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Biology
Standard level
Paper 2

Wednesday 19 May 2021 (morning)

Candidate session number

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1 hour 15 minutes

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.
- Answers must be written within the answer boxes provided.
- A calculator is required for this paper.
- The maximum mark for this examination paper is **[50 marks]**.



Please **do not** write on this page.

Answers written on this page
will not be marked.



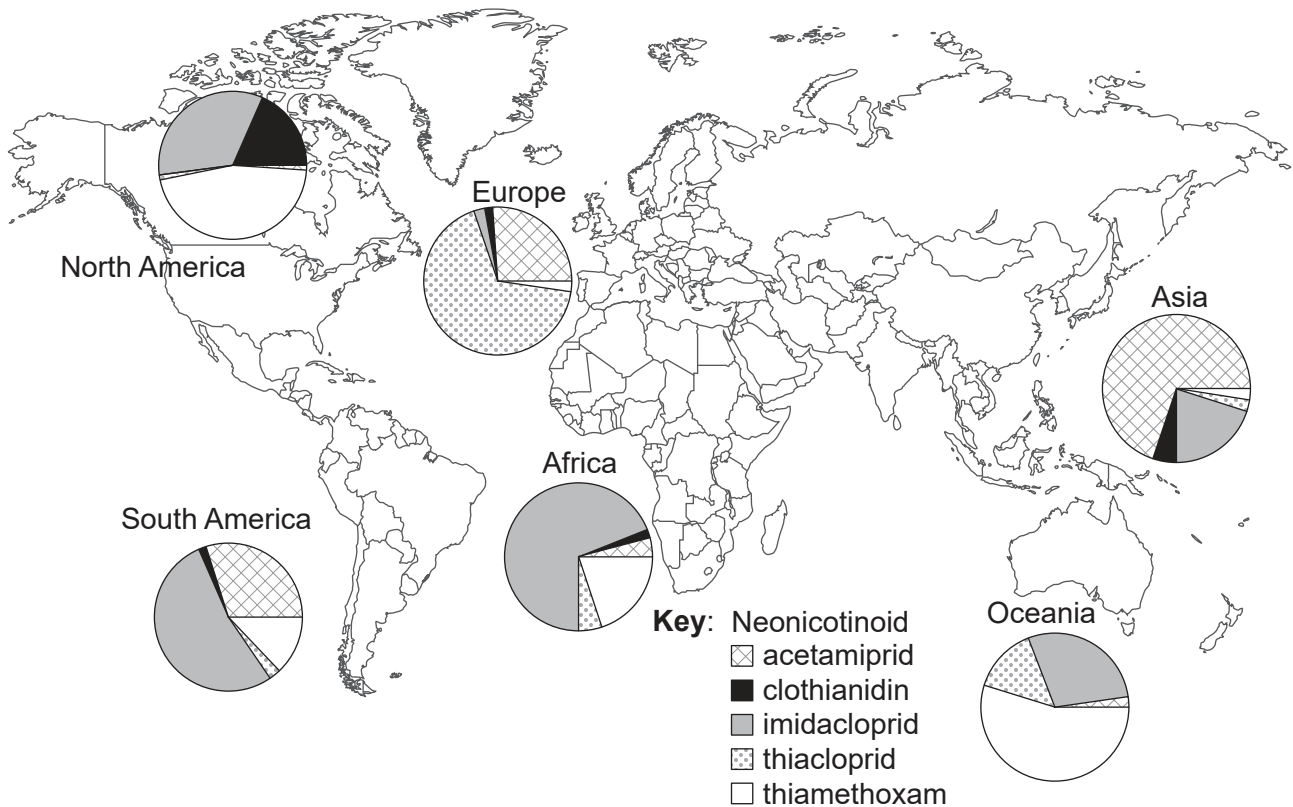
16EP02

Section A

Answer **all** questions. Answers must be written within the answer boxes provided.

