Cambridge Assessment International Education

# Cambridge International AS & A Level

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*9781856950 7*

**BIOLOGY** **9700/52**

Paper 5 Planning, Analysis and Evaluation **February/March 2022**

**1 hour 15 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 30.
- The number of marks for each question or part question is shown in brackets [ ].

This document has **16** pages. Any blank pages are indicated.


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**1** Some students wanted to investigate the effect of light intensity on the rate of photosynthesis in the Brazilian waterweed, *Egeria densa*. This plant is found in freshwater ponds.

The students used the apparatus shown in Fig. 1.1 in their investigation. A stand and clamp were used to hold the apparatus in a vertical position.

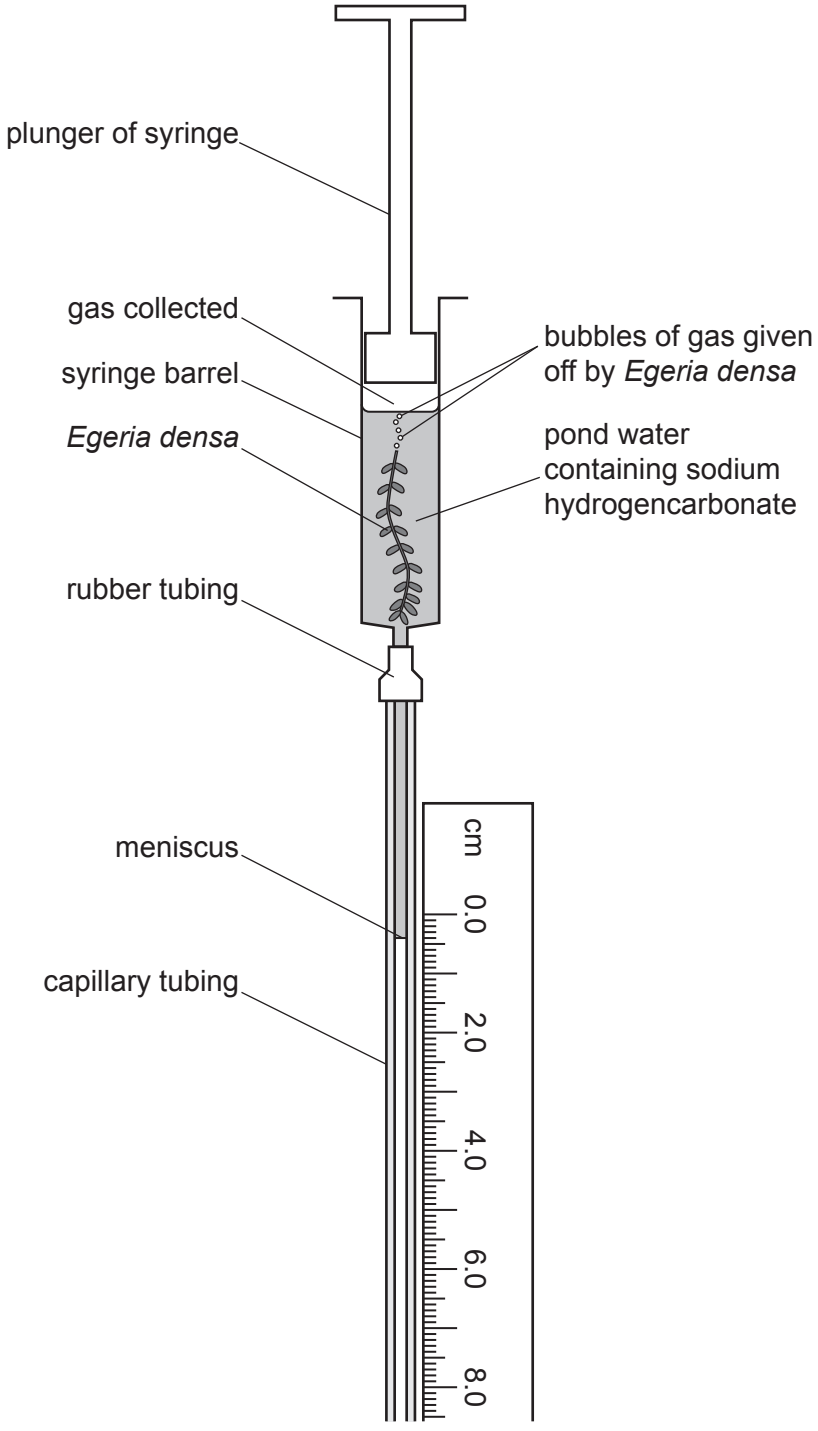



**Fig. 1.1**

The students carried out these steps to set up the apparatus shown in Fig. 1.1.

