2023

AP® Biology

Sample Student Responses and Scoring Commentary

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Free-Response Question 3

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Question 3: Scientific Investigation — 4 points

Sand lances of the genus *Ammodytes* are small fish that function as keystone organisms in several coastal ecosystems. These sand lances are prey fish that support organisms at higher trophic levels. Scientists performed experiments to examine how sand lance populations are likely to be affected by the rising temperatures and CO_2 levels associated with climate change.

Sand lance embryos typically develop and mature into adult fish at low temperatures (approximately 5°C) and stable, low CO_2 levels (approximately 400 µatm). Over the course of two years, the scientists measured the survival rate of sand lance embryos allowed to develop and mature in a laboratory at three different temperatures, 5°C, 7°C, and 10°C, with the level of CO_2 maintained at 400 µatm, 1,000 µatm, and 2,100 µatm for each temperature.

(a) **Describe** the effect of increased biodiversity on the resilience of an ecosystem in a changing environment. **1 point**

- (Ecosystem) resilience/it will be greater (with increased biodiversity).

(b) **Justify** the scientists' selecting 5°C as the lowest temperature and 400 µatm as the lowest CO_2 level in their study of sand lance embryo survival. **1 point**

Accept one of the following:

- These are the normal/current conditions at which the embryos develop and were used as a basis for comparison.
- These (current) conditions were used as a basis to compare the effects of changes in environmental conditions/increases in temperature and CO_2.

(c) **State** a null hypothesis for the experiment. **1 point**

Accept one of the following:

- Climate change will have no effect on sand lance (embryo) survival/sand lance development/the size of sand lance populations.
- (Increases in) temperature/CO_2 levels will have no effect on sand lance (embryo) survival/sand lance development /the size of sand lance populations.
- There will be no difference in the sand lance (embryo) survival rates/sand lance development/the size of sand lance populations measured at all/different temperatures and CO_2 levels.

(d) The scientists claim that a reduction in the population size of the *Ammodytes* sand lances will affect the stability of the entire coastal ecosystem. Provide reasoning to **support** the scientists' claim. **1 point**

Accept one of the following:

- There will be a negative effect on other trophic levels because the sand lance provides food for many other species.
- There will be a negative effect on other trophic levels because there will be reduced energy to transfer (to higher trophic levels).

Total for question 3 — 4 points

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BEGIN Question 3

Begin your response to **QUESTION 3** on this page. Do not skip lines.

Increasing biodiversity will also increase the resiliance of an ecosystem in a changing environment because if there was a change, a small group of the ecosystem will only be the ones affected and not the majority. The scientists selected 5°C and 400 µatm as their lowest CO_2 levels as the control group since sand lances normally develop and mature in those conditions. The scientists can use this control group to compare with other experimental groups to observe the changes to sand lances in response to changes. The null hypothesis is that the changes in CO_2 and temperature levels will have no affect on the sand lance population and their rate of survival. Because sand lances are classified as a keystone species, they are very important to control the environment/ecosystem. Reducing the sand lances can decrease the secondary & tertiary consumers that prey on it, while increasing the producer population. Ultimately, the population of sand lance predators would decrease because of the lack of food & competition, making the ecosystem unstable.

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BEGIN Question 3

Begin your response to **QUESTION 3** on this page. Do not skip lines.

a) Increased biodiversity increases the resilience of an ecosystem in a changing environment. Since there is a greater variety of organisms in the ecosystem, there is a greater likelihood that some of the organisms will survive.

b) The scientists selected 5°C as the lowest temperature & 400 µatm as the lowest CO_2 level because these are normal conditions and can be used as a control group to compare to the development of embryos at other temperatures and CO_2 levels.

c) Rising temperatures and CO_2 levels have no effect on the development of sand lance embryos.

d) The Ammodytes sand lances are a keystone species in the coastal ecosystems, meaning that a reduction in their population size would result in reduced biodiversity in the ecosystem, lowering ecosystem stability.

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BEGIN Question 3

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a) With a changing environment organisms have to adapt and overtime evolve to survive in the new changes in the ~~e~~ environment.

b) By choosing the lowest options in the laboratory, scientists are able to simulate similar natural conditions typical for the sand laces.

c). An increase in temperature and CO_2 levels doesn't have an effect on the embryo development of sand laces.

d) Since sand laces are a keystone organism for many coastal ~~e~~ ecosystems, which means many organisms prey on the sand laces. So if there's a decrease in sand laces, then organisms higher up in the food chain loose a source of energy which would then affect them.

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Question 3

Note: Student samples are quoted verbatim and may contain spelling and grammatical errors.

Overview

The stimulus of Question 3 described small fish called sand lances (*Ammodytes spp*.) that function as keystone organisms and are preyed upon by organisms at higher trophic levels. A scientific investigation into the effect of rising temperatures and CO_2 levels on sand lance development was presented.

In part (a) students were expected to describe that increased biodiversity results in increased ecosystem resilience (Skill 1.A; Learning Objective [LO] SYI-3.F from the AP Biology Course and Exam Description [CED]).

In part (b) students were asked to justify the use of the control conditions in the experiment (Skill 3.C).

In part (c) students were expected to write a null hypothesis for the experiment (Skill 3.B).

Part (d) described a claim of the scientists that "a reduction in the population size of the *Ammodytes* sand lances will affect the stability of the entire coastal ecosystem." Students were asked to provide reasoning to support the claim (Skill 6.B; LO SYI-3.G).

Sample: 3A
Score: 4

The response earned 1 point in part (a) for describing the effect of increased biodiversity as greater resilience. The response earned 1 point in part (b) for justifying scientists' selection of 5°C as the lowest temperature and 400 μatm as the lowest CO_2 level "since sand lances normally develop and mature in those conditions," allowing them "to compare with other experimental groups to observe the changes to sand lances." The response earned 1 point in part (c) for stating that "the changes in CO_2 and temperature levels will have no affect on the sand lance population and their rate of survival." The response earned 1 point in part (d) for supporting the claim that with a reduction in the population size of the *Ammodytes* sand lances, "the population of sand lance predators would decrease because of the lack of food."

Sample: 3B
Score: 3

The response earned 1 point in part (a) for describing that increased biodiversity "increases the resilience." The response earned 1 point in part (b) for justifying the scientists' selection of 5°C as the lowest temperature and 400 μatm as the lowest CO_2 level as "these are normal conditions and can be used … to compare to the development of embryos at other temperatures and CO_2 levels." The response earned 1 point in part (c) for stating, "Rising temperatures and CO_2 levels have no effect on the development of sand lance embryos." The response did not earn a point in part (d) because it does not support the claim with the reasoning that there will be a negative effect on other trophic levels because the sand lance provides food or energy for other trophic levels.

Sample: 3C
Score: 2

The response did not earn a point in part (a) because it does not describe the effect of increased biodiversity as greater resilience. The response did not earn a point in part (b) because, while it indicates that the scientists' selection of 5°C as the lowest temperature and 400 μatm as the lowest CO_2 level simulated "natural conditions" at which embryos develop, it does not justify that these conditions were used as a basis for comparison, or these

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Question 3 (continued)

conditions were used as a basis to compare the effects of changes in environmental conditions. The response earned 1 point in part (c) for stating, "An increase in temperature and CO_2 levels doesn't have an effect on the embryo development of sand lances." The response earned 1 point in part (d) for supporting the claim that a reduction in the population size of the *Ammodytes* sand lances would have the result that "organisms higher up in the food chain loose a source of energy."

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