INSECT ISLAND

A simulation of solving a scientific mystery while learning about insects

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PURPOSE

“… beetles as large as 21 centimeters (cm) …”

Your students become true scientists as they work to solve a scientific mystery. After hearing mysterious reports from a South Pacific island about beetles as large as 21 centimeters long, students work to solve the mystery. As a result, students are better prepared to conduct and understand scientific investigations. Through using the SCIENTIFIC METHOD during this simulation, they learn to hypothesize, observe, draw conclusions from factual information, and carefully record their endeavors in a SCIENCE JOURNAL—just as scientists do.

Specifically, your students will gain the following:

Knowledge
1. Characteristics of insects
2. Limitations of various structures
3. Relationship between form and function
4. Factors that make a structure strong
5. Steps of the SCIENTIFIC METHOD
6. Importance of keeping accurate scientific notes
7. Scientific classification of living things, particularly insects

Skills
1. Using a classification chart to understand more about insects
2. Conducting experiments according to the SCIENTIFIC METHOD
3 Enhancing language arts and problem-solving skills by accurately collecting and recording scientific data, observations, and questions in a SCIENCE JOURNAL
4. Analyzing the form of something to discover its function
5. Reading for information and determining the validity of data

Feelings and Attitudes
1. Appreciating the usefulness and diversity of insects
2. Learning to work as a member of a team
3. Increasing confidence in applying the SCIENTIFIC METHOD
4. Developing healthy skepticism regarding conflicting reports

“… appreciating the usefulness and diversity of insects …”

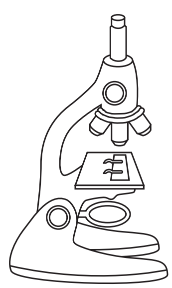
OVERVIEW - 1

Most students are fascinated by mysteries because they are able to take pieces of information and see how they fit together as they attempt to solve a problem. Unfortunately, some students are under the impression that all mysteries are connected with murder and suffering because that's what they have seen on television and in movies. However, students need to recognize that mysteries are worked on and solved daily in science, history, health, engineering, and many other disciplines. INSECT ISLAND is a simulation that will engage, excite, and challenge students as they *actively increase* their understanding of the scientific process. As they use the SCIENTIFIC METHOD during this simulation, they have the opportunity to work as scientists do to solve a real mystery. Students are motivated as they uncover clues and gain information, much like a detective does. INSECT ISLAND is the third of Interact's Science Mysteries series, stressing the scientific method and discovery. The author wishes to thank Beth Arner, who began this series with PETERSON'S POND and MYSTERIOUS MACHINE.

PHASE 1

OPTIONAL PHASE 1

Classification and Scientific Method



SCIENTIFIC METHOD This first phase offers a number of optional activities to provide your students with the background knowledge necessary to work successfully through the entire simulation. These activities which include the INSECT IDENTIFICATION expand students' knowledge about the scientific process, the importance of carefully recording observations and experimental notes in a SCIENCE JOURNAL, and basic knowledge of what makes a structure strong and how to classify living things. You decide which, if any, of these activities your students will need to experience to complete PHASE 2 successfully.

PHASE 2

PHASE 2

Mystery

INSECT INVESTIGATIONS This phase, the main portion of the simulation, may be the only phase you choose to do. Divided into teams, students participate in a variety of laboratory explorations to determine if 21-cm beetles could possibly inhabit a tropical island. These INSECT INVESTIGATIONS include learning about exoskeletons and endoskeletons, building a large "beetle" and testing its strength, testing the relative strength of simulated insect legs, and testing the speed simulated insect blood travels through its body, based on size. In each laboratory exploration, students use the SCIENTIFIC METHOD and keep a careful record of all scientific observations and experiments in their SCIENCE JOURNALS.

"… learning about exoskeletons and endoskeletons …"

T.E.A.M. ACTIVITIES Students also participate in daily group problem solving sessions, called **T.E.A.M.** ACTIVITIES (**T**ogether **E**veryone **A**ccomplishes **M**ore), which provide additional information about insects. Working alone and in groups, students complete INSECT IDENTIFICATIONS, practicing the process of classifying insects.

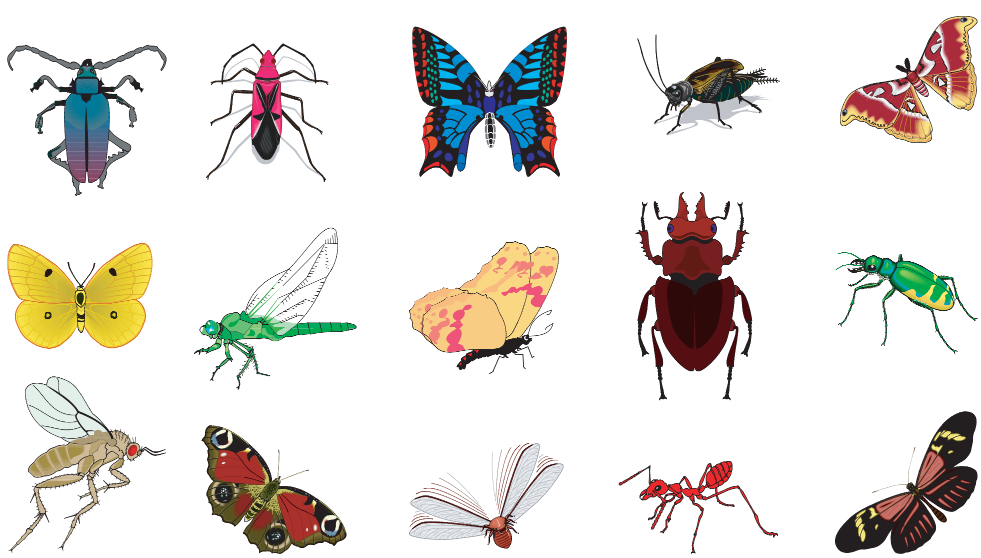
"… make their own judgments about the mystery …"

CLUE FAXES Students receive daily updates from Kylie Porter, Minister of Agriculture, including clues to help solve the mystery. At the end of each day, during a short debriefing session, students discuss what they learned during that day. After completing the five sessions and the final debriefing session in PHASE 2, students are able to make their own judgments about the mystery. They then send Ms. Porter their recommendation as to whether 21-cm beetles are possible or not (consider either recommendation reasonable as long as students give adequate support for the argument they choose).