- Honeybees (*Apis mellifera*) are key pollinators in most ecosystems. The worldwide use of neonicotinoid pesticides has caused concern because they may be contributing to the decline of honeybee populations.

Scientists measured the concentration of five neonicotinoids (acetamiprid, clothianidin, imidacloprid, thiacloprid and thiamethoxam) in honey samples from 198 different locations across the world. Each pie chart shows the relative frequency of neonicotinoids in honey samples from a continent.



[Source: Republished with permission of American Association for the Advancement of Science, from A worldwide survey of neonicotinoids in honey, Mitchell, E.A., et al., *Science*, Volume 358, Issue 6359, 2017. Permission conveyed through Copyright Clearance Center, Inc. <https://science.sciencemag.org/content/358/6359/109.full>.]

- Identify in which continent the fewest types of neonicotinoid were detected in honey samples. [1]

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- Using the data, outline the different use of thiamethoxam in North and South America. [1]

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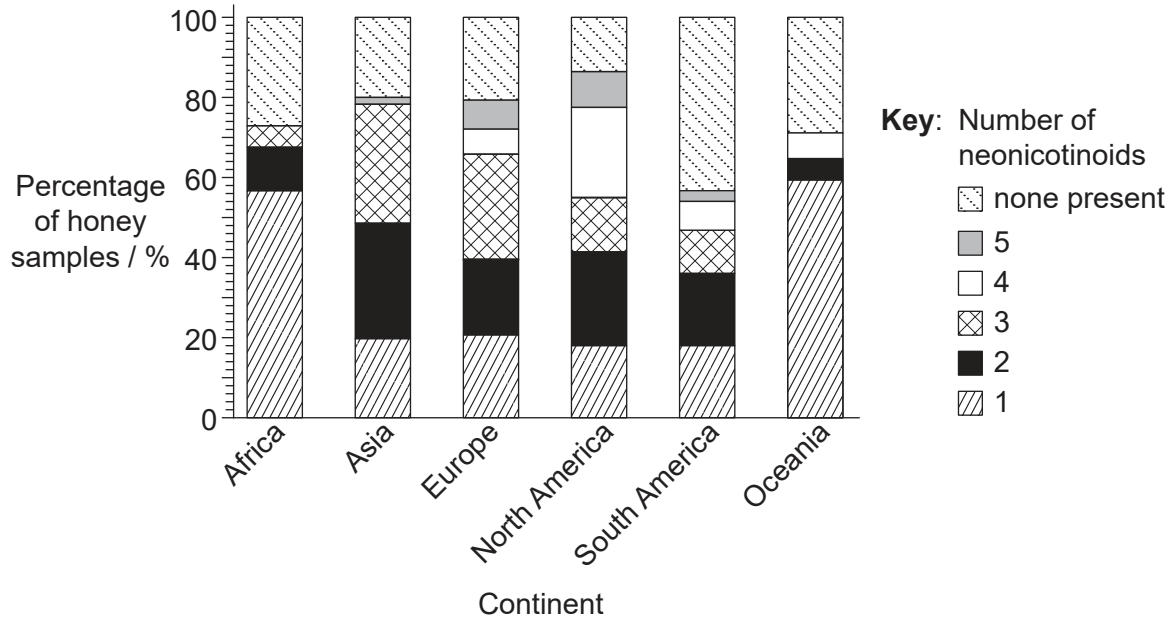


16EP03

Turn over

(Question 1 continued)

The neonicotinoids can be used alone or together with other neonicotinoids. The percentage of honey samples with 0, 1, 2, 3, 4 or 5 different neonicotinoids in each continent are shown in the stacked bar chart.



[Source: Republished with permission of American Association for the Advancement of Science, from A worldwide survey of neonicotinoids in honey, Mitchell, E.A., et al., *Science*, Volume 358, Issue 6359, 2017. Permission conveyed through Copyright Clearance Center, Inc. <https://science.sciencemag.org/content/358/6359/109.full>.]