- Some sodium hydrogencarbonate was added to a sample of pond water as a source of carbon dioxide.
- The syringe barrel was filled with the pond water containing sodium hydrogencarbonate.
- A fresh piece of *E. densa* was cut under water.
- The cut stem was quickly placed in the pond water in the syringe barrel.
- The plunger was replaced, as shown in Fig. 1.1, and adjusted until the meniscus in the capillary tubing was near the top of the scale.
- A bench lamp was used as a light source.

The students noticed that bubbles of gas were given off from the *E. densa*. As the gas collected in the syringe barrel, the meniscus moved down the capillary tube. The plunger of the syringe did not move.

The students used the apparatus to investigate the effect of different light intensities on the rate of photosynthesis in *E. densa*.

**(a)** Suggest a suitable control for this investigation.

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..... [1]

**(b) (i)** Describe a method, using the apparatus shown in Fig. 1.1, that the students could use to investigate the effect of light intensity on the rate of photosynthesis of *E. densa*.

Your method should be set out in a logical order and be detailed enough to allow another person to follow it.

The steps carried out to set up the apparatus shown in Fig. 1.1 should **not** be included.

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**(ii)** Complete the sketch graph to predict the results that you would expect from the method you have given in **(b)(i)**.

Include axis labels with units in your answer.



[3]

**(c)** The students decided to use paper chromatography to separate the photosynthetic pigments found in *E. densa* leaves.

- *E. densa* leaves were ground up in a small volume of solvent to make a concentrated solution of pigments.
- The different pigments in the solution were separated using paper chromatography.
- The distance moved by the solvent was measured on the completed chromatogram.
- The distances moved by the pigments were also measured.
- The $R_f$ values were calculated for these pigments.

Table 1.1 shows the results.

**Table 1.1**

| pigment number | colour of pigment | distance moved by pigment / mm | distance moved by solvent / mm | $R_f$ value |
|---|---|---|---|---|
| 1 | orange | 105 | 107 | 0.98 |
| 2 | yellow | 94 | 107 | ..... |
| 3 | blue–green | 62 | 107 | 0.58 |
| 4 | green | 45 | 107 | 0.42 |

**(i)** Complete Table 1.1 by calculating the $R_f$ value for pigment 2.

Give your answer to two significant figures.

The formula for the calculation of $R_f$ is:

$$R_f = \frac{\text{distance moved by pigment}}{\text{distance moved by solvent}}$$

[1]

**(ii)** The students used a published source to find the $R_f$ values for three of the pigments that they expected to be present.

- $R_f$ of carotene = 0.95
- $R_f$ of chlorophyll *a* = 0.60
- $R_f$ of chlorophyll *b* = 0.50

The students correctly identified pigment 1 as carotene, pigment 3 as chlorophyll *a* and pigment 4 as chlorophyll *b*.

The calculated $R_f$ values were not exactly the same as the $R_f$ values in the published source.

Describe **one** difficulty with paper chromatography that could explain why the $R_f$ values calculated by the students were **not** exactly the same as the published data.

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..... [1]

[Total: 13]

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**2** An invasive alien species is a species that has been introduced into an ecosystem where it is not normally found and causes harm to this ecosystem. Invasive alien species can change habitats, reduce biodiversity and cause the extinction of native species. Saltcedar trees, *Tamarix* spp., are invasive alien species introduced to North America from Europe and Asia in the early 1800s.

A biologist carried out an investigation in a woodland ecosystem next to the Virgin River in Arizona, North America. In the woodland, there were areas that contained only saltcedar trees and areas that contained a mixture of native tree species and saltcedar trees.

The biologist wanted to test the hypothesis that:

The diversity of rodents (mice and rats) is lower in areas with only saltcedar trees than in areas with a mixture of native tree species and saltcedar trees.

**(a)** Identify the **independent** variable in this investigation.

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..... [1]

**(b)** The biologist decided to trap rodents in an area with only saltcedar trees and to trap rodents in an area with a mixture of native tree species and saltcedar trees.

