

# **ADAPTATION TO LIFE IN A CAVE: CRICKETS ACTIVITY**

**Created by Ray Bowers**

**For the Virtual Center for the Environment (VCE)**

**A part of the Institute of Natural Resources Analysis and Management (INRAM)**

# ADAPTATION TO LIFE IN A CAVE: CRICKETS ACTIVITY

## TEACHER INFORMATION

**ABSTRACT:** As animals adapt to life in a cave they change structurally and how they function. This graphing activity will focus on research on rhabdophorid crickets published The American Midland Naturalist and Comparative Biochemistry and Physiology. This research looks at three closely related crickets, *Ceuthophilus stygius* that lives outside of the caves and in the cave entrance, *Ceuthophilus carlsbadensis* that primarily lives in cave entrances near bat and bird roosts, and *Ceuthophilus longipe* that lives deeper in the caves. Comparisons of metabolic rate and egg production are made in the activity. In the activity students will be given two sets of data and asked to graph the data and compare the organism living outside of the cave to the organisms living inside of the cave. These comparisons are not only found in rhabdophorid crickets but are generally characteristic of other cave organisms as reported by Poulson and White (1969) and Culver (1982).

**GRADE LEVEL (S):** 7--12

**OBJECTIVES:** Students will:

1. Develop a graph format, and graph the data about the reproductive rate and average metabolic rate.
2. Compare the characteristics mentioned in the previous objective in three related crickets.
3. Hypothesize about how living in a cave has affected these characteristics.

### **NATIONAL STANDARDS:**

Unifying Concepts and Processes

Evidence, models, and explanation (5-12)

Change, consistency, and measurement (5-12)

Science as Inquiry – Development of:

Abilities necessary to do scientific inquiry (5-12)

Understandings about scientific inquiry (5-12)

Life Science – Development of an understanding of:

Diversity and adaptations of organisms (5-8)

Biological evolution (9-12)

### **NEW MEXICO STANDARDS:**

#### **Strand I: Scientific Thinking and Practice**

**Standard I: Understand** the processes of scientific investigations and use inquiry and scientific ways of observing, experimenting, predicting, and validating to think critically.

5-8 Benchmark I: Use scientific methods to develop questions, design and conduct experiments using appropriate

9-12 Benchmark I:	technologies, analyze and evaluate results, make predictions, and communicate findings. Use accepted scientific methods to collect, analyze, and interpret data and observations and to design and conduct scientific investigations and communicate results.
5-8 Benchmark II:	Understand the processes of scientific investigation and how scientific inquiry results in scientific knowledge.
9-12 Benchmark II:	Understand that scientific processes produce scientific knowledge that is continually evaluated, validated, revised, or rejected.
5-8 Benchmark III:	Use mathematical ideas, tools, and techniques to understand scientific knowledge.
9-12 Benchmark III:	Use mathematical concepts, principles, and expressions to analyze data, develop models, understand patterns and relationships, evaluate findings, and draw conclusions.

## **Strand II: Content of Science**

**Standard II (Life Science): Understand** the properties, structures, and processes of living things and the interdependence of living things and their environments.

5-8 Benchmark I:	Explain the diverse structures and functions of living things and the complex relationships between living things and their environments.
9-12 Benchmark I:	Understand how the survival of species depends on biodiversity and on complex interactions, including the cycling of matter and the flow of energy.

### **MATERIALS:**

- Characteristics of Raphidophorid Cricket chart
- Colored pencils
- Graph paper

**BACKGROUND:** Rhabdiphorid or camel crickets of the genus *Ceuthophilus* are found throughout North America both inside and outside of caves. *Ceuthophilus stygius* is found outside and in the entrance of caves. Northup et al (1993) reports that *Ceuthophilus carlsbadensis* occurs primarily on the guano deposits under bat roosts and areas visited by humans in Carlsbad Cavern. *Ceuthophilus longipes* is predominately found in more "food limited" areas of Carsbad Caverns (Northup et al, 1993).

Reproduction rates were compared by using the average number of eggs per female. The average was determined by modifying the data on *Ceuthophilus carlsbadensis* and *Ceuthophilus longipes* from Northup et al's (1991) study (Northup, 2004). Northup et al's (1991) information was compared to the reproductive rates of *Ceuthophilus stygius* from Cyr et al's (1991) study.

The metabolic rate was measured in calories of energy per gram of body weight per hour of the study. These were recorded by Northup et al (1991) in their studies of bioenergetics.

## **PROCEDURES:**

1. Use the low and high readings to determine the range of the numerical axis of the graph.
2. Graph the two characteristics on separate graphs. I like to have the crickets on the horizontal axis and the characteristics on the vertical axis.
3. Different colors of pencils can be used for each type of cricket.