- (c) Identify the total percentage of honey samples contaminated with neonicotinoid pesticides in the continent with the lowest overall levels of contamination. [1]

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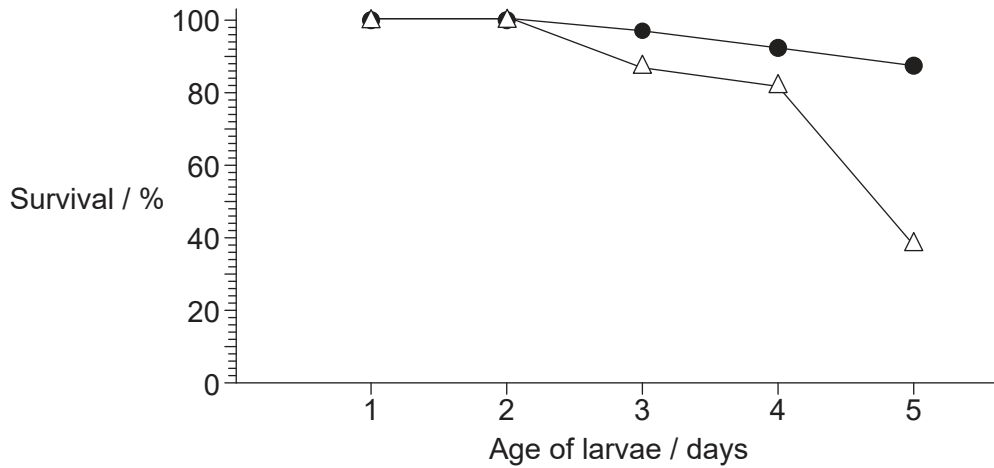


16EP04

(Question 1 continued)

In order to grow, honeybee larvae are fed royal jelly, a high energy food with very high acetylcholine concentrations.

In an experiment, larvae were bred artificially on a diet with reduced acetylcholine content in the royal jelly. The graph shows the mean survival rate of these larvae compared to control larvae fed on a normal diet.



Key:

- Control
- △ Reduced acetylcholine royal jelly

(d) Deduce the conclusions that can be drawn from the data in the graph. [2]

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(e) Suggest a reason for the effect of a diet reduced in acetylcholine on the larval survival rate. [1]

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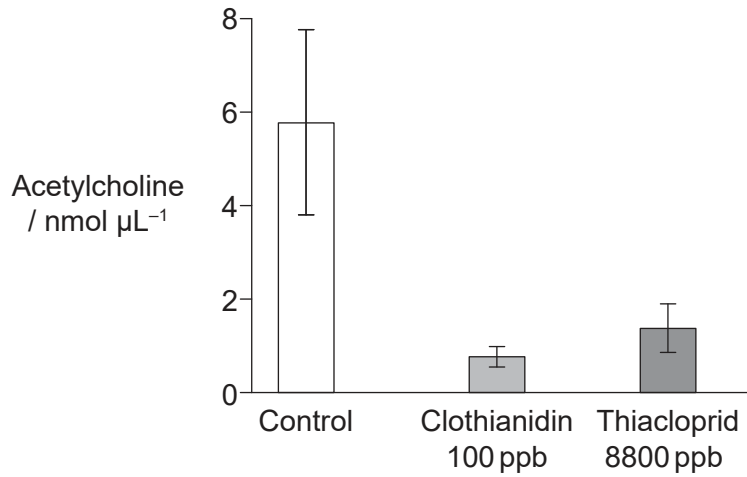


16EP05

Turn over

(Question 1 continued)

The concentration of acetylcholine was measured in royal jelly produced by honeybees that had never been exposed to neonicotinoids (control) and honeybees that had been exposed for three weeks to two neonicotinoids; clothianidin and thiacloprid.



(f) Compare and contrast the effect of clothianidin and thiacloprid treatments on the concentration of acetylcholine in royal jelly.

