Ecological Interactions Activity

Teacher Guide

Main Concepts:

1. To describe the difference between mutualism, parasitism, and competition.
2. To explain why no two species can occupy the same niche in a community.
3. To predict what could happen if an invasive species is introduced into an ecosystem.

Module Overview

Students will be introduced to basic vocabulary about ecological relationships (niche, symbiosis, mutualism, competition, parasitism, commensalism, generalists, and specialists). Then, students will be split up into groups of three to do an activity that simulates these different relationships. Each student will represent a different species competing for limited food (M&Ms). Between rounds, students will count how many M&Ms they collected and answer questions.

Links to Curriculum

Missouri Science Standards

All populations living together within a community interact with one another and with their environment in order to survive and maintain a balanced ecosystem:

4.1.A-a. Explain the nature of interactions between organisms in different symbiotic relationships (i.e., mutualism, commensalism, parasitism)

4.1.A-b. Explain how cooperative (e.g., symbiosis) and competitive (e.g., predator/prey) relationships help maintain balance within an ecosystem

4.1.A-c. Explain why no two species can occupy the same niche in a community

Next Generation Science Standards

HS-LS2-6. Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem. *[Clarification Statement: Examples of changes in ecosystem conditions could include modest biological or physical changes, such as moderate hunting or a seasonal flood; and, extreme changes, such as volcanic eruption or sea level rise.]*

Timing

This activity takes about 60 minutes to complete. There is a lot of starting and stopping, so you should develop a system for that. It will probably take longer with younger groups of students.

Materials for a class of 30 *(Included by the Young Scientist Program)*

- 10 paper bowls
- 10 baggies of M&Ms (with 10 M&Ms of each color)
- 30 plastic cups
- 30 stacks of species note cards
- 30 plastic spoons
- 30 copies of the student worksheets

Background

A **niche** is the way of life of a species, or its role in an ecological community (what it eats, where it lives, how it interacts with other species, etc). For example, the niche of a honey bee is the time of day it is active, the type of flowers it gets nectar from, the temperature range it can survive, where it builds its hive, which other species it interacts with, and how it interacts with those other species (mutualism, parasitism, commensalism, etc). Another way of thinking about a niche is that it is the sum of the biotic (living) and abiotic (nonliving) resources that a species uses.

Species do not live by themselves—they live in ecological communities and are constantly interacting with other species. Something that affects one species will impact all the other species it interacts with. For example, if a frog species goes extinct in a community, then the snakes that usually eat it will have to find another food source or they will go extinct as well. And since there are no more frogs left to eat the moths, the moth population might increase so dramatically that it becomes out of control and eats all of the plants in the community, leaving no food for other plant eaters.

Species can have many different types of interactions with each other, some positive and some negative. Both types of these interactions are needed to maintain balance in an ecosystem. **Symbiosis** means "to live together," and happens when two species have a close relationship with each other. Interactions that fall under the category of symbiosis are *mutualism*, *parasitism*, and *commensalism*.

Parasitism is an interaction that harms one species and benefits the other species. A parasite lives on or in a host organism. For example, tarantula wasps lay eggs in tarantulas. This benefits the wasps because the larvae eat the tarantula's tissues. It kills the tarantula, however. Other types of interactions that harm one species and benefit the other are **predation** (where a predator eats its prey) and **herbivory** (where the consumer eats a plant species).

Competition is an interaction that harms both species. Two species are competing for a limited resource. This reduces the fitness of one or both of the species. For example, hyenas chase away vultures that are trying to eat the remains of the same zebra.

Mutualism is a type of interaction where both species benefit each other. For example, bees and flowers have a mutualistic relationship. The flowers need to bees to pollinate them so their seeds can be fertilized. Bees need flowers to make honey for their hives.

