

LEAF CUTTING ANTS

Fungus Farmers

How much leaf do leaf cutter ants chew?

ACTIVITY



Activity Overview

Leaf cutting ants carry away leaf pieces that are up to 30 times their weight. They sometimes carry these pieces 100-200 meters (about 2 football fields). It can take a whole day for one trip. Once they return to their nest, ants chew the leaves but they don't eat them. They use them as nutrients for growing fungi. It is the fungi that the young ants actually eat.

It is important to learn about the leaf cutting activities of these "fungus farmers." In Central America, for example, they help limit the spread of water hyacinths so that they don't grow uncontrollably in waterways. However, in the southeastern United States water hyacinths grow uncontrollably and have become a real pest, blocking rivers and streams. Their expansion is not limited by leaf cutting ants.

In this activity, you will use the TI-73 Explorer™ to become familiar with a technique for measuring the amount of leaves Leaf Cutter Ants chew. This technique could be used to assist scientists in determining whether or not Leaf Cutter Ants may limit the growth of water hyacinths. You will use a piece of construction paper to simulate a leaf and a hole punch to simulate Leaf Cutter Ants.

How can you measure leaves with irregular shapes? How can you measure the amount of leaves chewed by the ants?



LEAF CUTTING ANTS

Fungus Farmers

ACTIVITY

Procedure

1 Collect your data.

- Your teacher will provide you with several squares cut out of construction paper. The length of a side (**s**) for each square is different.
- Copy Table 1 in your journal.
- Measure the length of one side of a square (**s**) in centimeters using a metric ruler. Enter the measurement in Table 1.
- Calculate the square's area using the formula $A = s^2$. Enter the area in Table 1. For example, if $s = 4$ cm then $A = 4 \times 4 = 16$ cm².

You may use your TI-73 Explorer™ to make the calculation by typing in the length of the side and then pressing x^2 **ENTER**.

- Use the balance to weigh each square. Enter the mass in grams in Table 1.

Table 1

Length of a side (cm)	Area (cm ²)	Mass (g)

Using the data collected and the TI-73 Explorer™, a mathematical model can be developed to determine the mass or area of any two dimensional object made from the same construction paper, regardless of shape. If you know the **Mass** of the object in grams (g) you can determine the **Area** in square centimeters (cm²).

2 Reset the TI-73 Explorer™ to the default settings.

- Turn on the TI-73 Explorer™.
- Press **2nd** **[MEM]** **7** **2** **2**.
- Press **2nd** **[MEM]** **6** **ENTER**.

3 Enter your data in the TI-73 Explorer™.

- Press **[LIST]**. Enter each **area** from Table 1 in **L1**, pressing **ENTER** after each number.
- Enter the **mass** of each square in **L2**, pressing **ENTER** after each number.

L1	L2	L3	1
██████	-----	-----	
L1(1)=			

Materials*

- T-73 Explorer™
- Metric Ruler
- Squares of various sizes made of construction paper
- Hole punch
- Balance with accuracy to at least 0.1 gram
- Large leaf



TI-73 Explorer™

* This activity has been written for the TI-73 Explorer™ but you can easily substitute the TI-83 or TI-83 Plus.



LEAF CUTTING ANTS

Fungus Farmers

ACTIVITY

4 Set up the axes before plotting the data (set up the window).

- Press **WINDOW** to set up the proper scale for the axes.
- Set the **Xmin** value as 0.
- Set the **Xmax** value as 500.
- Leave the ΔX Value unchanged.**
- Set the **Xscl** to 20.
- Set the **Ymin** value as 0.
- Set the **Ymax** value as 6.0.
- Set the **Yscl** to 1.

```
WINDOW
Xmin=0
Xmax=500
ΔX=5.319148936...
Xscl=20
Ymin=0
Ymax=6
Yscl=1
```

5 Graph your data.

- Press **2nd** [PLOT] **1** **ENTER** **ENTER** to select scatter plot (L1).
- Press **2nd** [STAT] **1** to select **L1** (surface area) for the X-axis.
- Press **2nd** [STAT] **2** to select **L2** (mass) for the Y-axis.
- Press **ENTER**.
- Press **GRAPH** to see the plot.

```
Plot1 Off
Type: [Scatter] [Line] [Square] [Circle]
Xlist:L1
Ylist:L2
Mark: [Square] + .
```

6 Draw a best-fit line.

To develop the mathematical model, use the TI-73 Explorer™ to analyze the data points on the graph and draw a best-fit line. A best-fit line passes as near to as many of the data points as possible. Once drawn, the best fit line can be used to determine the mass or the area of any object made from the same construction paper.