The biologist:

- placed 25 small mammal traps at random sites in each area of woodland
- baited each trap with 10 g of food for rodents
- checked each trap after 24 hours
- identified any rodents caught in the trap
- marked the rodents with an ear tag and released them back into the woodland
- carried out this trapping process on four days in April.

The number of **different** individuals of each rodent species trapped during the four trapping sessions was recorded.

**(i)** Identify **three** variables, **other than** the small mammal trap and ear tag, that the biologist standardised in this investigation.

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**(ii)** Describe a method that the biologist could have used to select the trap sites randomly.

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..... [2]

**(c)** Table 2.1 shows the results of the investigation.

**Table 2.1**

| species | number of individuals ($n$) | |
|---|---|---|
| | area with only saltcedar trees | area with a mixture of native tree species and saltcedar trees |
| deer mouse | 5 | 4 |
| western harvest mouse | 2 | 1 |
| desert woodrat | 0 | 1 |
| long-tailed pocket mouse | 1 | 2 |
| Merriam's kangaroo rat | 0 | 1 |
| total ($N$) | 8 | 9 |

Simpson's index of diversity ($D$) is a method of assessing biodiversity.

The formula for Simpson's index of diversity is:

$$D = 1 - \left(\Sigma\left(\frac{n}{N}\right)^2\right)$$

**key to symbols:**

$n$ = number of individuals of each species present in the sample

$N$ = the total number of all individuals of all species present in the sample

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**(i)** The Simpson's index of diversity (*D*) for the area with only saltcedar trees is 0.531.

Calculate Simpson's index of diversity (*D*) for the area with a mixture of native tree species and saltcedar trees.

You may use Table 2.2 for your working.

Write the value for Simpson's index of diversity (*D*) on the dotted line.

Give your answer to three significant figures.

**Table 2.2**

| **species** | **number of individuals (*n*)** | $\frac{n}{N}$ | $\left(\frac{n}{N}\right)^2$ |
|---|---|---|---|
| deer mouse | 4 | | |
| western harvest mouse | 1 | | |
| desert woodrat | 1 | | |
| long-tailed pocket mouse | 2 | | |
| Merriam's kangaroo rat | 1 | | |
| total ($N$) | 9 | | |

Simpson's index of diversity (*D*) = .....
[2]

**(ii)** With reference to Table 2.1 and the values for *D* in the two different areas, state **and** explain the conclusions that can be made from the results of the investigation.

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..... [3]

**(d)** Fig. 2.1 shows a deer mouse, *Peromyscus maniculatus*, from North America.



**Fig. 2.1**

The biologist extended the study to investigate the abundance of the deer mouse. The biologist wanted to test a new hypothesis that:

The abundance of the deer mouse is higher in areas with only saltcedar trees than in areas with a mixture of native tree species and saltcedar trees.

The biologist used the trapping procedure described previously to calculate the abundance of the deer mouse in eight areas with only saltcedar trees and eight areas with a mixture of native tree species and saltcedar trees.

The biologist then calculated the mean abundance of the deer mouse in each type of woodland.

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Fig. 2.2 shows the biologist's results.