**CONCLUSIONS:** Allow the students to draw conclusions from the graphs. What can be concluded about the characteristics and where the crickets live? Hypothesize why *Ceuthophilus carlsbadensis*, *Ceuthophilus longipes*, *Ceuthophilus stygius* vary in their characteristics.

## **References:**

- Cyr, Michelle M. Eugene H. Studier, Kathleen H. Lavoie and Kelly L. McMillin. 1991. Annual Cycle of Gonad Maturation, Characteristics of Copulating pairs and egg-laying Rates in Cavernicolus Crickets, Particularly *Hadenococcus subterraneus* (Insecta: Orthoptera). The American Midland Naturalist. Vol. 125; No. 2.
- Culver, David C. 1982. Cave Life, Evolution and Ecology. Cambridge, Mass.
- National Research Council. 1996, National Science Education Standards. Washington D.C.: National Academy Press
- New Mexico Department of Education. 2003. New Mexico Science Content Standards, Benchmarks, and Performance Standards.  
<http://164.64.166.11/cilt/standards/science/index.html>
- Northup, Diana E. and Clifford S. Crawford. 1991. Patterns of Fecundity and Age Class Distribution of Rhabdiphorid "Camel Crickets" (*Ceuthophilus longipes* and *C. carlsbadensis*) from Carlsbad Cavern. The American Midland Naturalist. Vol. 127; No. 1.
- Northup, Diana.E. Kathleen H. Lavoie, and Eugene H. Studier. Bioenergetics of Camel Crickets (*Ceuthophilus carlsbadensis* and *C. longipes*, and *C. conicaudus*) ) from Carlsbad Caverns National Park, New Mexico. Comparative Biochemistry and Physiology. Vol. 106A; 3. Number 3897
- Northup, Diana E. 2004. Personal communication
- Poulson, Thomas L and William B. White. 1969. The Cave Environment. Science. Volume 165, Number 3897

## Some Characteristics of Rhaphidophorid Crickets

*Ceuthophilus carlsbadensis* ( C. c. ); *Ceuthophilus longipes* ( C.1. ); *Ceuthophilus stygius* ( C. s. )

### Crickets and Habitat

Characteristics	<u>C. s.</u> Surface	<u>C. c.</u> Near guano	<u>C.1.</u> Deep cave
Eggs or Ova Per female:	25.5 from 1.	8.85 modified from 2.	1.81 modified from 2.
Standard Metabolic Rate; Cal/hr	2.625 from 3.	1.044 from 3.	0.520 from 3.