[2]

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(g) Explain how neonicotinoids affect synaptic transmission in insects.

[3]

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(This question continues on the following page)



16EP06

(Question 1 continued)

- (h) Companies that manufacture neonicotinoid pesticides have argued that they do not cause significant harm to honeybees. Construct an argument, based on the data in this question, for serious concern about the manufacture and use of neonicotinoid pesticides. [4]

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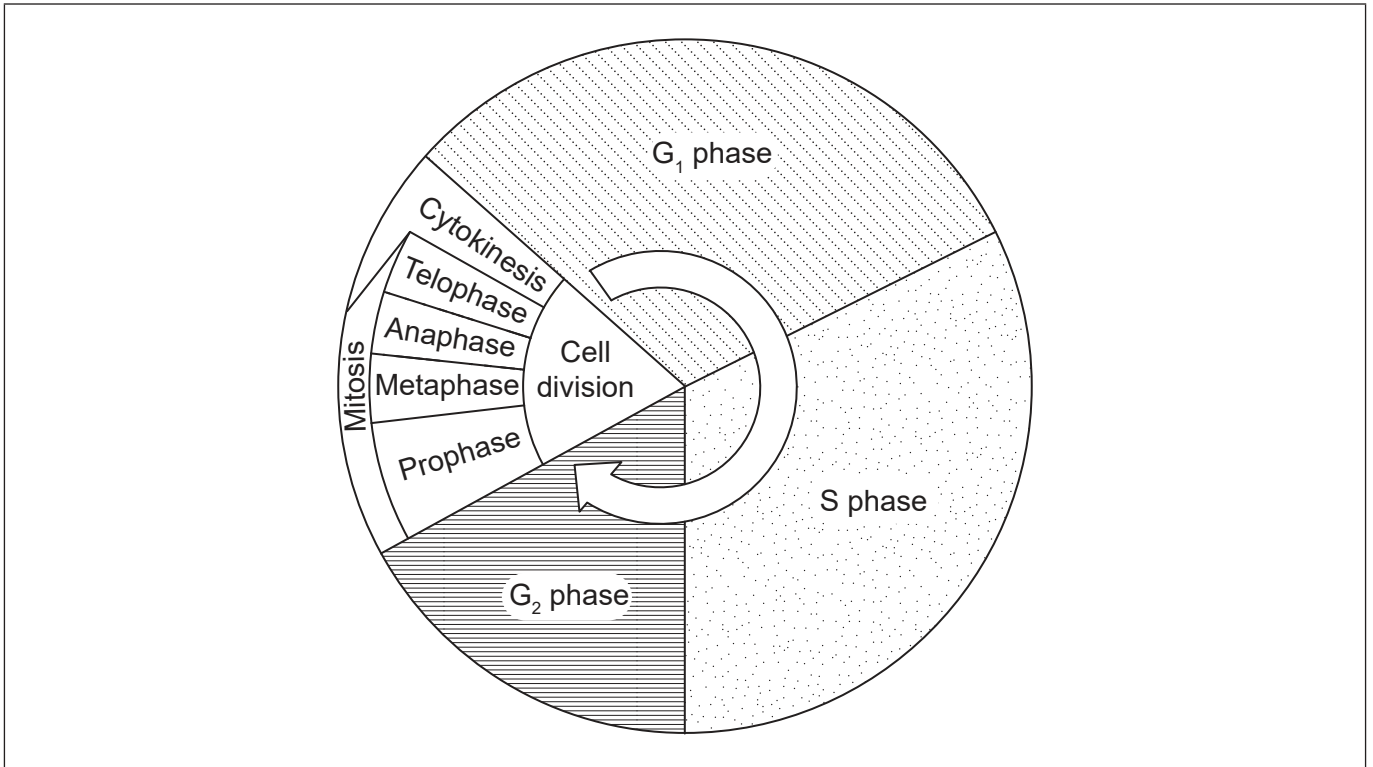
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2. The diagram shows the stages in the cell cycle.



