Ecology Practice Exam Questions: Community Ecology – Answer Key

1. Soybeans (a legume) are colonized by *Rhizobium*, bacteria that fix nitrogen and are contained within nodules on the soybeans roots. *Rhizobium* require a host plant; they cannot fix nitrogen if it is outside the nodule. *Rhizobium* transfer nitrogen to the host plant and the plant transfers sugars (products of photosynthesis) to the *Rhizobium*.
    a. What is the relationship between the soybean and a *Rhizobium* bacterium? Include the fitness effects on both organisms in your answer. (2 marks)

Mutualism (+/+) (1 mark)
Both species benefit from the exchange of food and nutrients (1 mark)

    b. In some cases, not all of the *Rhizobium* present in the root nodules will participate in transferring nitrogen to the host soybean plant, but they will still consume the host sugars. In this case, what is the relationship between the soybean and these populations of *Rhizobium*? Include the fitness effects on both organisms in your answer. (2 marks)

Parasitism (+/–) OR commensalism (+/ 0) (1 mark)
***Rhizobium* benefits/has higher fitness (+) because it gains sugars (0.5 mark)**
Soybean has lower fitness because it loses sugars OR equal fitness (– or 0) because it has excess sugar it can give to the *Rhizobium* bacteria (0.5 mark)

    c. Why don't legumes become dominant in grasslands? Nitrogen is often the limiting nutrient in terrestrial environments. Legumes (plants with nitrogen-fixing bacteria in their roots) live in grasslands, but are generally less common than grasses. Propose a hypothesis that takes into account species interactions to explain why legumes that can fix nitrogen (and therefore escape nitrogen-limitation) are not dominant species when grasses are present. (2 marks)

Grasses are competitively dominant over legumes in the regions where grasslands biomes occur. Hypothesis should be reasonable and explicitly refer to species interactions (e.g., competition) for full marks.

    d. How could you test your hypothesis? Explain what your treatment and control would be. What are your predicted results if this hypothesis is TRUE? (4 marks)

1 mark for controls. 1 mark for treatment. 1 mark for correct and logical prediction that would be observed if the hypothesis is true. NOT TESTABLE – LEFT IN JUST FOR INTEREST'S SAKE

2. The oxpecker is a bird that feeds on parasitic ticks. Parasitic ticks drink the blood of large mammals, like cows. Previously, it was thought that the cows benefitted from the removal of ticks by the oxpeckers. A more recent study has found that the oxpecker eats only ticks that have already fed on the cows and the presence of the oxpeckers does not reduce the number of ticks on the cow to a level that is beneficial. (12 marks)

    a. Explain how all three organisms benefit, are harmed, or are unaffected by the interactions with the other organisms. Explain the reasoning behind each of your answers. (6 marks)

Organism	**Interaction with:**	**Outcome and Reasoning**
Oxpecker	**Cow**	**Benefits from a food source (ticks) →Decreases starvation risk → Increases survival → Increases reproductive success → Increases fitness**
	Tick	**Benefits because it gets a meal from tick →Decreases starvation risk → Increases survival → Increases reproductive success → Increases fitness**
Cow	**Oxpecker**	**Harmed: increases wounds →Decreases survival → Decreases reproductive success → Decreases fitness** OR **Neutral: No fitness benefit or cost from removal of ticks by oxpeckers**
	Tick	**Harmed by ticks – blood loss from parasite →Decreases survival → Decreases reproductive success → Decreases fitness**
Tick	**Oxpecker**	**Harmed by being eaten by oxpecker →Decreases survival → Decreases reproductive success → Decreases fitness**
	Cow	**Benefits from blood meal →Decreases starvation risk → Increases survival → Increases reproductive success → Increases fitness**

© UBC 2018W1– NOT FOR RESALE

In addition to eating ticks, oxpeckers drink blood by enlarging wounds in the skin of cows. It was hypothesized that oxpeckers prefer blood versus ticks as food. Paul Weeks tested this hypothesis by dividing a herd of cows into two groups: for one group, oxpeckers were prevented from landing on the cows; for the other group, oxpeckers could land and feed on the cows. The number of ticks and wounds on the cows in the two groups were measured at the beginning and end of the experiment.