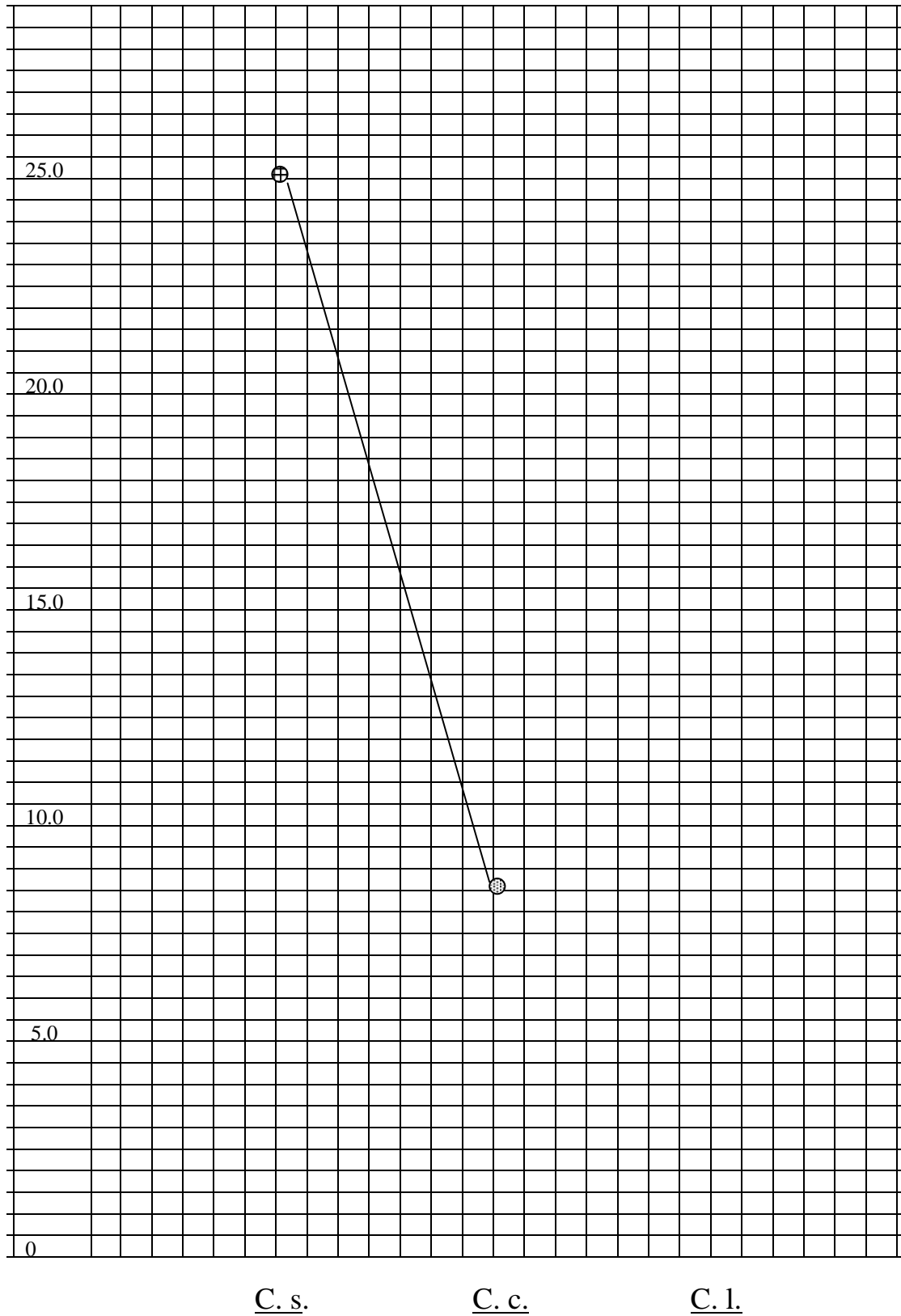
1. Cyr, Michelle M. Eugene H. Studier, Kathleen H. Lavoie and Kelly L. McMillin. 1991. Annual Cycle of Gonad Maturation, Characteristics of Copulating pairs and egg-laying Rates in Cavernicolus Crickets, Particularly Hadenoeus subterraneus (Insecta: Orthoptera). The American Midland Naturalist. Vol. 125; No. 2.
2. Northup, Diana E. and Clifford S. Crawford. 1991. Patterns of Fecundity and Age Class Distribution of Rhaphidophorid "Camel Crickets" (*Ceuthophilus longipes* and *C. carlsbadensis*) from Carlsbad Cavern. The American Midland Naturalist. Vol. 127; No. 1.
3. Northup, Diana.E. Kathleen H. Lavoie, and Eugene H. Studier. Bioenergetics of Camel Crickets (*Ceuthophilus carlsbadensis* and *C. longipes*,and *C. conicaudus*) ) from Carlsbad Caverns National Park, New Mexico. Comparative Biochemistry and Physiology. Vol. 106A; 3.

## **SAMPLES**

### **Eggs or Ova per Female of Rhabdophorid**

Developed by Ray Bowers for the VCE a part of INRAM

Eggs  
Per Female



# **STUDENT ADAPTATION TO LIFE IN A CAVE: CRICKETS ACTIVITY**

## **ADAPTATION TO LIFE IN A CAVE: CRICKETS ACTIVITY**

**Student Name** \_\_\_\_\_



**QUESTION:** How do related species that live outside and inside of cave compare?  
What characteristics might help cave animals adapt to life in a cave?

**MATERIALS:**

- Characteristics of Rhabdophorid Cricket chart
- Colored pencils
- Graph paper

**BACKGROUND:** Rhabdophorid or camel crickets of the genus *Ceuthophilus* are found throughout North America both inside and outside of caves. *Ceuthophilus stygius* is found outside and in the entrance of caves. Northup et al (1993) reports that *Ceuthophilus carlsbadensis* occurs primarily on the guano deposits under bat roosts and areas visited by humans in Carlsbad Cavern. *Ceuthophilus longipes* is predominately found in more "food limited" areas of Carlsbad Caverns (Northup et al, 1993).

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The metabolic rate was measured in calories of energy per gram of body weight per hour of the study. These were recorded by Northup et al (1991) in their studies of bioenergetics.

**METHODS:**

1. Graph the two characteristics on separate graphs.
2. Different colors of pencils can be used for each type of cricket.

**CONCLUSIONS:** Continue conclusions on the back if needed

## Some Characteristics of Rhabdophorid Crickets

## Crickets and Habitat

Characteristics	<u>C. s.</u> Surface	<u>C. c.</u> Near guano	<u>C.1.</u> Deep cave
Eggs or Ova Per female:	25.5 from 1.	8.85 modified from 2.	1.81 modified from 2.
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