(a) State processes occurring during interphase. [2]

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(b) (i) Using the letter C, label the stage on the diagram where chromosome supercoiling occurs. [1]

(ii) Using the letter M, label the stage on the diagram where sister chromatids migrate to opposite poles. [1]

(c) Distinguish between the outcomes of a cell dividing either by mitosis or meiosis. [2]

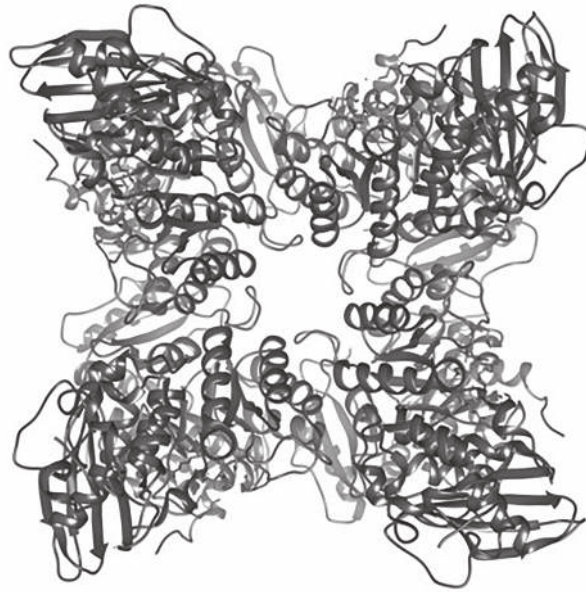
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(d) The mitotic index is an important prognostic tool for predicting the response of cancer cells to chemotherapy. Outline how the mitotic index is calculated. [1]

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3. The image represents the structure of the enzyme Rubisco from common pea (*Pisum sativum*).



(a) State **one** function of Rubisco. [1]

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(b) State a role of the active site of an enzyme. [1]

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(c) State the genus of the plant where this Rubisco is found. [1]

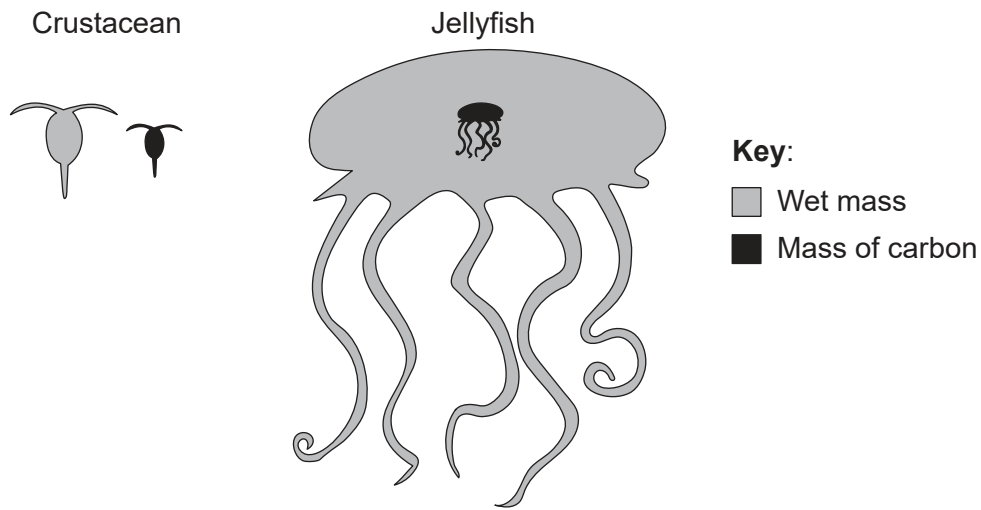
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(d) Outline **one** factor that could affect the activity of Rubisco. [2]

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4. The mass of an individual organism can affect its physiology and feeding ecology. The diagram shows the relative mass of carbon (black) and total wet mass (grey) of a marine crustacean, *Calanus hyperboreus* and a jellyfish, *Bathocyroe fosteri*.



