Soil Matters for Nesting Diamondback Terrapins!

A Lesson to be used for
High School
Earth Science
or STEM programs

developed by

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Background:

The temperature of the soil plays a key role in the outcome of Northern Diamondback Terrapin hatchlings (*Malaclemys terrapin terrapin*). Not only does warmer soil lead to faster hatchings, the temperature of the soil impacts the gender of a hatchling (Tang, 2016). Temperature-dependent sex determination (TSD), which is common for vertebrates classified under the reptile class, is a type of environmental sex determination through which, during embryonic development, temperature determines the sex of the offspring ("Temperature-dependent," 2014). In terrapins, a higher nest temperature produces more females, while a lower nest temperature produces more males ("Basic Facts," 2012). Typically, a nest temperature below 28°C, or 82°F, will produce males and temperatures above 30°C, or 86°F, will produce females (Alderton, 1988).

In this lab, soil types, with different expected soil fractions, will be tested to determine if a relationship exists between the percent sand of a soil and its change in temperature. Because in New Jersey, there are daily soil temperature variations between 2 to 12°C, this lab will resemble the temperature change during a simulated two-day period (Alderton, 1988). Through the conduction of this lab, a greater understanding will be obtained on soil fractions and their effect on soil temperature. This information can then be applied to hypothesize the majority sex of a nest of Northern Diamondback Terrapin hatchlings depending on its location.

Objective:

To determine a possible trend between varying soil types and the temperature of the soils through the conduction of a lab, and by extension, the effect of soil type on the sex of a Northern Diamondback Terrapin hatchling.

Materials:

- Soil samples (three from three different locations)
- Vernier software*
- 3 Vernier temperature probes*
- Vernier computer interface*
- Logger *Pro**
- Tape
- Bowl
- Heat lamp
- Ruler
- Plastic milk jugs
- Computer
- Ice

***In place of Vernier System, you can use a Celsius thermometer. Vernier or compatible equipment is for more advanced versions of this lab.**

Prelab:

1. Prepare a plastic milk jug for the soil simulation (*Figure 1*).

2. Cut the top off the milk jug. NOTE: Make sure to leave at least 10 cm of the milk jug.
3. Create vertical 3 holes, approximately the same circumference as the Temperature Probes, at 1 cm, 3 cm, and 7 cm. below the soil surface.

Procedure:

1. Collect three different soil types with different expected soil fractions.
   - Soil was collected from areas that were close to bodies of water, such as the Barnegat Bay.
2. The class should be split into three groups each of which consisting of approximately 10 students. Each group will be assigned to collect data (sand fractions and temperature readings) for one of the three soil types.
3. In order to determine percentage sand composition of the soil sample, first add 15 mL of the sample into the soil tube along with 1 mL of dispersant.
4. Add 30 mL of water to the tube, and invert it several times to ensure all of the soil is in solution, and that the dispersant has been evenly incorporated.
5. Once the soil has been thoroughly mixed, let it sit for 30 seconds, undisturbed.
6. After 30 seconds, take a reading of where the sand has settled out of solution and separated with the liquid. This number is the fraction of sand out of 15 mL for the sample.
7. After percent sand composition for the soil sample has been determined, experimentation may begin.
8. Connect three Temperature Probes to Channels 1-3 of the Vernier computer interface.
9. Prepare the computer for data collection by opening the file "09 Soil Temperature" from the *Earth Science with Vernier* folder.
10. A plastic milk jug had already been prepared with soil (*refer to figures*). One one side, you should find three small holes, at 1 cm, 3 cm, and 7 cm below the soil surface.
    a. Insert Probe 1 (Probe in Channel 1) into the hole that is 1 cm below the soil surface. Push the probe in far enough so that the tip of the probe is in the center of the jug.
    b. Insert Probe 2 the same distance into the hole that is 3 cm below the soil surface.
    c. Insert Probe 3 the same distance into the hole that is 7 cm below the soil surface.
11. The Temperature Probes must be parallel to the table during data collection. Secure them in this position by taping them to a ruler as shown in *Figure 2*.
12. Position the lamp so that the bulb is between 5 and 10 cm from the soil surface. Do NOT turn it on yet. Once it is in position, move it slightly off to the side to make room for the bowl of ice to be placed on the soil. Later, when you are instructed to turn on the lamp, move it back over the soil.
13. Fill the bowl with ice.
14. When everything is ready, place the bowl of ice on the surface of the soil as shown in Figure 3 and click "Collect" to begin data collection.