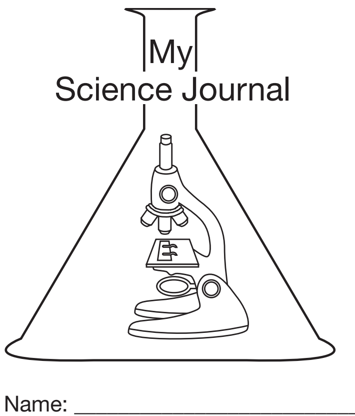
PHASE 3

Optional PHASE 3
Presentations, Challenge Projects, and Insect Gallery

If you have the class time and are interested in having your students take information learned in this simulation one step further, allow students to complete PHASE 3. It has a number of suggestions to extend the learning beyond the explorations that take place during PHASES 1 and 2. Students can make presentations of their conclusions from PHASE 2; prepare challenge projects included in the STUDENT GUIDE: PHASE 1; and, using their new-found knowledge of insect taxonomy and structure, construct their own giant insects.



SETUP DIRECTIONS - 1



Teaching Tip

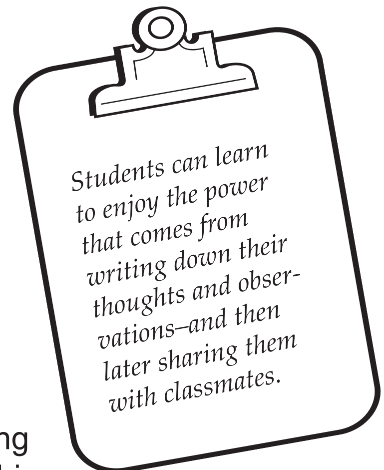
Require that students carry their own clipboards on all study trips into the field to examine insects or to any other place where they might hear an authority speak about insects.

1. **Preparation reading** Carefully and thoroughly read this TEACHER GUIDE and both STUDENT GUIDES before beginning the simulation. This study will help you plan your time and adjust the simulation to meet your students' needs and abilities.

2. **SCIENCE JOURNAL** In this simulation, each student in your class will need a SCIENCE JOURNAL. You can have students make these journals in a number of ways. You may copy MY SCIENCE JOURNAL cover master on page 36 (***M36***) for each student to attach to the front of his or her composition book or notebook. Or students could fold a sheet of 11" x 17" construction paper in half, glue the SCIENCE JOURNAL cover on the front, fill the folder with lined paper, and staple it all together.

3. **Study trip** If a field is nearby, or a pond, and the time of year is conducive, consider visiting it to observe and/or collect insects. See pages 19-21 for more information on insect collection, care, and preservation.

4. **Guest speakers** If possible, enhance this unit by inviting an entomologist to come and speak to your class during or after this simulation. Local universities, colleges, nature centers, or farm extension offices might have someone willing to spend time with your students.



5. **An insect terrarium** Consider creating an insect terrarium in your classroom. This activity would be especially helpful if you cannot visit a natural insect habitat. See page 20 for directions.

6. **Time schedule** The simulation time schedule is flexible. Be sure to look carefully through each phase to determine how you can best use this simulation in your classroom. The UNIT TIME CHART assumes that you will work on this simulation one hour every day, strictly imposing the time limits for certain activities as noted. It will last one week if you do only **PHASE 2**, the main portion of the simulation. If your students need background knowledge regarding taxonomy, structures, and the SCIENTIFIC METHOD, use **PHASE 1** to prepare them for **PHASE 2**. If you choose not to impose the time limits for certain activities, you should plan on the simulation taking more time.

   Note: If you decide to have your students take what they have learned in this simulation one step further, add the time you think they will need to complete the optional **PHASE 3**.

7. **PHASE 3 presentations** If you decide to have your students present their recommendations to the Minister of Agriculture (see **PHASE 2**) as part of an extension of this simulation—and you do not wish to assume this role yourself—invite someone else to pose as this dignitary. Your school principal or a local entomologist may be willing to fill this role.

8. **Duplication** Make copies of the **MASTER** pages which begin on page 36:
(**MASTER number** and quantity to duplicate are in *italics*.)

PHASE 1

OPTIONAL PHASE 1

- CONSTRUCTION T.E.A.M. SIGN-UP—***M40*** *one per class*
- INSECT IDENTIFICATION 1—***M41*** *overhead transparency*
- INSECT IDENTIFICATIONS 1 to 4—***M41*** *to* ***M44*** *class set*
- MINI-FIELD GUIDE—***M48*** *to* ***M51*** *class set + overhead transparencies*
- MY SCIENCE JOURNAL—***M36*** *class set*
- SCIENTIFIC METHOD—***M38*** *class set*
- YOUR SCIENCE JOURNAL—***M37*** *class set*
- Any other student HANDOUTS you see fit—*optional overhead transparencies*

PHASE 2

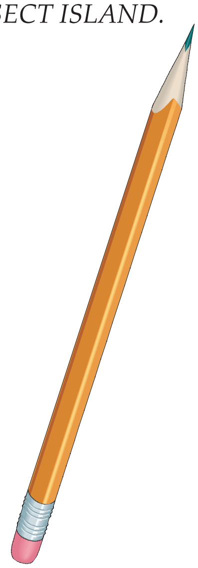
PHASE 2

- CLUE TRACKING—***M75*** *one per group or class set*
- INSECT CLUE FAXES 1 to 5—***M70*** *to* ***M74*** *class set*
- INSECT IDENTIFICATION 1—***M41*** *overhead transparency*
- INSECT IDENTIFICATIONS 1 to 7—***M41*** *to* ***M47*** *class set*
- INSECT INVESTIGATIONS 1 to 4—***M66*** *to* ***M69*** *class set*
- MINI-FIELD GUIDE—***M48*** *to* ***M51*** *class set + overhead transparencies*
- MY SCIENCE JOURNAL—***M36*** *class set*
- SCIENTIFIC DETECTIVE RECORD FORM—***M39*** *four per group + overhead transparency*
- SCIENTIFIC METHOD—***M38*** *class set*
- T.E.A.M. ACTIVITIES 1 to 4—***M52*** *to* ***M62*** *one set per group*
- T.E.A.M. ACTIVITY 5 - A: DEFENSE ATTORNEYS—***M63*** *class set for half the class*
- T.E.A.M. ACTIVITY 5 - B: PROSECUTING ATTORNEYS—***M64*** *class set for half the class*
- T.E.A.M. ACTIVITY 5 - C: COCKROACH ON TRIAL—***M65*** *one per class*
- YOUR SCIENCE JOURNAL—***M37*** *class set*

SETUP DIRECTIONS - 3

Teaching Tip

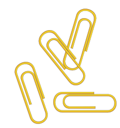
Seek parent and student help as you gather the materials the class needs for INSECT ISLAND.

