

**BIOLOGY**
STANDARD LEVEL
PAPER 2

SPECIMEN PAPER

1 hour 15 minutes

Candidate session number

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Examination code

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INSTRUCTIONS TO CANDIDATES

- Write your session number in the boxes above.
- Do not open this examination paper until instructed to do so.
- Section A: answer all questions.
- Section B: answer one question.
- Write your answers in the boxes provided.
- A calculator is required for this paper.
- The maximum mark for this examination paper is [50 marks].



SECTION A

Answer **all** questions. Write your answers in the boxes provided.

1. Large areas in northern Indiana (USA) are used for the cultivation of corn (*Zea mays*). Headwater streams are water bodies that drain the land and merge to form larger rivers.

Ecologists asked questions after the introduction of genetically modified *Bt* corn varieties:

- does organic debris from fields of genetically modified corn enter headwater streams?
- are there any effects on stream life?

To try to answer these questions, a group of researchers took measurements from twelve headwater streams in Indiana and carried out laboratory experiments. Corn crops were growing on both sides of each of the streams.

After the corn was harvested, traps were used to measure the amount of corn leaves, cobs and pollen entering the streams. The results are shown in the table.

Stream	Leaf and cob inputs / $\text{g m}^{-2} \text{y}^{-1}$	Pollen inputs / $\text{g m}^{-2} \text{y}^{-1}$
1A	0.1	0.03
1B	1.3	0.73
1C	0.7	0.09
1D	3.4	0.39
1E	1.5	0.59
1F	8.2	0.16
2A	3.0	1.05
2B	0.0	0.27
2C	0.2	0.37
2D	0.3	0.24
2E	0.6	0.31
2F	0.9	0.38

[Source: adapted from Rosi-Marshall, *et al.*, (2007), *Proceedings of the National Academy of Sciences*, **104**, pages 16204–16208. Copyright (2007) National Academy of Sciences, U.S.A.]

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(Question 1 continued)

- (a) Identify the stream with the highest total input of organic debris from corn crops. [1]

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- (b) Determine, with a reason, whether the data in the table supports the hypothesis that the inputs of leaves and cobs to streams is always greater than the input of pollen. [1]

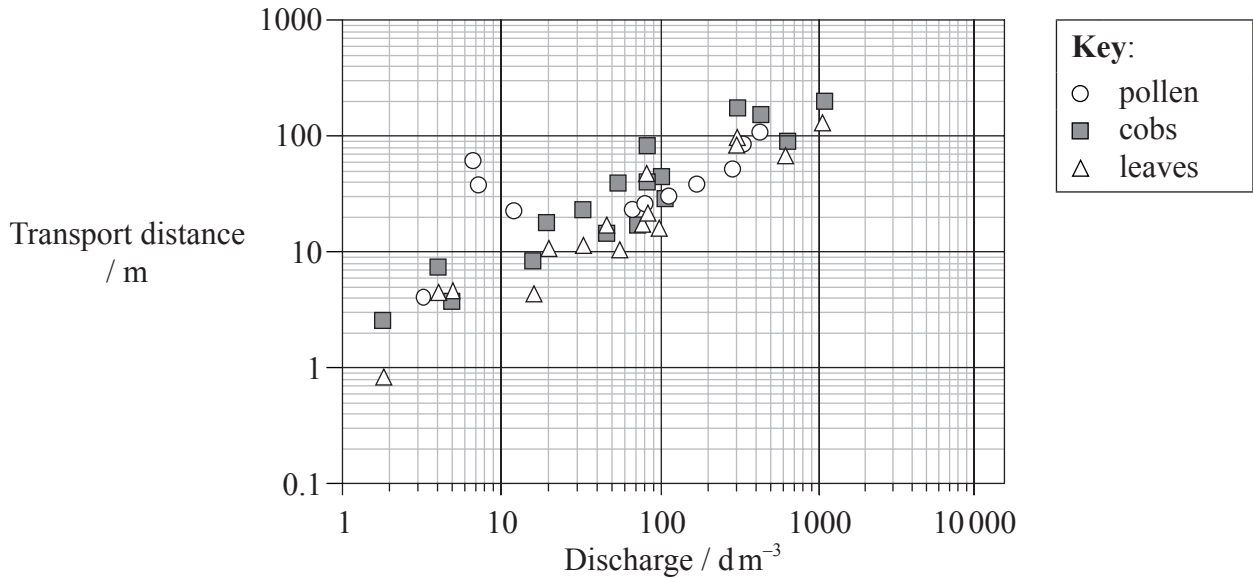
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(Question 1 continued)

Leaves, cobs and pollen were stained with a pigment and then released into the streams to find the average transport distance. The volume of water flowing in the streams (discharge) was also measured. The results are shown in the graph.



[Source: adapted from Rosi-Marshall, *et al.*, (2007), *Proceedings of the National Academy of Sciences*, **104**, pages 16204–16208. Copyright (2007) National Academy of Sciences, U.S.A.]