[Source: Kristian McConville, Angus Atkinson, Elaine S. Fileman, John I. Spicer, Andrew G. Hirst. Disentangling the counteracting effects of water content and carbon mass on zooplankton growth. *Journal of Plankton Research*. 2017, Volume 39, Issue 2, Pages 246–256. <https://doi.org/10.1093/plankt/fbw094>. Adapted (and translated) by permission of Oxford University Press.]

- (a) State **one** process that results in the loss of carbon dioxide from a marine organism such as a crustacean or a jellyfish. [1]

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- (b) The crustacean and the jellyfish obtain carbon compounds by feeding. State **one** source of carbon for marine organisms, other than feeding. [1]

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- (c) Explain how energy enters, flows through and is lost from marine food chains. [3]

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16EP10

(Question 4 continued)

(d) (i) Deduce whether jellyfish or crustacea are a richer source of carbon in a food chain. [1]

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(ii) Suggest with a reason whether having a large body mass is an advantage or disadvantage for jellyfish. [1]

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16EP11

Turn over

Section B

Answer **one** question. Up to one additional mark is available for the construction of your answer. Answers must be written within the answer boxes provided.

5. Pastry cream or confectioners' custard is made with a combination of milk (rich in casein and lactose), egg yolks, sugar, starch and a flavouring such as vanilla.
- (a) Describe the structure of starch. [5]
 - (b) Explain how amino acids in casein could reach the liver, starting from the moment when the person takes a bite of pastry cream pie. [7]
 - (c) Congenital lactase deficiency is a type of lactose intolerance that occurs in infants. It is inherited in an autosomal recessive pattern. Calculate the chance of congenital lactose intolerance in a child whose parents are both carriers for the disorder, showing fully how you reached your answer. [3]
6. Tuberculosis (TB) is an infectious disease caused by the bacterium *Mycobacterium tuberculosis*.
- (a) Outline the structures in *M. tuberculosis* that are not present in a human cell. [3]
 - (b) Explain the production of antibodies when a patient is infected with the TB bacterium. [7]
 - (c) Describe the risk to the human population of indiscriminate use of antibiotics. [5]



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16EP13

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16EP14

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16EP15

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References:

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1.(d) Wessler I, Gärtner H-A, Michel-Schmidt R, Brochhausen C, Schmitz L, Anspach L, et al. (2016) Honeybees Produce Millimolar Concentrations of Non-Neuronal Acetylcholine for Breeding: Possible Adverse Effects of Neonicotinoids. *PLOS ONE* 11(6):e0156886. doi:10.1371/journal.pone.0156886 Copyright: © 2016 Wessler et al. This is an open access article distributed under the terms of the Creative Commons Attribution License (<https://creativecommons.org/licenses/by/4.0/>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

1.(f) Wessler I, Gärtner H-A, Michel-Schmidt R, Brochhausen C, Schmitz L, Anspach L, et al. (2016) Honeybees Produce Millimolar Concentrations of Non-Neuronal Acetylcholine for Breeding: Possible Adverse Effects of Neonicotinoids. *PLOS ONE* 11(6):e0156886. doi:10.1371/journal.pone.0156886 Copyright: © 2016 Wessler et al. This is an open access article distributed under the terms of the Creative Commons Attribution License (<https://creativecommons.org/licenses/by/4.0/>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

4. Kristian McConville, Angus Atkinson, Elaine S. Fileman, John I. Spicer, Andrew G. Hirst. Disentangling the counteracting effects of water content and carbon mass on zooplankton growth. *Journal of Plankton Research*. 2017, Volume 39, Issue 2, Pages 246-256. <https://doi.org/10.1093/plankt/fbw094>. Adapted (and translated) by permission of Oxford University Press.

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