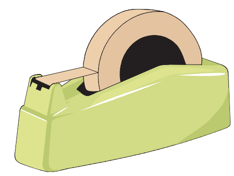


9. **Materials** Note carefully the separate lists of activity supplies for **PHASE 1**—*optional,* **PHASE 2**, and **PHASE 3**—*also optional*. Gathering these materials ahead of time will help you run this simulation smoothly.

OPTIONAL PHASE 1

- Additional resources about insects (e.g. posters, Internet, etc…)—*optional*
- Art paper—*class set*
- Assorted unrelated objects for bags—*eight to 10 per group (straws, band aids, dominoes, dice, spools, nails, screws, washers, bolts, small toys, paper clips, coins, etc.)*
- Construction paper—*one sheet of 11" x 17" per student*
- Paper bags—*one per group*
- Pencils or markers
- Regular FIELD GUIDES—*optional*
- Stapler—*one per group*





Building Challenge 1

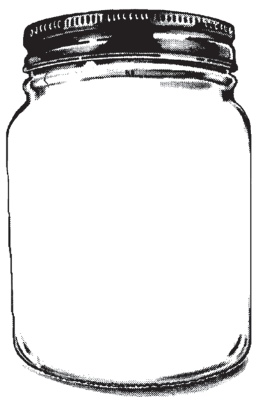
- Masking tape—*one roll per group*
- Ruler (meter or yardstick)—*one per group*
- Small paper clips—*minimum of 10 per group*
- Typing paper—*75 sheets of 8.5" x 11" per group*
- Washers or other weights—*minimum of 20 per group*

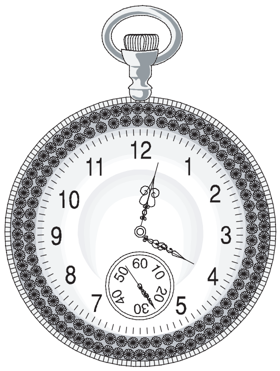
Building Challenge 2

- Cardboard tubes (cut from toilet or paper towel rolls)—*40 one-inch tubes per group for half the class*
- Cards—*one deck per group for half the class*
- Interlocking building blocks—*one set per group for half the class (One set = 350 four-dot squares and 150 eight-dot rectangles)*
- Rulers (30-cm or 12-inch)—*one per group*
- Salt—*one plastic shaker filled per group*

Field Study

- Collection jars with lids
- Dowel (half to three-quarters of an inch in diameter) or broom handle (18 to 24 inches long)
- Duct tape
- Elastic band to hold netting on as lid
- Heavy wire or hangar
- Lamp—*optional*
- Large terrarium or empty aquarium (Glass is easiest to see through and keep clean.)
- Needle and thread or sewing machine
- Netting, muslin, or cheesecloth (30 to 36 inches square)
- Peat moss
- Piece of sod with long grass same length and width as container
- Spray mister
- Water (Small container with cotton plug)





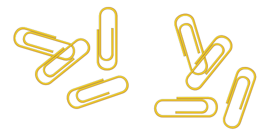
PHASE 2

- Construction paper—*one sheet of 11" x 17" per group*
- Regular Field Guides—*optional*

INVESTIGATION 1

- Candy (coated and crushable)—*minimum of 11 per group*
- Masking tape—*one roll per group*
- Ruler (meter or yardstick)—*one per group*
- Padding materials (cotton balls, facial tissue, paper towels, etc.)
- Pennies—*five per group*

INVESTIGATION 2



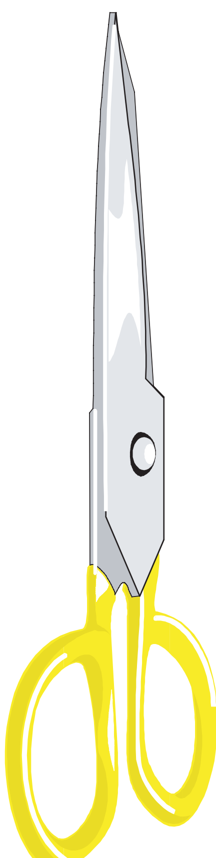
- Paper clips (large and small)
- Pins (straight)
- Straws (plastic drinking type)—*100 per group*
- Washers or other weights

INVESTIGATION 3

- Cardboard (4" x 6" or 10 cm x 15 cm)—*one piece per group*
- Clay (in lumps of 2-ounces or 57-grams each)—*three per group*
- Pennies—*30 per group*
- Rulers (30-cm or 12-inch)—*one per group*

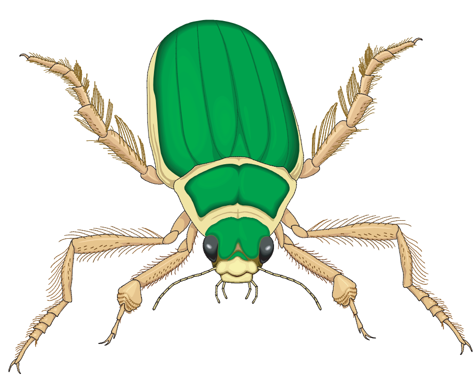
INVESTIGATION 4

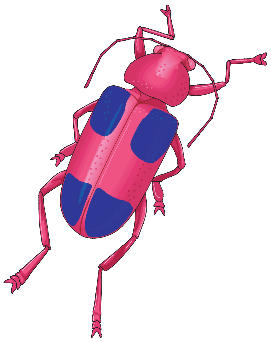
- Clock with a second hand or stopwatch—*one per group*
- Food colors (any color)—*one squeeze bottle per group*
- Meat tray (foam or plastic, smooth, flat surface, at least 21 cm long)—*one per group*
- Paper towel (strong kitchen-type, not school-type)—*one sheet per group*
- Plates (10-inch, plastic or foam)—*three per group*
- Rulers (30-cm or 12-inch)—*one per group*
- Scissors—*one pair per group*
- Sponge (wet but not dripping)—*one per group*



OPTIONAL PHASE 3

- Appliance boxes (for giant insects cutout)—*optional*
- Paint or markers (for giant insects)—*optional*





RESOURCES - 1

Selected Resources—Students

Caney, S. 2006. *Steven Caney's Ultimate Building Book*. Running Press Kids.