15. Once every five minutes, you will need to change the setup. These changes will simulate the temperature changes over a two-day period. Watch the time in the meter.
16. Data collection will stop after 40 minutes.
17. Autoscale your graph by clicking the Autoscale button on the toolbar.
18. Analyze your data to determine the temperature changes.
    a. Click the Statistics button and select all three Temperature Probes.
    b. Click “OK”
    c. Find the minimum and maximum temperatures for each sensor and record them in the data table. NOTE: You may need to move the Statistics boxes around so that they are visible and it is clear which one is associated with which line.
    d. Subtract to find the change in temperature for each sensor and record time in your data table.
19. Compile the data collected into Microsoft Excel.
20. Using the Data Analysis ToolPak, compare the temperature change of each soil sample with the percent sand composition of the sample using a regression test.
21. Using the Data Analysis ToolPak once again, compare the temperature of each sample and the depth at which the temperatures were recorded using an ANOVA test.

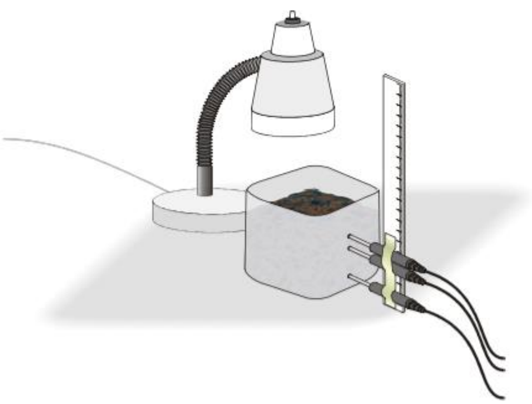

Figure 1

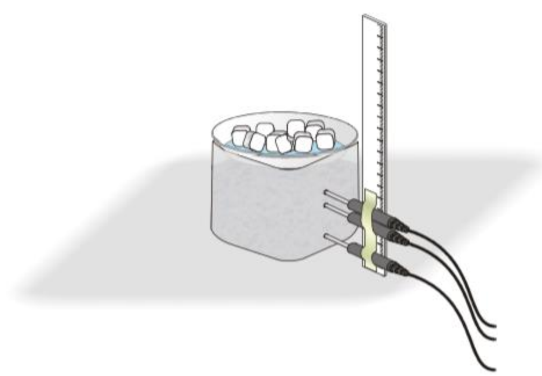

Figure 3

<u>Simulation:</u>

Time (minutes)	Change to Setup	Time of Day (simulated)
0	Place bowl of ice on soil	Nighttime
5	Remove ice and position lamp above soil (do not turn lamp on)	Morning
10	Turn on lamp	Daytime
15	Turn off lamp and move it aside	Evening
20	Place bowl of ice on soil	Nighttime

25	Remove ice and position lamp above soil (do not turn lamp on)	Morning
30	Turn on lamp	Daytime
35	Turn off lamp and move it aside	Evening
40	Data collection will stop	

Data Table:

	Sand Fraction (mL/15 mL)	1 cm Depth	3 cm Depth	7 cm Depth
Soil Type #1				
Maximum Temperature (°C)				
Minimum Temperature (°C)				
Change in Temperature (°C)				
Soil Type #2				
Maximum Temperature (°C)				
Minimum Temperature (°C)				
Change in Temperature (°C)				
Soil Type #3				
Maximum Temperature (°C)				
Minimum Temperature (°C)				
Change in Temperature (°C)				

Further Questions:

1. Did the rising and falling temperatures reach their peaks and valleys at the same time?
2. How long after the light was turned off did the 1 cm line reach its first temperature peak?
3. How long after the 1 cm line reached its first peak did the 3 cm line reach its peak?
4. Looking at the graphs, was there a correlation between temperature change and the percentage of sand in the soil sample?
5. How would the introduction of precipitation (rain, snow, sleet, etc…) affect the moisture within a soil type and impact the temperature change of that soil?

References:

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