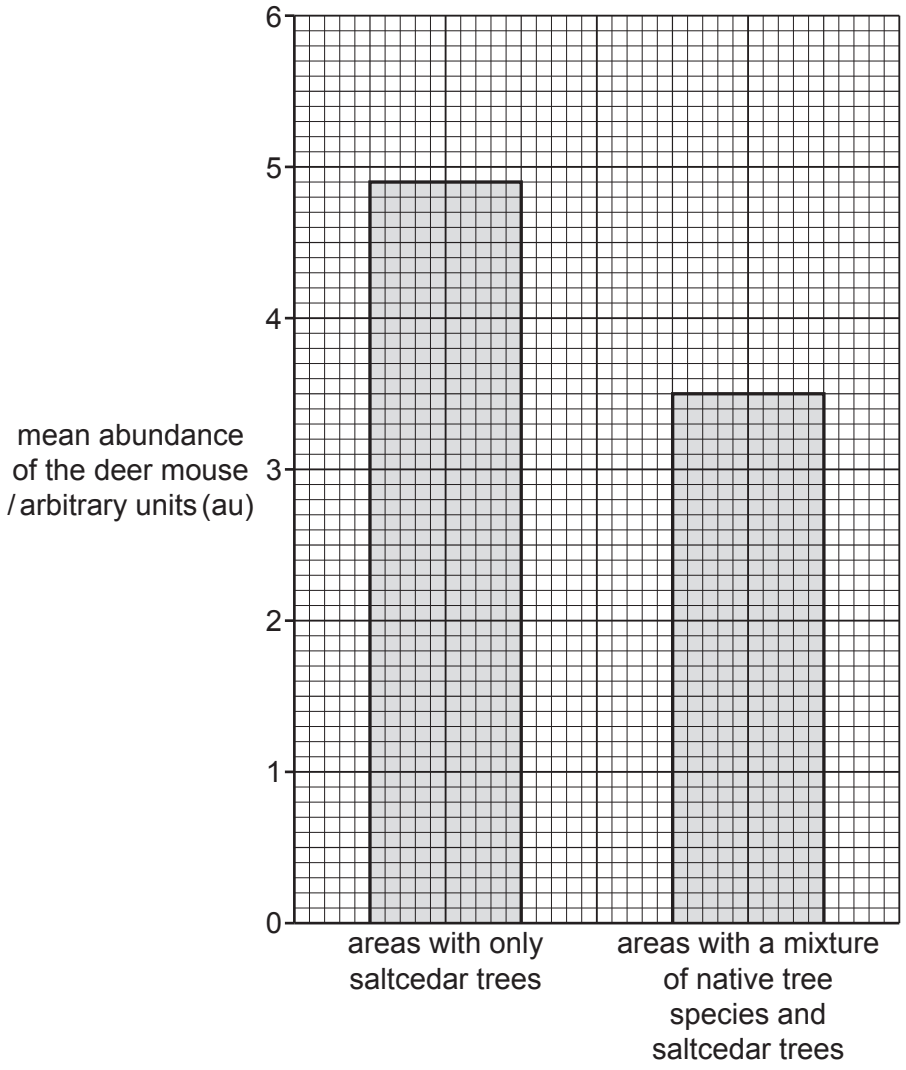



**Fig. 2.2**

**(i)** The standard error (SE) for the mean abundance of the deer mouse in each type of woodland was 0.8 au.

Plot SE error bars on Fig. 2.2. [1]

**(ii)** Explain, with reference to Fig. 2.2, what these SE error bars indicate about the data.

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**(iii)** The biologist then analysed these data using a *t*-test to compare the abundance of the deer mouse in the two types of woodland.

State a null hypothesis for the *t*-test.

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..... [1]

[Total: 13]

**3** Mussels, *Mytilus edulis*, are molluscs that live in sea water on the shorelines of coastal regions around the world. Mussels are a popular seafood and so are widely cultivated. After harvesting the mussels, the mussel farmer must replace them with young mussels. This is often done by collecting young mussels from wild marine ecosystems.

Fig. 3.1 shows mature mussels after harvesting.



**Fig. 3.1**

The slipper limpet, *Crepidula fornicata*, is an invasive alien species introduced into Europe from North America. Slipper limpets compete with the mussels and reduce the yield of mussels. Sometimes slipper limpets are accidentally collected with young mussels. Mussel farmers want to prevent the introduction of slipper limpets when re-stocking their mussel farms.

Fig. 3.2 shows slipper limpets.



**Fig. 3.2**

Scientists investigated the best way to kill slipper limpets without harming the mussels. The scientists put 30 slipper limpets (length > 30 mm) into each of four trays. Each tray of slipper limpets was exposed to a different test condition for a period of three days at a temperature of 12 °C to 13 °C. The four test conditions are shown in Table 3.1.

**Table 3.1**

| test condition | | details of test condition |
|---|---|---|
| 1 | air exposure | leave organisms exposed to the air |
| 2 | brine rinse | at the start of day 1, rinse organisms with a saturated salt (sodium chloride) solution for 5 minutes and then leave exposed to the air |
| 3 | repeat brine rinse | at the start of day 1, day 2 and day 3, rinse organisms with a saturated salt (sodium chloride) solution for 5 minutes and then leave exposed to the air |
| 4 | brine soak | at the start of day 1, soak organisms in a saturated salt (sodium chloride) solution for 1 hour and then leave exposed to the air |

This procedure was repeated with one tray of 30 slipper limpets (length < 30 mm) and one tray of 30 mussels (length > 30 mm) for each of the four test conditions.

After three days, the scientists counted the number of dead slipper limpets and dead mussels in each tray.