Commensalism is an interaction that benefits one species and does not affect the other species at all. For example, while cattle graze in fields they unintentionally stir up insects that were resting in the grass. Cattle egrets follow the cows' paths and eat these insects. The egrets benefit because cows help them find food. The cows are not benefitted or harmed by the egrets.

Interaction	Species 1	Species 2
Mutualism	+	+
Competition	-	-
Parasitism, Predation, and Herbivory	+	-
Commensalism	+	0 (neutral)

Some species are **generalists**, meaning they can eat many different types of foods. Raccoons are generalists, since they can eat many different foods such as eggs, bugs, nuts, birds, and berries. Other species are **specialists**, meaning they eat only a certain type of food. Koalas are specialists, since almost their entire diet is eucalyptus leaves.

References and Further Information

"Ecological Communities"
http://www.globalchange.umich.edu/globalchange1/current/lectures/ecol_com/ecol_com.html
(Introduces ecological communities and food webs, and talks about keystone species.)

"National Geographic"
http://education.nationalgeographic.com/activity/ecological-relationships/?ar_a=1
(This discusses ecological relationships with a focus on marine ecosystems.)

"Untamed Science"
http://www.youtube.com/watch?v=zSmL2F1t81Q
(This is a 5-minute YouTube video about Mutualism, Commensalism, and Parasitism.)

Activity Protocol

1. Fill out the introduction portion of the handout as a class.
2. M&M Activity
    a. Put students in groups of 3. Each student is a different species (Species A, B and C).
    b. Each group gets a baggy of materials. Each student gets a spoon, cup, and set of note cards.
    c. For each round, have students read the instructions on their note card about how they can survive the winter. Students should keep their instructions hidden from other group members.
    d. Place the bowl of M&Ms in the center of each group. Students will use a spoon to collect M&Ms and place them into their cups. No stealing from other student's cups!
    e. Each round lasts 1 minute (or less). At the end of the round, students should record how many M&Ms each species collected, then return the M&Ms to the community bowl and answer questions.
3. Have students answer the elaboration questions at the end of the handout, then discuss as a class.

Materials

Per group of 3 students:

- 1 bowl of M&Ms (10 of each color of M&M)
- 3 stacks of note cards (one stack per student)
- 3 empty cups (one per student)
- 3 plastic spoons (one per student)

Safety
The M&Ms have been handled by many people and should NOT be eaten.

Helpful Tips
Students may struggle to understand what a "niche" is, so it helps to walk them through a specific example. Name an animal (such as a honeybee) and give them examples of its niche (the time of day the bee is active, the type of flowers it gets nectar from, the temperature range it can survive, where it builds its hive, which other species it interacts with, and how it interacts with those other species, etc). Then ask a student to name another animal, and have the class come up with examples for the things that make up its niche.

HANDOUT ANSWER KEY

The Young Scientist Program - Teaching Kits
http://ysp.wustl.edu
Washington University School of Medicine
Funding provided by The Leon Lowenstein Foundation

Introduction

A niche is _____the role a species plays in its ecological community (what it eats, where it lives, how it interacts with other species, etc.)_____

Interaction	Species 1	Species 2	Definition	Example
1. Parasitism (parasite lives on or inside of a host) **2. Predation** (predator eats prey) **3. Herbivory** (organism eats a plant species)	+	-	An interaction that benefits one species and harms another.	 Tarantula wasps lay eggs inside of tarantulas while they're still alive.
Mutualism	+	+	An interaction where both species benefit.	 Bees pollinate flowers.
Competition	-	-	An interaction that harms both species	 Hyenas and lions both try to eat the same prey.
Commensalism	+	0	An interaction that benefits one species and doesn't affect the other species.	 Egret birds eat insects that cows & horses disturb.

A **generalist** is a species that can eat many different types of foods. For example, raccoons eat many things, including human garbage!

List another example: __Cows and other grazing animals (most species)__.

A **specialist** is a species that eats only a certain type of food. For example, koalas only eat eucalyptus plants.

List another example: _____Pandas eat bamboo_____.

