**Name:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_Date:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**IB Biology**

**STUDY OF PLANT POPULATIONS**

Ecological communities are built on the interactions between the creatures (both plants and animals) that live there and the physical environment that surrounds them. The living creatures, or **biotic factors**, interact as predators, prey and competitors for resources. The physical environment, or **abiotic factors**, such as water, sunlight, climate, temperature, soil and oxygen are part of what determine how many living creatures can be supported in the ecosystem. In particular, the more sunlight and water that is available in an area the more different kinds of plants and animals can live in that area. To understand this, picture the difference between a desert and a tropical rainforest. The desert gets little water and therefore not many plants can grow there, so not many animals can live there. In contrast, a tropical rainforest gets plenty of both sunlight and rain and is therefore lush with a wide variety of both plants and animals.

Because of this, the tropical rainforest is said to have a **high biodiversity**. Biodiversity is a measure of the number and variety of different plant and animal species that live in an ecosystem. A high biodiversity leads to a more stable ecosystem because there is a wider variety of food and shelter/nesting resources for creatures to use. If there is a shortage of one, they can turn to another and still survive.

When studying an ecosystem, ecologists — scientists that study natural communities — first try to survey what populations of organisms naturally live there. They then also measure how many of each creature lives there. This is referred to as the **population density** of that species. Ecologists measure population density by counting the number of each species in a sample area, called a *quadrat*. If they count the population size in a number of quadrats chosen at random around the ecosystem, scientists can estimate how many of each species live in the whole ecosystem. The population size of each creature that the environment can support is called the **carrying capacity** of that community. The carrying capacity is how many of a certain species that can survive in an area given the resources (food, water, and nesting sites) available.

In this lab, we are going to practice the technique of measuring populations in a study area using quadrat sampling. We will then compare the results of two different populations using statistical analysis.

**PROCEDURE**

1. Explore the area of study to find examples of common plant species that can be identified using the species key.

2. Choose two species to investigate. How are these species distinguished from one another?

3. Mark out a 10 m by 10 m study area using a tape measure.

4. Draw a map of the larger area with the study area identified. Draw any large features that happen to fall in your study area, such as trees, rocks, pavement, etc. Also indicate abiotic factors that may influence the distribution of species (sunlight, water, soil type, etc.).

5. Working in pairs, use a random number generator to generate x and y coordinates for 4 points.

6. Place the quadrat at your first point and count the number of individuals of each species under investigation. Decide in advance which two edges of the quadrat are "in" and which two are "out". Repeat for your other points. Record data in the data table on the next page. We will compile data from each of the 5 groups for a total of 20 quadrats.

Map:

Title:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Quadrat size:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **Species A:** | | **Species B:** | |  |
| **Quadrat Coordinates** | **Individuals per quadrat**  **(+ )** | **Individuals per m2** | **Individuals per quadrat**  **(+ )** | **Individuals per m2** | **Notes/Observations** |
| 1 |  |  |  |  |  |
| 2 |  |  |  |  |  |
| 3 |  |  |  |  |  |
| 4 |  |  |  |  |  |
| 5 |  |  |  |  |  |
| 6 |  |  |  |  |  |
| 7 |  |  |  |  |  |
| 8 |  |  |  |  |  |
| 9 |  |  |  |  |  |
| 10 |  |  |  |  |  |
| 11 |  |  |  |  |  |
| 12 |  |  |  |  |  |
| 13 |  |  |  |  |  |
| 14 |  |  |  |  |  |
| 15 |  |  |  |  |  |
| 16 |  |  |  |  |  |
| 17 |  |  |  |  |  |
| 18 |  |  |  |  |  |
| 19 |  |  |  |  |  |
| 20 |  |  |  |  |  |
|  | Mean |  | Mean |  |  |
| SD |  | SD |  |

**Part 1**

1. Which data are more variable? How do you know?

2. Using EXCEL, conduct a t-test to determine if there is a significant difference in populations of Species A and B in the study area.

H0=

d.f.=

confidence=

3. Result:

**Part 2**

Populations are often unevenly distributed in an area because certain parts of the area are more suitable to a species than others. If two species live in the same areas of a habitat, then they will likely be found in the same quadrats. This is called a positive association. Species can also have a negative association (are not found in the same areas of a habitat) or be independent of one another.

The chi-squared (χ2) test is used to determine if there is an association between two species. This test can be used if the samples were randomly selected and all of the expected frequencies are greater than five.

1. Complete the following:

H0:

H1:

2. Complete the contingency table for the observed frequencies of each species. Enter the number of quadrats containing or not containing Species A and Species B (non-shaded areas). Calculate the row and column totals. Do not complete the shaded columns yet.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | Species A present | Expected frequency | (O-E)2  E | Species A absent | Expected frequency | (O-E)2  E | Row Totals |
| Species B present |  |  |  |  |  |  |  |
| Species B absent |  |  |  |  |  |  |  |
| Column Totals |  |  |  |  |  |  |  |

3. Calculate the expected frequencies for each of the four possibilities above. Assume that the species are independently distributed. Use the following formula and enter the results in the center columns (light shading) above.

Expected frequency = row total x column total

grand total

4. Calculate: (observed - expected)2 and write values in the darker-shaded columns.

expected

5. The formula to calculate chi-squared appears below. Most of the work has been done in the table above. Calculate chi-squared by adding the numbers in the 4 darker-shaded columns.

χ2 =∑ (O-E)2  
 E

χ2 =

6. Calculate the number of degrees of freedom:

d.f. = (number of rows-1)(number of columns-1)

d.f. =

7. Look up the critical value for χ2 with the degrees of freedom calculated in #6 and a significance level of 5%. Compare the critical value to the χ2 value calculated in #5. Reject the null hypothesis if χ2 is greater than the critical value. Accept the null hypothesis if χ2 is less than or equal to the critical value.

Critical value:

Accept or reject null hypothesis?

Explain what this means:

References:

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