Carter, D. 2002. *Butterflies and Moths* (A Smithsonian Handbook). DK Adult.

Greenaway, T. 2000. *Big Book of Bugs*. DK Children.

Leahy, C. 1998. 2nd ed. *Insects: A First Guide to Insects of North America*. Houghton Mifflin Harcourt.

Kneidel, S. 1994. *Pet Bugs: A Kid's Guide to Catching and Keeping Touchable Insects*. Jossey-Bass.

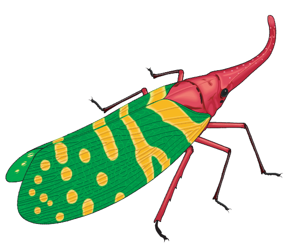
Murawski, D. 2010 (in press). *Face to Face with Butterflies*. National Geographic Children's Books.

Parker, S. 2010 (in press). *Extreme Bugs: Creepy and Crawly, Mad and Bad!* Barron's Educational.

Selected Resources—Teachers

Borror, D.J., and R.E. White. 1998. 2nd Ed. *A Field Guide to Insects*. Houghton Mifflin Harcourt.

Imes, R. 1992. *The Practical Entomologist*. New York: Simon & Schuster/ Fireside.



Lingelbach, J. 2000. Rev. Ed. *Hands-On Nature: Information and Activities for Exploring the Environment With Children*. Woodstock, VT: Vermont Institute of Natural Science.

Kneidel, S. 1993. *Creepy Crawlies and the Scientific Method: Over 100 Hands-On Science Experiments for Children*. Golden, CO: Fulcrum Publishing.

O'Toole, C. 1995. *Alien Empire* (companion book to the *Nature* [PBS] mini-series). New York: HarperCollins.

Stokes, D., L. Stokes, and E. Williams. 1991. *The Butterfly Book: An Easy Guide to Butterfly Gardening, Identification, and Behavior*. Boston: Little, Brown.

Selected Resources—Organizations and Suppliers

For information concerning insects, you or your students can contact the following organizations and suppliers:

Carolina Biological Supply
800-334-5551
Web site: http://www.carolina.com

Center for Insect Science Education Outreach
520-621-6310
Web site: http://cis.arl.arizona.edu
E-mail: insects@arl.arizona.edu

Entomological Society of America
301-731-4535
Web site: http://www.entsoc.org
E-mail: esa@entsoc.org

Insect Lore
800-LIVE-BUG
Web site: http://www.insectlore.com
E-maile: livebug@insectlore.com

Let’s Get Growing! (National Gardening Association)
800-LETS-GRO
Web site: http://www.letsgetgrowing.com

The Entomology Foundation
301-459-9082
Web site: http://www.entfdn.org

AUTHENTIC ASSESSMENT

Authentic Assessment
can result in genuine, authentic self esteem

What is authentic assessment? Many teaching methods achieve authentic assessment; several have been incorporated into INSECT ISLAND. Authentic assessment involves looking at more than a single test to judge a student's ability in an area of study. Before judging a student's work, it helps to look at his/her progress over a period of time. At the end of a unit of study, a student should be able to show thoughtful understanding of a complex idea. A student can demonstrate knowledge and skills orally, in writing, and through photographs, videos, and projects. Interact simulations are ideal tools to use for authentic assessment because an emphasis is placed upon students facing challenges and then producing something to demonstrate their accomplishments.

Achieving authentic assessment In this simulation, students accomplish a great deal. They use and understand the SCIENTIFIC METHOD, and acquire skills and knowledge which will benefit them throughout their lives. They write down thoughts, ideas, observations, and experiments in a SCIENCE JOURNAL. After the simulation has been completed, you may want to use each student's SCIENCE JOURNAL as an assessment tool to determine and to demonstrate to parents what learning has taken place.

You take time in INSECT ISLAND to observe how students work together in their groups during daily T.E.A.M. group problem solving. During the daily debriefing session, students also give evidence of what they learned during that session and provide you with information on how well they are understanding concepts covered that day. If additional discussion is needed, you have the opportunity to provide that *immediately*. Of course, having students complete daily science activities to your satisfaction is a type of authentic assessment.

Extensions Finally, you may decide to have certain (or all) students do an extension of this simulation as described in the optional PHASE 3. Students put the skills they learned in this simulation to practical use as they work on one of the options described. (Students may also develop their own extensions.) A completed PHASE 3 project is an ideal way to demonstrate authentic assessment.

Final essay If you choose not to have students complete an extension project as described in PHASE 3, ask students to write an essay at the end of PHASE 2. This essay will demonstrate to each student, to you, and to others that learning has taken place. As a result, your students will feel a sense of closure and accomplishment; this feeling, of course, is an example of *genuine, authentic self-esteem*.

