Heading & Title

**Introduction**

**Purpose**

In this investigation you will conduct a virtual experiment and grow two species of the protozoan *Paramecium*, alone and together. You will then compare growth curves of the populations of each species.

**Discussion**

How does competition affect population growth?

The genus *Paramecium* consists of unicellular species of protists that live in freshwater environments. Under **ideal conditions** (sufficient **food, water, and space**) populations of these species grow rapidly and follow a pattern known as exponential growth. **Exponential growth** is explosive population growth in which the total number of potentially reproducing organisms increases with each generation. However, populations of organisms will not increase in size forever. Eventually, limitations on food, water, and other resources will cause the population to stop increasing.

When a population arrives at the point where its size remains stable, it has reached the carrying capacity of the environment. The **carrying capacity** is the greatest number of individuals a given environment can sustain. Competition for resources among members of a population (intraspecific competition) places limits on population size.

**Competition** for resources among members of two or more different species (interspecific competition) also affects population size. In a classic series of experiments in the 1930s, a Russian ecologist, G.F. Gause, formulated his **principal of competitive exclusion**. This principle states that if two species are competing for the same resource, the species with a more rapid growth rate will outcompete the other. In other words, **no two species can occupy the same niche**.

In competing populations of organisms, genetic variations that reduce competition are favored through natural selection. Suppose two species (A and B) compete for the same food source. Individuals of species A can also use another food source, which reduces the competition over the food source needed by species B. The individuals of species A that can use another food source survive because they do not have to compete with individuals of species B for that food. In nature, organisms frequently invade unoccupied habitats simply to avoid intense competition. Once the organism is in a new habitat, any variations that allow it to use the available resources will tend to be perpetuated through the population. In this way, the genetic makeup of the population may slowly change, and the species will become adapted to a new niche.

**Hypothesis**

**Materials**

P. caudatum stock culture 4 cells/mL in flask

P. aurelia stock culture 4 cells/mL in flask

Pipettes test tubes (with rice) Compound Microscope

[**Population Growth Virtual Lab Website**](https://nt7-mhe-complex-assets.mheducation.com/nt7-mhe-complex-assets/9-12_SciMar-20-2018/Biology/BL_04/index.html)OR

Video Link: <http://somup.com/c3lVr0wF6T> (4:56)

**Procedures:**

1. Click on: [**Population Growth Virtual Lab Website**](https://nt7-mhe-complex-assets.mheducation.com/nt7-mhe-complex-assets/9-12_SciMar-20-2018/Biology/BL_04/index.html)OR

Video Link: <http://somup.com/c3lVr0wF6T> (4:56) [*only if website doesn’t work*]

2. The website shows instructions on the left-hand side and also contains pages to enter data and questions. All information will be recorded on this lab worksheet.

3. Begin the experiment by filling the test tubes with samples from the stock cultures in the flasks as follows:

a. Locate the pipette to the LEFT (*P. caudatum* stock culture).

b. Click the purple bulb at the top of the pipette. Then, drag the pipette to test tube 1. Repeat until **test tube 1** has 10 ml of the *P. caudatum* sample.

c. Locate the pipette to the RIGHT (*P. aurelia* stock culture).

d. Click and hold the purple bulb at the top of the pipette. Then drag the pipette to test tube 2. Repeat until **test tube 2** has 10 ml of the *P. aurelia* sample.

e. Locate the pipette to the LEFT (*P. caudatum* stock culture). Click the purple bulb at the top of the pipette. Then, drag the pipette to **test tube 3** to add 5 ml of the *P. caudatum* sample.

Note: There is rice in the test tubes. The rice is food for bacteria, which in turn will be food for the *Paramecium*. The two species of *Paramecium* do not prey upon each other.

4. Make a hypothesis about how you think the two species of *Paramecium* will grow alone and how they will grow when they are grown together. Put that in the introduction section (p. 1).