- Press **2nd** [STAT] **4** to move the cursor to the **CALC** menu.

```
Ls OPS MATH [Left] [Right]
1:1-Var Stats
2:2-Var Stats
3:Manual-Fit
4:Med-Med
5:LinReg(ax+b)
6:QuadReg
7:ExpReg
```



LEAF CUTTING ANTS

Fungus Farmers

ACTIVITY

- b. Press $\boxed{5}$ to select **LinReg(ax + b)**.

```
LinReg(ax+b)
```

- c. Press $\boxed{2nd}$ $\boxed{[STAT]}$ $\boxed{1}$ $\boxed{,}$ $\boxed{2nd}$ $\boxed{[STAT]}$ $\boxed{2}$ $\boxed{,}$ to select **L1 and L2**.

```
LinReg(ax+b) L1,  
L2,
```

- d. Press $\boxed{2nd}$ $\boxed{[VARS]}$ $\boxed{2}$. To select **Y-Vars**.

```
Y-VARS  
1:Y1  
2:Y2  
3:Y3  
4:Y4  
5:FnOn  
6:FnOff
```

- e. Press $\boxed{1}$ or \boxed{ENTER} to select **Y1**.

```
LinReg(ax+b) L1,  
L2,Y1
```

- f. Press \boxed{ENTER} to calculate the best fit line. *Note that you may not have the same numbers as shown here.*

```
LinReg  
y=ax+b  
a=.0105016082  
b=.0084687948
```

- g. Press \boxed{GRAPH} to see the graph of the best-fit line.



LEAF CUTTING ANTS

Fungus Farmers

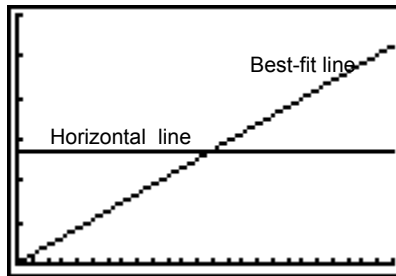
ACTIVITY

7 Determine the area of another square provided by your teacher.

This time determine the area of the unknown square using its mass and the best-fit line on your TI-73 Explorer™.

- Use the balance to find the mass of the square in grams.
- Press $\boxed{Y=}$ and $\boxed{\downarrow}$ until the cursor is next to $Y2=$.
- Press $\boxed{\text{CLEAR}}$ and type the mass of the square.

- Turn off **Plot1**. To do this, press $\boxed{\Delta}$ until the cursor is on **Plot1**. Press $\boxed{\text{ENTER}}$. Press $\boxed{\text{GRAPH}}$ to see the intersection of the best-fit line and a horizontal line. The horizontal line crosses the Y-axis at a value equal to the mass of the square. Therefore, the Y coordinate of the point of intersection is the mass of the square.

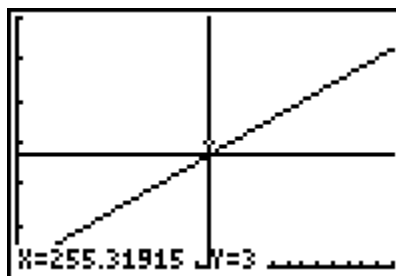


The X coordinate of the point of intersection is the area of the square. To find the X coordinate, follow the steps below.

- Press $\boxed{\text{DRAW}}$.

```
0:00 POINTS STO  
1:ClrDraw  
2:Line(  
3:Horizontal  
4:Vertical  
5:Shade(  
6:Circle(  
7:↓Text(  
8:↓
```

- Select **4:Vertical** by pressing $\boxed{4}$. Using $\boxed{\rightarrow}$ or $\boxed{\leftarrow}$ move the vertical line to the point of intersection. The X value given on the screen is the area of the square in square centimeters (cm^2). Enter the area of the square in your journal. *Note that you may not have the same numbers as shown here.*



You can always find the area of a square using the formula $A = s^2$. But when you have an irregular shape like a leaf, the $A = s^2$ method can be very difficult to use. Using mass to determine the leaf's area as you just did is easier. As long as the leaf is cut out of the same material as the squares you used earlier, you can use the graph to find the area.



LEAF CUTTING ANTS

Fungus Farmers

ACTIVITY

8 Find the area of a leaf.

Leaves have irregular shapes. Determining the area of an object, like a leaf, can be quite difficult, however the mathematical model will make it simple to find the area of the leaf in this section.

- Trace a large leaf on construction paper and cut it out. You may draw and cut out your own leaf.
- Repeat Step 7 to determine the area of the whole leaf. Record the area of the leaf in your journal.

9 Find the area of a leaf chewed by an ant.

- For about 20 seconds, punch holes out of your leaf with the hole punch. Let's suppose that these 20 seconds of punching are equal to one day of leaf chewing by 10 ants.
- Repeat Step 7 to determine the area of the leftover leaf. Record the area of the left over leaf in your journal.
- Use the following formula to find the area of leaf chewed by the ant. Enter your answer in your journal.

$$\text{Area of chewed leaf} = \text{Area of whole Leaf} - \text{Area of left over leaf}$$

Data Analysis

- Why was it important to use a best fit line to find the area of the leaf? (Hint: Would you need a best fit line if the mass of your leaf was exactly the same as the mass of one of the squares on your graph?)
- Your graph can help you find the area of any shape cut out of the same construction paper. Use your graph to find the area of a circle that weighs 3 g. The circle is made out of construction paper.
- Describe how you would use the mathematical model developed in this activity to find the mass of a leaf with a known area.
- Use your graph to find the mass of a construction paper leaf that has an area of 200 cm^2 .

Use the area of chewed leaf you found in Step 9 and the mathematical model to answer Questions 5 – 8.

- What is the mass of a leaf chewed by 10 ants in one day?
- If 10 ants chewed leaves for 10 days, what would be the total mass of the leaves chewed?
- If 10,000 ants chewed leaves for one day, what would be the area chewed?
- What would be the area of leaves chewed by 10,000 ants in one week?