UNIT TIME CHART

Day 1	Day 2	Day 3	Day 4	Day 5
Optional PHASE 1: Classification and Scientific Method				
Introduce the concept of classifying objects STUDENT GUIDE: PHASE 1 MINI-FIELD GUIDE SCIENCE JOURNAL IDENTIFICATION 1	Define "insect" Draw imaginary insects STUDENT GUIDE: PHASE 1 MINI-FIELD GUIDE SCIENCE JOURNAL IDENTIFICATION 2	TEAM SIGN UP Observation activity Introduce SCIENTIFIC METHOD with Building Challenge 1 STUDENT GUIDE: PHASE 1 MINI-FIELD GUIDE SCIENCE JOURNAL IDENTIFICATION 3	Building Challenge 2 Review SCIENTIFIC METHOD STUDENT GUIDE: PHASE 1 MINI-FIELD GUIDE SCIENCE JOURNAL IDENTIFICATION 4	Field study Making an insect net Simulating an Insect Island environment Safely collecting specimens SCIENCE JOURNAL
PHASE 2: Mystery				
T.E.A.M. ACTIVITY 1 CLUE FAX 1 and TRACKING SHEET STUDENT GUIDE: PHASES 1 & 2 MINI-FIELD GUIDE INVESTIGATION 1 IDENTIFICATION 1* (******If not done in PHASE 1)* Debriefing DETECTIVE FORM SCIENCE JOURNAL	T.E.A.M. ACTIVITY 2 CLUE FAX 2 and TRACKING SHEET STUDENT GUIDE: PHASES 1 & 2 MINI-FIELD GUIDE INVESTIGATION 2 IDENTIFICATION 2* IDENTIFICATION 5 Debriefing DETECTIVE FORM SCIENCE JOURNAL	T.E.A.M. ACTIVITY 3 CLUE FAX 3 and TRACKING SHEET STUDENT GUIDE: PHASES 1 & 2 MINI-FIELD GUIDE INVESTIGATION 3 IDENTIFICATION 3* IDENTIFICATION 6 Debriefing DETECTIVE FORM SCIENCE JOURNAL	T.E.A.M. ACTIVITY 4 CLUE FAX 4 and TRACKING SHEET STUDENT GUIDE: PHASES 1 & 2 MINI-FIELD GUIDE INVESTIGATION 4 IDENTIFICATION 4* IDENTIFICATION 7 Debriefing DETECTIVE FORM SCIENCE JOURNAL	T.E.A.M. ACTIVITY 5 CLUE FAX 5 and TRACKING SHEET Analysis of all the clues
Optional PHASE 3: Presentation, Challenge Projects, and Insect Gallery				
You determine the content and timing of PHASE 3. Optional Presentations of groups' conclusions to "Ms. Porter"				

This UNIT TIME CHART is an example. Alter as desired.

PHASE 1

OPTIONAL PHASE 1

Classification and Scientific Method

This simulation asks students to compare and contrast the characteristics of common and unusual insects in many different ways. First, however, students will learn how to correctly identify particular insects as well as how to name and organize them according to their scientific classifications.

PHASE 1: DAY 1

Materials:

1. Activity supplies:
   - Construction paper—*one sheet of 11" x 17" per student for SCIENCE JOURNAL (see step 2 in SETUP DIRECTIONS.)*
   - Paper bags and items (groups do not need to have the same objects)—*eight to 10 small unrelated objects per group*
2. INSECT IDENTIFICATION 1—***M41*** *class set + overhead transparency*
3. MINI-FIELD GUIDE—***M48*** *to* ***M51*** *class set + overhead transparencies*
4. MY SCIENCE JOURNAL cover—***M36*** *class set*
5. STUDENT GUIDE: PHASE 1—*class set*
6. Supplementary FIELD GUIDES—*see RESOURCES, page 8*
7. YOUR SCIENCE JOURNAL—***M37*** *class set*

Teaching Tip

Each eight-page Student Guide includes all three phases. Separate the Phase 2 portion of the Student Guides, and reserve for use during Phase 2 of the simulation.

Procedure:

1. Divide your students into groups of two to four students. Read or tell the following:

Read or Tell

"In this simulation, we will learn about insects, their structures, and structures in general. One way to understand more about insects is to understand how scientists classify insects. By 'classify' we mean arranging in groups or categories according to characteristics set by scientists.

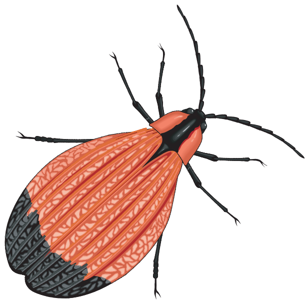
"Today we will begin to learn how to classify insects so that you can begin to investigate insect structures. But first we'll classify some other common objects."

DAILY DIRECTIONS - 2

2. Give each small group a paper lunch sack containing eight to 10 unrelated objects.
3. Ask each group to sort and classify all their objects into categories. They must name the categories, have at least two categories, and at least two objects in each category. Have each group share their reasoning with the rest of the class.
4. Distribute a STUDENT GUIDE: PHASE 1 and a MINI-FIELD GUIDE to each student.
5. Direct students to read page 1 of the STUDENT GUIDE.
6. Discuss this information and have students fill in their address information.
7. Distribute INSECT IDENTIFICATION 1.
8. Discuss how to follow the "road map" and locate information on the KEY TO ADULT WINGED INSECT ORDERS (pp. 2-3 of STUDENT GUIDE: PHASE 1).
9. Using the overhead transparencies, help your students complete the first question in both Parts 1 and 2 of INSECT IDENTIFICATION 1 as a class. For Part 1, help students find the order on the KEY TO ADULT WINGED INSECT ORDERS to give them practice using it. Then have them select a particular insect, using their MINI-FIELD GUIDE. Have students examine the KEY TO ADULT WINGED INSECT ORDERS and use the clues regarding insect body structure to complete the first question in Part 2 for the insect they have named.
10. Have partners or small groups complete the remaining questions.
11. Discuss answers to INSECT IDENTIFICATION 1. Answers will vary, depending upon the particular insects selected. You may wish to have groups or individuals exchange papers to double-check that directions were followed.
12. Have students make their SCIENCE JOURNALS as described in the SET UP DIRECTIONS (step 2, page 4), using the MY SCIENCE JOURNAL cover.
13. Read and discuss the YOUR SCIENCE JOURNAL handout.
14. Have students write about what they learned today in their SCIENCE JOURNALS. They should store all of their handouts with their SCIENCE JOURNALS.

Teaching Tip

Looking at the MINI-FIELD GUIDE and the KEY TO ADULT WINGED INSECT ORDERS (STUDENT GUIDE: PHASE 1, p. 2), discuss the differences between the Latin and common names. Explain that Latin is the language of scientific identification. Define "larva."



DAILY DIRECTIONS - 3

PHASE 1: DAY 2

Materials:

1. Activity supplies:
   - Art paper—*one sheet of 11" x 17" per student*
   - Pencils or markers
2. Additional resources about insects (e.g. posters, Internet, etc…)—*optional*
3. INSECT IDENTIFICATION 2—***M42** class set*
4. Library books and other resources about insects—*see RESOURCES, pp. 8-9*
5. MINI-FIELD GUIDE—*from Day 1*
6. SCIENCE JOURNAL—*from Day 1*
7. STUDENT GUIDE: PHASE 1—*from Day 1*

Procedure:

1. Referring to the zebra swallowtail example on page 1 of the STUDENT GUIDE: PHASE 1, have students work in small groups to answer in writing the question "What is an insect?" Encourage students to use library books and other resources.