The scientists repeated the whole investigation at a temperature of 4 °C to 5 °C, using fresh samples of slipper limpets and mussels.

The results of these tests are shown in Fig. 3.3A and Fig. 3.3B.

A mussel farmer concluded from the results of the investigation shown in Fig. 3.3 that:

Young mussels used to re-stock the mussel farm should be given a brine soak treatment to kill any slipper limpets that are present.

Evaluate this conclusion.

You should use the data in Fig. 3.3A and Fig. 3.3B to support your answer.

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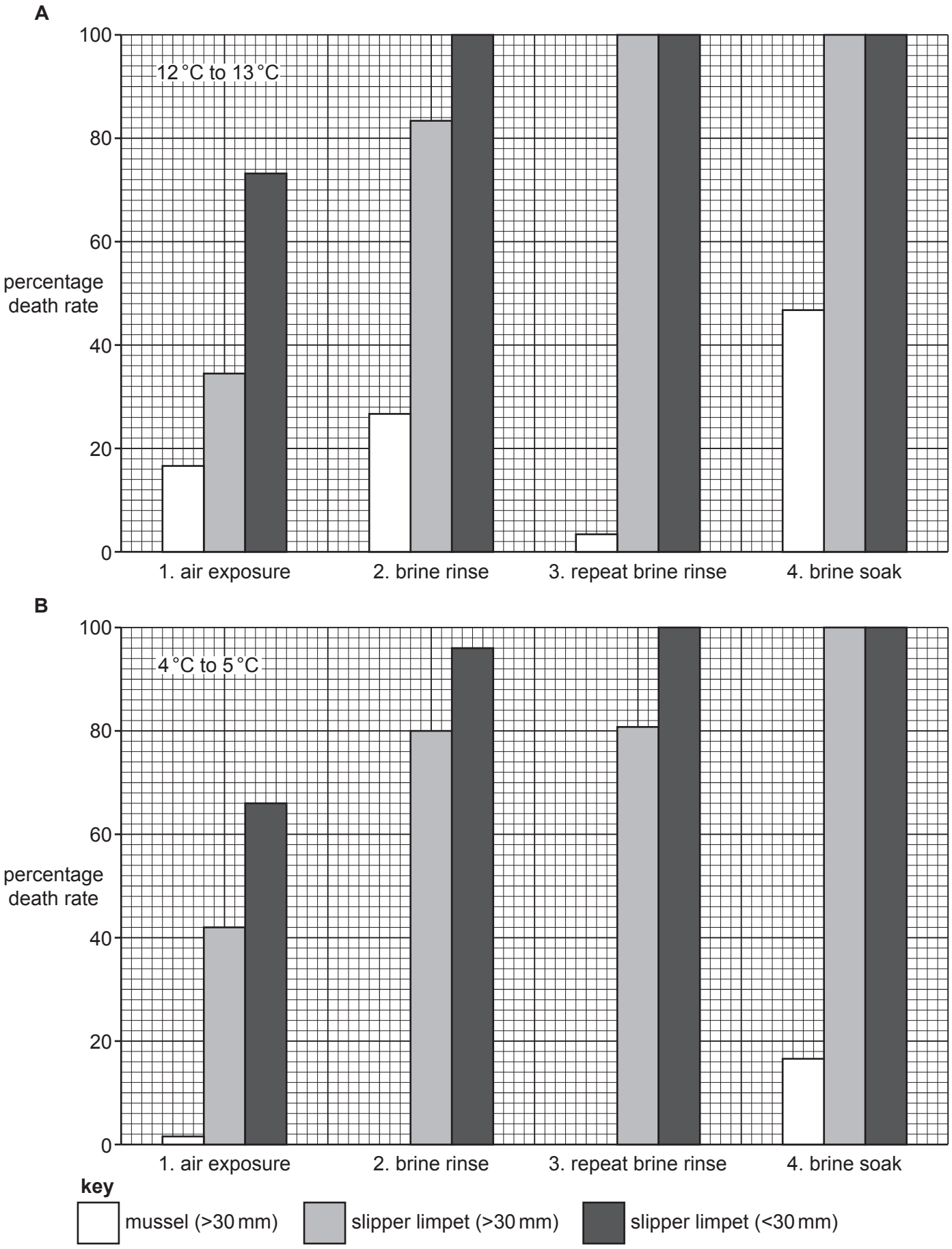



**Fig. 3.3**

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