(c) Estimate the maximum transport distance for cobs. [1]

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(d) State the relationship between discharge rates and transport distance for debris from the corn crop. [1]

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(Question 1 continued)

(e) Distinguish between the transport distance of cobs and leaves.

[2]

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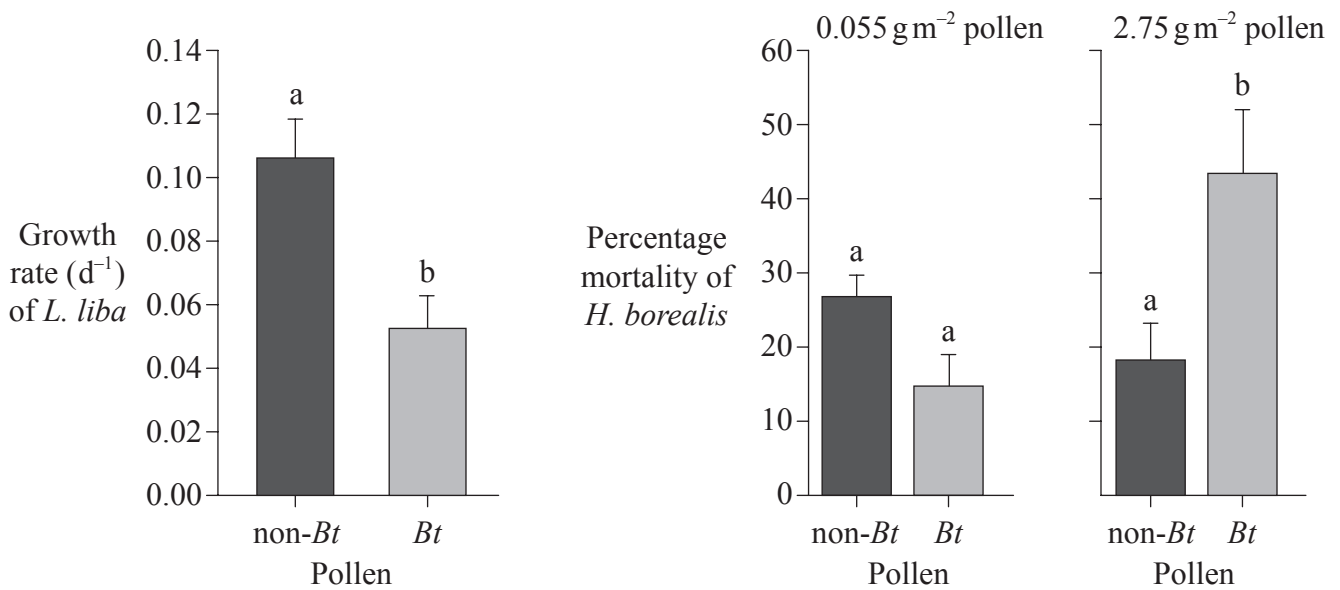
(Question 1 continued)

Larvae of caddis flies were observed in parts of the headwater streams where organic debris from corn crops had accumulated. Laboratory experiments were performed to try to find out if these larvae could be affected by consuming debris from *Bt* corn.

Lepidostoma liba is a caddis fly that feeds by shredding dead plant matter. The growth rate of *L. liba* was measured when it was fed on leaves from *Bt* corn and non-*Bt* corn. *Helicopsyche borealis* is a caddis fly that feeds by scraping algae surfaces. The mortality rate of *H. borealis* was measured when it fed on biofilms of algae containing *Bt* pollen or non-*Bt* pollen.

Two concentrations of pollen were tested. One concentration (0.055 g m^{-2}) was based on the maximum observed daily pollen input rate to streams. The other concentration was 50 times higher (2.75 g m^{-2}).

The results are shown in the bar charts. Statistically significant differences between non-*Bt* pollen and *Bt* pollen in each bar chart are indicated by different letters on error bars.



[Source: adapted from Rosi-Marshall, *et al.*, (2007), *Proceedings of the National Academy of Sciences*, **104**, pages 16204–16208. Copyright (2007) National Academy of Sciences, U.S.A.]

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(Question 1 continued)

- (f) Using the data in the bar charts, evaluate the effects of the *Bt* pollen on caddis flies. [3]

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The research described in this question was strongly criticized soon after it was published by some other biologists and by the company that produced *Bt* varieties of crop plants. In particular there were objections to a statement in the research paper that “Widespread planting of *Bt* crops has unexpected ecosystem-scale consequences”.

- (g) Discuss whether this statement in the research paper was justified, based on the methods used in the research and the data obtained. [3]

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2. The photograph shows a heart, viewed from the ventral side.



(a) Label the photograph to show the position of

- the right ventricle
- the left atrium
- a coronary blood vessel.

[3]

(b) Outline **two** ways the body uses to increase the heart rate.

[2]

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