Read or Tell

Like all insects, the *Graphium marcellus* (zebra swallowtail) belongs to the animalia (animal) kingdom. Within the animalia kingdom, all insects belong to the phylum Arthropoda (usually called arthropods). Within the phylum Arthropoda, insects belong to the class Insecta. Non-insect arthropods belong to one of four other classes and include—among others—crabs, shrimp, lobsters, millipedes, spiders, scorpions, ticks, mites, centipedes, and the extinct trilobites.

Teaching Tip

You may wish to explain that Latin genus and species names of living things are traditionally italicized, but for the purposes of this simulation, this has not always been done.

2. Share and discuss the resulting definitions as a class. In order to decide whether an Arthropod belongs to the class Insecta (insects), students must make sure it has the following characteristics:
   - Three pairs of legs
   - An exoskeleton divided into three parts
   - A pair of compound (many-part) eyes
   - A pair of antennae
   - May have a pair of wings as an adult

Teaching Tip

3. You may wish to have students decorate the covers of their SCIENCE JOURNALS with these fanciful drawings.

6. Encourage students to use the KEY TO ADULT WINGED INSECT ORDERS (page 2 of the STUDENT GUIDE: PHASE 1) as well as the MINI-FIELD GUIDE "habits" remarks to help them make interesting comments.

3. Using this information and the information on the KEY TO ADULT WINGED INSECT ORDERS, have each student create and draw an imaginary insect. Students may use information from one or more insect orders to create a unique specimen, but the body structure of the specimen must meet the definition of an insect.

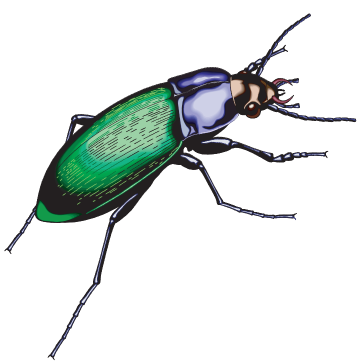
4. Have each student give the imaginary insect a name, including kingdom, phylum, class, order, family, genus, and species, based on its characteristics. Then have each student write a description of the insect in her/his SCIENCE JOURNAL, including body structure characteristics, eating habits, and so on.

5. Allow students to share their creations with the class.

6. Distribute INSECT IDENTIFICATION 2 to each student. Have students work alone, then in pairs or small groups to identify the four insects. Students should store all of their work and handouts in their SCIENCE JOURNALS.

   Answer key for INSECT IDENTIFICATION 2:
   (A) snowy tree cricket — (B) deer fly
   (C) yellowjacket — (D) gypsy moth

7. Have students clean up for the day.



PHASE 1: DAY 3

Materials:

1. Activity supplies for **Building Challenge 1**:
   - Masking tape—*one roll per group*
   - Pencils
   - Ruler (meter or yardstick)—*one per group*
   - Small paper clips
   - Typing paper—*75 sheets of 8.5" x 11" per group*
   - Washers or other weights
2. CONSTRUCTION TEAM SIGN-UP—***M40*** *one per class*
3. INSECT IDENTIFICATION 3—***M43*** *class set*
4. MINI-FIELD GUIDE—*from Day 1*
5. SCIENCE JOURNAL—*from Day 1*
6. SCIENTIFIC METHOD—***M38*** *class set*
7. STUDENT GUIDE: PHASE 1—*from Day 1*

DAILY DIRECTIONS - 5

Procedure:

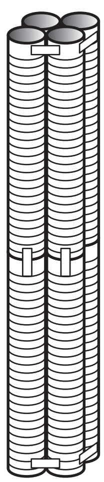
1. Begin passing around the CONSTRUCTION TEAM SIGN-UP sheet, requesting each student sign his or her name. While students are signing, begin the rest of the lesson.

2. Divide your class into cooperative groups of two to four students (smaller groups mean a higher level of individual participation) and distribute the activity supplies to each group.

3. Offer the following building challenge (you may wish to allow more time, but the simulation will take longer to complete):

Read or Tell

> Within 30 minutes and using only the supplies given, design and build a 90-cm tall (36-inch) tower that is 30 cm x 30 cm (12" x 12") at its base and top. When you are finished building, use the paper clips to hang as many washers or other weights as possible from the top of your structure without making it collapse or fall.



4. Have individual students record in their SCIENCE JOURNALS what method(s) they think will work the best.

5. Encourage students to problem solve and redo the structures until they are satisfied with the results. Questions to ask while students are building:

Read or Tell

> What are you doing to make your tower stronger?
>
> What more might you do to make your tower stronger?
>
> If you had twice as much paper and tape, could you build a tower that was as strong, but twice as high?

6. When groups have finished building and testing their towers, ask them to share what helped make the structure stronger. Through asking questions such as those listed above, you can then guide them to see the types of solutions that worked best. Then have them write this information in their SCIENCE JOURNALS.

7. Distribute a SCIENTIFIC METHOD handout to each student.

Teaching Tip

You may wish to have extra paper on hand for students to use to correct mistakes, but each group must stay at or under the 75-sheet amount.
No "right" solution exists to this challenge. It is not necessary to offer formal rules in order to build with these materials. Children will intuitively work to make their structures stronger.

8. Read and discuss this handout in light of the building challenge they have just completed.
   a. **Problem**: Point out that the first step of the Scientific Method is to identify the problem, which is often written in question form. This is what the researcher wants to find out. Have groups discuss among themselves what they think the problem was for the building challenge and record it in their SCIENCE JOURNALS. One acceptable example might be: How can we build the strongest possible structure the right size with these materials?
   b. **Hypothesis**: The second step of the SCIENTIFIC METHOD is the hypothesis. This is an educated guess to answer the question stated in the problem. Students should label the predictions they made regarding the building challenge with the word “hypothesis.”
   c. **Experiment**: This is the procedure used to test the hypothesis. Have students record the steps and procedures they used in their SCIENCE JOURNALS.
   d. **Data**: These are accurate records of the results. Point out that often an experiment has to be repeated or modified as researchers see the results of their initial attempts. This is a normal part of scientific investigation. Have students record what the test of their hypothesis revealed and any changes they made to their original experiment and why.
   e. **Conclusion**: This is a summary of what the researchers discovered (concluded) as a result of their experimenting. Have students record their conclusions for today’s building challenge in their SCIENCE JOURNALS.

