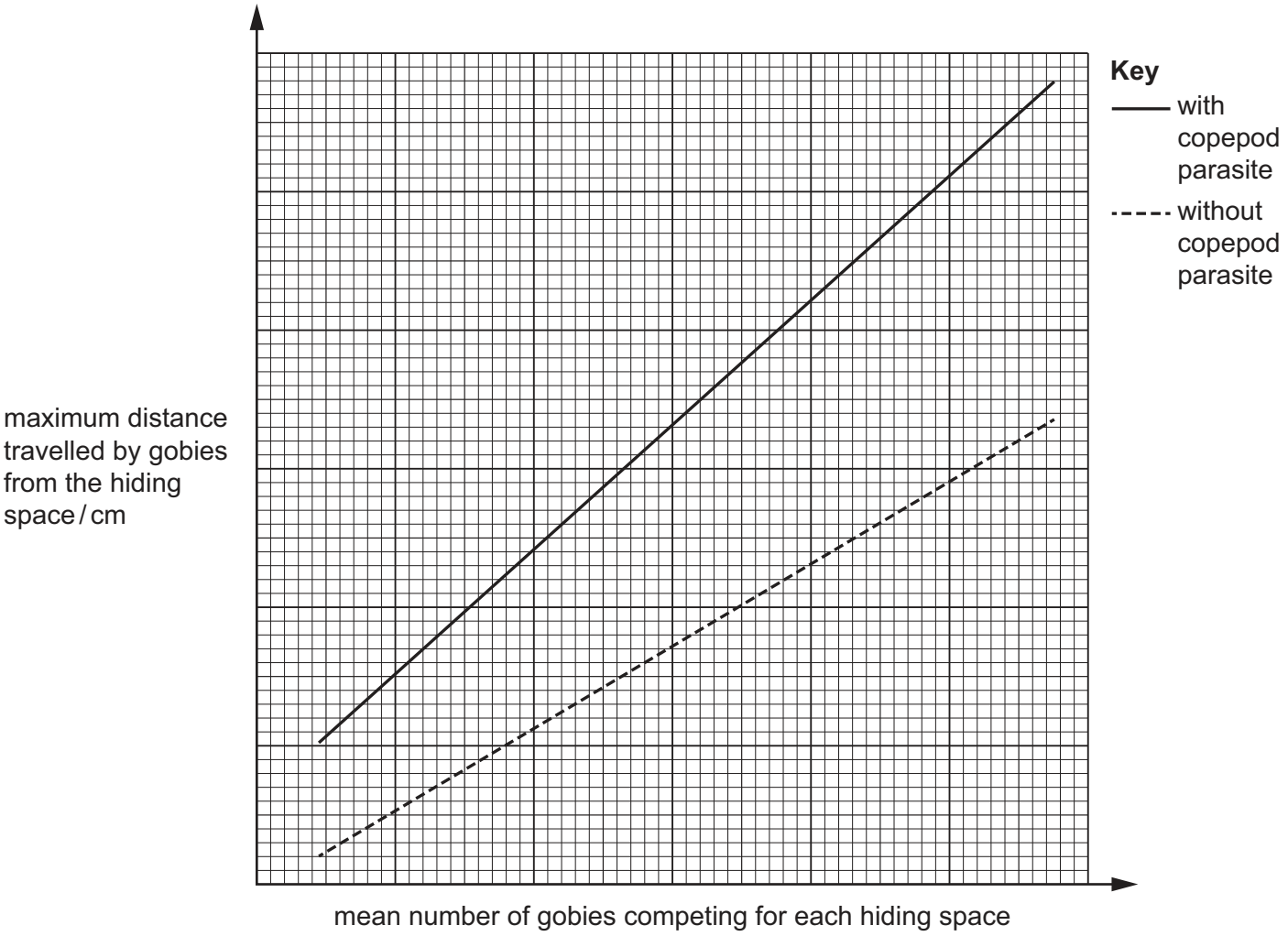

Fig. 5.2

(i) Use Fig. 5.2 to compare the behaviour of gobies with and without copepod parasites.

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..... [2]

(ii) Some copepod parasites have different stages of their life cycle in different organisms.

The parasite changes the behaviour of the goby.

Use Fig. 5.2 **and** your own knowledge to suggest ways that copepod parasites could affect gobies.

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..... [2]

(c) In another investigation, scientists observed the symbiotic relationship between two species of manta ray and each of two species of remora. Each individual manta ray only associates with one remora species.

Each time a manta ray was seen, the number of remora associating with it were counted and the mean number of remora per manta ray calculated.

Table 5.1 shows the results.

Table 5.1

manta ray species	remora species	total number of remora observed	number of manta ray observed	mean number of remora per manta ray
Mobula alfredi	*Echeneis naucrates*	1815	825	2.2
	Remora remora	52	40	1.3
Mobula birostris	*Echeneis naucrates*	81	45	1.8
	Remora remora	612	.....	3.6

(i) Use Table 5.1 to state the total number of genus groups observed.

..... [1]

(ii) Use the data in Table 5.1 to calculate the number of *Mobula birostris* observed with *Remora remora*.

Write your answer in Table 5.1. [1]

(iii) Discuss conclusions that can be made from the results of this investigation.

Use the data from Table 5.1 to support your answer.

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[Total: 12]

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