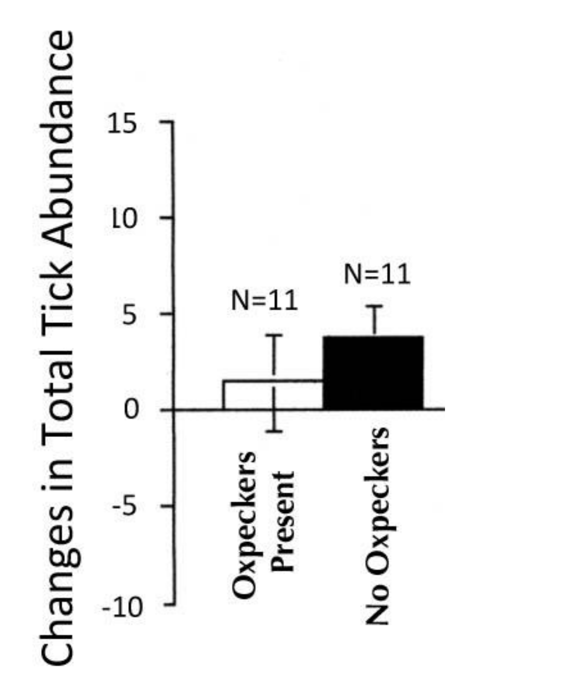

Figure 1A. Change in tick abundance with oxpeckers present and oxpeckers absent. N=11 cows per treatment. Bars represent variation around the mean (95% CI).

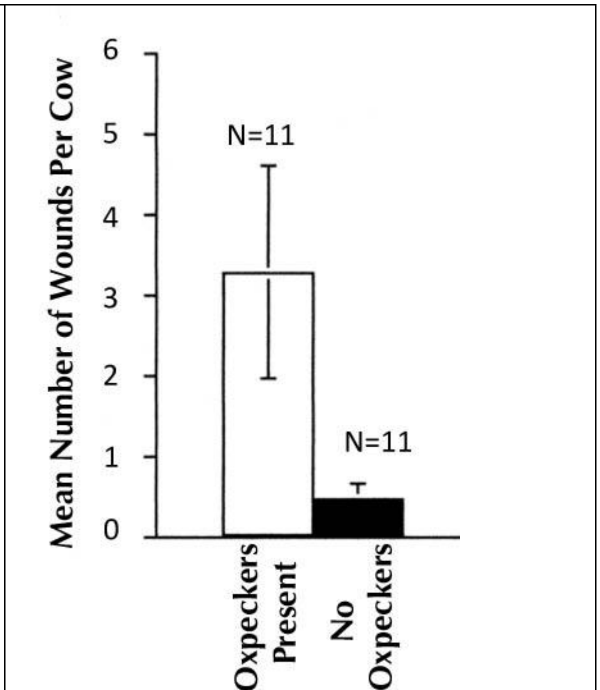

Figure 1B. Mean number of wounds per cow with oxpeckers present and oxpeckers absent. N=11 cows per treatment. Bars represent variation around the mean (95% CI).

b. Based on Paul Weeks' observations, what is the type of interaction between the cow and the oxpecker? Justify your answer with specific reference to the data provided. (4 marks)

Oxpeckers increase the number of wounds per cow [Note: must refer to data in the figure]**, which could decrease survival success → decrease reproductive success = fitness (1 mark).**
At the same time, oxpeckers don't substantially decrease the number of ticks per cow [Note: must refer to data in the figure]**, so cows probably don't experience much (if any) fitness benefit from the interaction (1 mark).**

Taken together, the data suggests that the net fitness benefit for the cow would be negative (0.5 mark). Assuming that the oxpeckers are receiving a net fitness benefit from the interaction with the cow (0.5 mark), the type of interaction would be parasitism (1 mark) [Note: consumption or predation also acceptable.]

3. *Daphnia pulex* and *Simocephalus vetulus* are common species of freshwater zooplankton. They eat algae, can live in the same ponds and grow well under the same abiotic conditions. Hydra are predators of both *Daphnia* and *Simocephalus*.

   Researchers investigated the effects of the interaction between the zooplankton by growing them either separately or together. They also investigated the effect of a predator, hydra, on the interaction between the two species when grown together.

The researchers set up an experiment with four replicates of each treatment. The treatments were:

- *Daphnia, grown alone* – fed algae, no predator.
- *Simocephalus, grown alone* – fed algae, no predator.
- *Daphnia + Simocephalus* – fed algae, no predator.
- *Daphnia + Simocephalus* – fed algae, predator.

The concentration of *Daphnia* at the **start** of each experiment was 20 individuals/L, and the concentration of *Simocephalus* at the start was 20 individuals/L. All treatments were given the same amount of algae at the beginning of the experiment. The concentration of individuals was measured after 14 days.