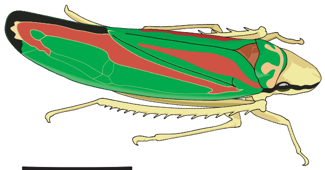
9. Now give students three minutes to write everything they remember about the artwork on the CONSTRUCTION TEAM SIGN-UP sheet they signed earlier in the class. Compare results as a class. Explain that observation is an important component to understanding science learning and applying the SCIENTIFIC METHOD. For example, if they observe that the building experiment they have tried is not working, they can then modify their approach until they succeed.

10. Distribute INSECT IDENTIFICATION 3 to each student. Have students work alone, then in pairs or small groups to identify the four insects.

Answer key for INSECT IDENTIFICATION 3:

(A) robber fly — (B) ground beetle
(C) monarch butterfly — (D) Colorado potato beetle

11. Have students clean up for the day.



Teaching Tip

Note: *Although this lesson takes more preparation than average, it is a favorite among students and well worth the effort. Review the SCIENTIFIC METHOD to predict what approach might work best.*

Have students bring building blocks from home already counted and sealed in a container. Keep them separate from other students' building blocks. You need enough to supply half of your cooperative groups.

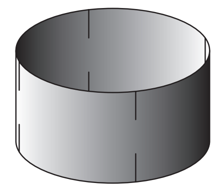
Ahead of time, have volunteers help prepare notched cardboard rings by cutting empty toilet paper or paper towel tubes into one-inch rings and making quarter-inch-deep notches in the tops and bottoms of these in four places (at 12, 3, 6, and 9 o'clock). Form an assembly line by having one person mark the inches, one person cut the tubes, and one person slit notches in the rings.

6. Circulate around the room and ask questions similar to those listed for PHASE 1: Day 3 to stimulate student thinking and problem solving.

PHASE 1: DAY 4

Materials:

1. Activity supplies for **Building Challenge 2**:
   - Pencils
   - Ruler (30-cm or 12-inch)—*one per group*
   - Salt—*one filled plastic shaker per group*
2. Additional supplies for **first half** of your cooperative groups:
   - Interlocking plastic building blocks—*one set per group (350 four-dot squares and 150 eight-dot rectangles per set)*
3. Additional supplies for **second half** of your cooperative groups:
   - Cardboard tubes—*40 one-inch notched tubes per group*
   - Cards—*one deck per group*
4. INSECT IDENTIFICATION 4—***M44** class set*
5. MINI-FIELD GUIDE—*from Day 1*
6. SCIENCE JOURNAL—*from Day 1*
7. STUDENT GUIDE: PHASE 1—*from Day 1*



Procedure:

1. Divide students into groups of two to four and distribute tube and playing card kits to half the groups and building block kits to the other half.

2. Present the following building challenge: Within 30 minutes, build a 30-cm tall (12 inches) tower that is 12 cm (5 inches) on each side at its base and top that can support a full salt shaker.

3. Using the scientific method, have students state today's problem as the **"question"** in their SCIENCE JOURNAL.

4. Have groups discuss and write their predictions that will work in their SCIENCE JOURNALS and label this as the **"hypothesis."**

5. Now have groups discuss and record in their SCIENCE JOURNALS how they plan to use their particular materials to accomplish the challenge. Have them label this as the **"experiment"**.

6. Encourage students to test their hypotheses and meet the building challenge. Remind them that it is a normal part of scientific investigation to have to modify their experiment ideas as they proceed. Allow additional time, if appropriate.

7. Once a group has completed a tower that can support the salt shaker (the **"conclusion"**) have members discuss then record in their SCIENCE JOURNALS the **"data"** they collected and their **"conclusions"** regarding what made the structure strong enough.

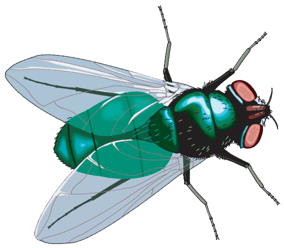
8. Have groups share their findings with the entire class comparing approaches, advantages, and disadvantages between methods and building materials.

9. Distribute INSECT IDENTIFICATION 4 to students. Have them work alone, then in pairs or small groups to identify the four insects.

Answer key for INSECT IDENTIFICATION 4:

(A) wood nymph butterfly (B) lightning bug

(C) meadow grasshopper (D) carrion beetle



PHASE 1: DAY 5

If you choose to include this **optional field study** in your insect studies, use the ideas in this section to get you off to a good start. If you do not wish to use this information with your entire class, simply give these instructions to interested students. See also the list of helpful reference books and supply companies on pages 8 and 9. Finally, have students record their observations of live insects in their SCIENCE JOURNALS.

Teaching Tip

If collecting as a class, one net per pair of students is sufficient.

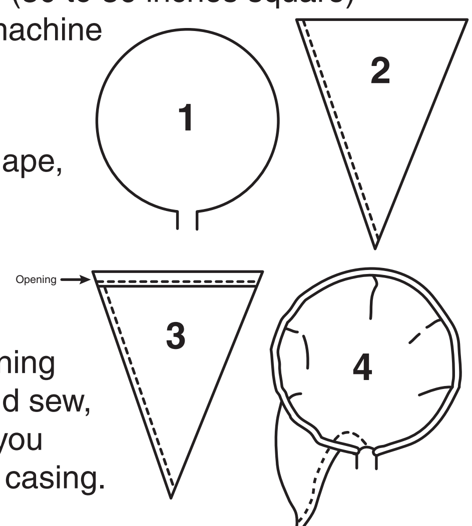
For safety's sake, ask for adult volunteers to help use the sewing machine.

MAKING AN INSECT NET

Catch flying insects with this inexpensive, easy-to-make tool.

Materials:

1. Dowel (half to three-quarters of an inch in diameter) or broom handle (18 to 24 inches long)
2. Duct tape
3. Heavy wire or hangar
4. Netting, muslin, or cheesecloth (30 to 36 inches square)
5. Needle and thread or sewing machine



Procedure:

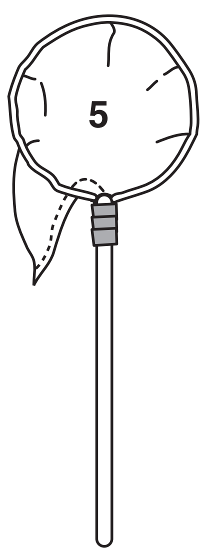
1. Bend the wire into a circular shape, leaving two ends as shown.