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Activity Instructions:

Each person in your group represents a different species (Species A, Species B, and Species C), so each person gets a different stack of cards. Don't let anyone else see the instructions on your card, or they'll have a better chance of beating you!

Put the bowl of M&Ms in the center of your group, and give each group member a spoon. Use the spoon to collect M&Ms—*only one at a time*. Leave your cup on the table, not in your hand. No cup guarding! At the end of the round, count how many M&Ms you collected, fill out the table, and answer the related questions. Then, put all of your M&Ms back into the community bowl for the next round.

Round 1			
	Species A	Species B	Species C
Number of M&Ms in the cup			
Did this species collect enough food to survive the winter?			

1. Which two species occupied the same niche in this community? How do you know?

   Species A and Species B. They both only eat green M&Ms.

2. Which ecological relationship does…
   a) …Species A and Species B have?
      *(mutualism / parasitism / **competition** / commensalism / none)*
   b) …Species A and Species C have?
      *(mutualism / parasitism / competition / commensalism / **none**)*
   c) …Species B and Species C have?
      *(mutualism / parasitism / competition / commensalism / **none**)*

3. Why will two species not be able to occupy the same niche in a community for very long?

   One species will outcompete the other and drive it to extinction.

4. Was your species a generalist or a specialist? Why?

   All were specialists. They can all only eat one color of M&M.

Round 2			
	Species A	Species B	Species C
Number of M&Ms in the cup			
Did this species collect enough food to survive the winter?			

5. Which ecological relationship does…
   a) …Species A and Species B have?
      *(mutualism / parasitism / competition / commensalism / **none**)*
   b) …Species A and Species C have?
      *(mutualism / **parasitism** / competition / commensalism / none)*
   c) …Species B and Species C have?
      *(mutualism / **parasitism** / competition / commensalism / none)*

6. Was your species a generalist or a specialist? Why?

   Species C is a generalist. Species A & B are specialists (only eat 2 colors).

Round 3			
	Species A	Species B	Species C
Number of M&Ms in the cup			
Did this species collect enough food to survive the winter?			

7. Which ecological relationship does…
   a) …Species A and Species B have?
      *(**mutualism** / parasitism / competition / commensalism / none)*
   b) …Species A and Species C have?
      *(**mutualism** / parasitism / competition / commensalism / none)*
   c) …Species B and Species C have?
      *(**mutualism** / parasitism / competition / commensalism / none)*

Round 4			
	Species A	Species B	Species C
Number of M&Ms in the cup			
Did this species collect enough food to survive the winter?			

8. Which ecological relationship does…
   a) …Species A and Species B have?
      *(mutualism / parasitism / competition / **commensalism** / none)*
   b) …Species A and Species C have?
      *(mutualism / parasitism / competition / **commensalism** / none)*
   c) …Species B and Species C have?
      *(mutualism / parasitism / **competition** / commensalism / none)*

Elaboration Questions

9. If the environment changed suddenly, for example because of global warming, do you think generalist or specialist species would be better able to adapt and avoid going extinct? Why?

   Generalist species. They are more likely to have food left after a big change.

10. What would happen if a new invasive species came into your ecosystem that ate blue, red, and orange M&Ms and was better at collecting food than all three of your species?

    The three species would eventually go extinct.

11. Using what you have learned about ecological interactions, think an example of each interaction in which humans are involved:

    a. Competition: Humans compete with all organisms for space.

    b. Parasitism: Humans have many parasites: head lice, ticks, tapeworms, etc.

    c. Mutualism: We have mutualistic relationships with all domesticated plants/animals.

    d. Commensalism: Pigeons thrive in metropolitan ecosystems without really affecting humans (except for being mildly disgusting).

12. "*All populations living together within a community interact with one another and with their environment in order to survive and maintain a balanced ecosystem*." Do you agree with this statement? Why or why not?

    Yes. Answers will vary.