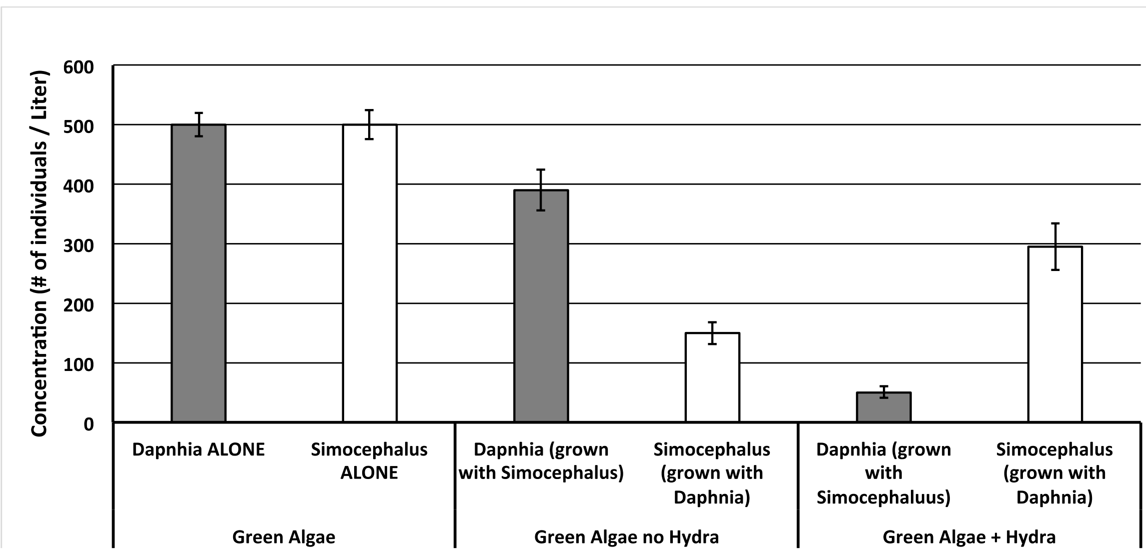

Figure 4.1. The abundance of *Daphnia* and *Simocephalus* measured in individuals/L in artificial ponds after 14 days. Bars represent variation around the mean (95% confidence intervals).

a. In the **absence** of a predator (hydra), what interaction is occurring between *Daphnia* and *Simocephalus*? How does the interaction affect the fitness of both species? Explain your answer and support your statements with data from the figure and text. Figure 4.1. (4 marks)

Interaction*:* **competition (½ mark) for food (½ mark)**

Effect on fitness of *Daphnia*: **decreases (½ mark)**

Effect on fitness of *Simocephalus*: **decreases (½ mark)**

Explanation: When grown alone, the concentration of both species is 500 individuals/L. (½ mark). When grown together, the concentration of both species is reduced (*Daphnia* ~400 indiv/L; *Simocephalus* ~150 individuals/L (½ mark). The reduction in number of individuals when grown together is statistically significant (½ mark). There are

also significantly more *Daphnia* than *Simocephalus* or competition has a greater impact on *Simocephalus* (½ mark).

b. Provide one plausible explanation as to why there are fewer *Daphnia* than *Simocephalus* in the presence of hydra. (1 mark)

Logical answer; e.g., hydra prefer to eat *Daphnia*; OR *Simocephalus* have an adaptation that helps them avoid predators; etc.

c. When grown together for a long period of time, only one species of zooplankton will survive. Predict which species will survive in each of the following scenarios, and explain *why* you chose that species. Justify your answer with specific data from Figure 4.1. (4 marks)

1 mark for which species will survive and 1 mark for explanation

Scenario	Which species will survive?	Explain why:
i) starting with both species, plus algae	***Daphnia***	***Daphnia* is a stronger competitor for algae (as evidenced by the higher number of *Daphnia* than *Simocephalus* when they are grown together). For this reason, *Daphnia* will survive and *Simocephalus* will not.**
ii) starting with both species, plus algae, plus predator (hydra)	***Simocephalus***	**more *Daphnia* are eaten than *Simocephalus* by the hydra (as evidenced by the higher number of *Simocephalus* than Daphnia in the presence of hydra). For this reason, *Simocephalus* will survive and *Daphnia* will not.**

d. Surprisingly, *Daphnia* and *Simocephalus* can coexist in lakes containing green algae, and hydra. Green algae can occur anywhere in the lake with sufficient light. In lake ecosystems, *Simocephalus* and hydra are associated with aquatic plants that live close to the shoreline. *Daphnia* occurs in open water away from the shoreline. Describe how it is possible that these species co-exist within a lake. (3 marks)

Within lakes, these species are occupying different niches (1 mark) because they live in different regions of the lake. As a result, they may not be in direct competition for resources (green algae and cyanobacteria) (1 mark). *Daphnia* may also avoid predation by hydra by occurring in a location where hydra don't occur (1 mark).