5. Click on the microscope icon in the laboratory area. This will open up your workspace for observing the cultures and to make your wet mount preparations.

a. Click the box of clean slides and then the rack of cultures.

b. Click the first wet mount (test tube 1 contents on the left) individual slide and drag it to the microscope.

c. Click the “Grid On” icon on the microscope.

d. Count the number of specimens on the wet mount and multiply by TWO (2) because the data table asked for specimen/ml and the microscope slide only holds 0.5 ml. Record in the Calculations and Data section.

e. Do NOT click on any icons (Information, Start Over, Clear Slides, etc.).

f. Click and drag the second (middle) wet mount slide (test tube 2 contents) to the microscope and count the number of specimens on the wet mount and multiply by TWO (2) because the data table asked for specimen/ml and the microscope slide only holds 0.5 ml. Record in the Calculations and Data section.

g. Click and drag the third wet mount slide (test tube 3 contents on the right) to the microscope and count the number of specimens on the wet mount and multiply by TWO (2) because the data table asked for specimen/ml and the microscope slide only holds 0.5 ml. Record in the Calculations and Data section.

6. Click “Clear Slides” and then click on the calendar to advance 2 days of growth (i.e. Day 2).

7. Repeat procedures 5a – 6 for the Day 2 growth. Record all results in the data table of the Calculations and Data.

8. Repeat procedures 5a – 6 for the Day every two days of growth (i.e. Day 4, 6, 8, 10, 12, 14, and 16). Record all results in the data table of the Calculations and Data.

HONORS Only (procedures 9 – 10) or BONUS

9. When the “Data Table” is complete, enter the values from the data table into the computer table by clicking on the “Table” icon.

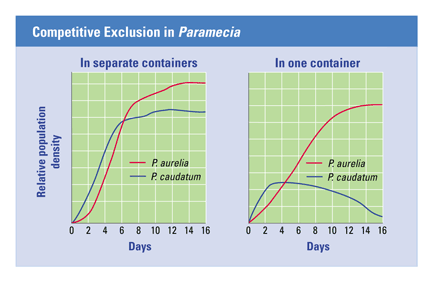
10. Click the “Graph” button to obtain a graph of your data over the 16 days. Print screen and insert that into the Calculations and Data section.

**Calculations and Data**

1. Complete the data table from the procedures. [**Multiply your counted numbers by 2**]

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | *P. caudatum* grown alone, cells/mL  Test Tube 1 | *P. aurelia* grown alone, cells/mL  Test Tube 2 | *P. caudatum* grown in mixed culture, cells/ mL  Test Tube 3 | *P. aurelia*  grown in mixed culture, cells/mL  Test Tube 3 |
| Day O |  |  |  |  |
| Day 2 |  |  |  |  |
| Day 4 |  |  |  |  |
| Day 6 |  |  |  |  |
| Day 8 |  |  |  |  |
| Day 10 |  |  |  |  |
| Day 12 |  |  |  |  |
| Day 14 |  |  |  |  |
| Day 16 |  |  |  |  |

2. Use the graph below to answer questions 3 & 4 from the data table:



3. Based on the experiment, what is the approximate carrying capacity for *Paramecium caudatum* population when it was grown alone? How do you know?

4. Based on the experiment, what is the approximate carrying capacity for *Paramecium aurelia* population when it was grown alone? How do you know?

5. Explain the differences in the population growth patterns of the two Paramecium species. What does this tell you about how *Paramecium aurelia* uses available resources?

6. Describe what happened when the *Paramecium* populations were mixed in the same test tube (#3). Do the results support the principle of competitive exclusion?

**Conclusions**

**Address Hypothesis** *(Was your hypothesis confirmed by the experiment? Explain.)*

**Analysis** (*Define the following*)

Niche

Competition

Carrying Capacity

Principle of Competitive Exclusion

**Questions** *(Rewrite the questions into statements conveying a complete thought).*

1. What do organisms compete for?

2. If two species compete for the same niche, what happens according to the principle of competitive exclusion? How did the results of this lab relate?

3. What other types of community interactions occur in natural habitats?

4. Name and define three types of symbiosis.

**Errors**

The virtual lab was done and did not include a “real life” element in which error could occur. Students may not follow directions and the simulation may malfunction.

**Bibliography**

Ecology Introduction Class Notes. Biology Course Site, Week 28. Learning CTR Online, n.d. Web. 19 March. 2022. <[www.learningctronline.com](https://www.pottersschool.org/teacher/)>.

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