2. Fold the netting into a triangle and sew its long side securely.

3. Fold down the edge of the opening about one and a half inches and sew, leaving an opening into which you can thread the wire. This is the casing.

4. Thread the wire into the casing, until only the two ends are exposed.

5. Tape the two wire ends securely to the dowel or broom handle.



DAILY DIRECTIONS - 9

SIMULATING AN INSECT ISLAND ENVIRONMENT

Teaching Tip

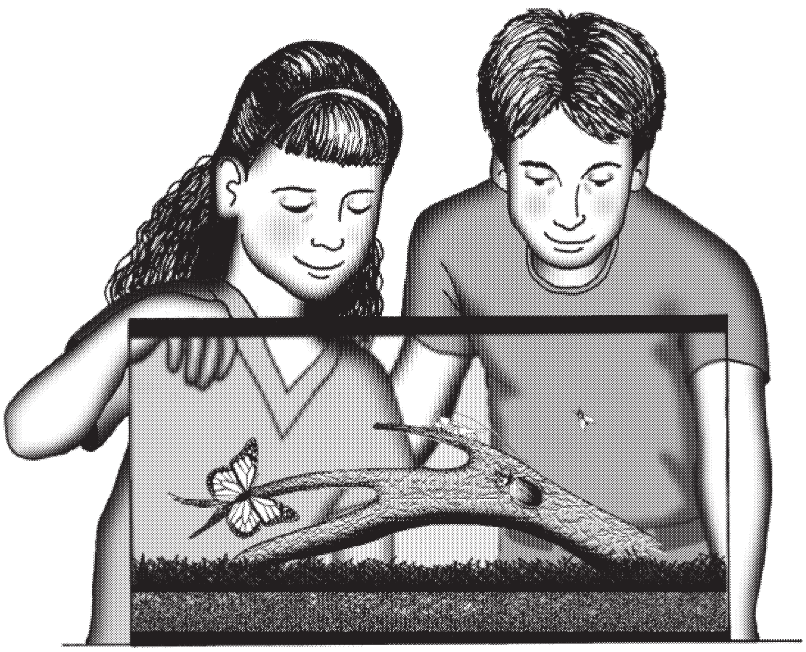
You can substitute borrowed museum or private or purchased collections for up-close study and identification.

Materials:

1. Elastic band to hold netting on as lid
2. Lamp—*optional*
3. Large terrarium or empty aquarium (Glass is easiest to see through and keep clean.)
4. Netting (6- to 8-inches longer and wider than the container)
5. Peat moss
6. Piece of sod with long grass same length and width as container
7. Small container of water with cotton plug
8. Spray mister

Procedure:

1. Place about 2 inches (5 cm) of peat moss in the bottom of the container.



2. Water the peat moss thoroughly.
3. Lay the piece of sod on top of the peat moss.
4. Form a lid by securing the netting with the elastic band.
5. If necessary, use a lamp near the terrarium to keep its temperature between 75-80½ F or 24½-27½ C for eight to 10 hours per day or longer.
6. Add insects that students collect by carefully lifting up one corner of the netting.
7. To provide a place where the insects can drink, lay a small container of water plugged with wetted cotton on its side in the bottom of the terrarium.
8. Have students research and provide what their insects need to eat. If the students cannot find this information, they should release the insect where it was found.
9. Spray the terrarium with the mister as needed; watch out for mold.
10. Students can use their MINI-FIELD GUIDE or other guides to correctly identify resident specimens. Students will enjoy observing how the insects interact up close!

The close quarters of the terrarium may cause different behavior than that seen in the wild.

SAFELY COLLECTING AND PREPARING SPECIMENS

Give students up-close experience with insects by collecting and preparing or housing specimens. You can arrange a field trip to a local field to use the insect nets as a class or you can encourage students to collect insects on their own time.

Materials:

1. Collection jars with lids
2. Insect nets
3. MINI-FIELD GUIDE—*from Day 1*

Teaching Tip

Collect aquatic insects using a large food sieve.

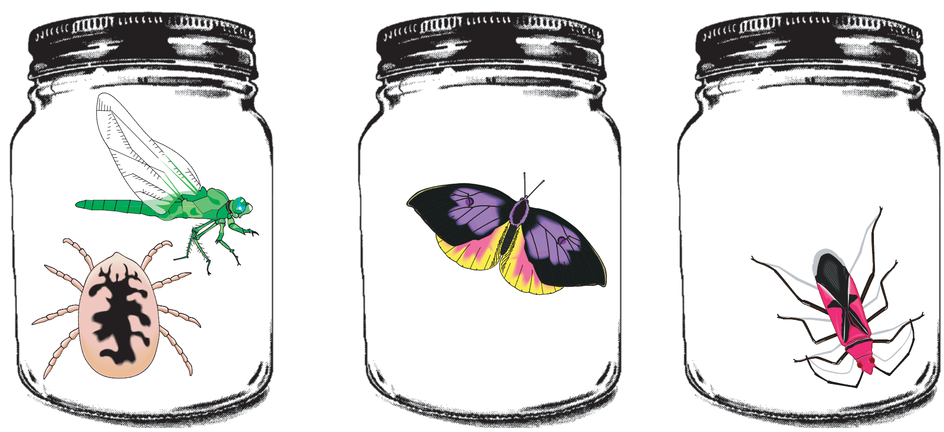
Use a plastic jar for a mini-cage that won't break. Have an adult make holes in plastic lids with a heated nail or have students use a piece of fabric secured with a rubber band.

WARNING: *Be sure to remind students that some insects bite, pinch, or sting and should be avoided.*

Procedure:

1. To use an insect net, use a long sweeping motion through tall grass. After three or four sweeps, flip the pointed end of the net over the opening to prevent insects from escaping.

2. Trap an insect further by clinching the net with a hand, then bringing a jar to this point and releasing the insect directly into the jar. Have a partner quickly cover the jar with its lid.



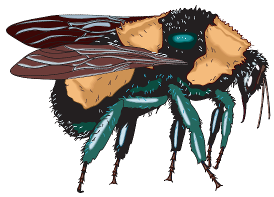
3. Use the MINI-FIELD GUIDE to try to identify the insect.

4. Note and collect the food source (if plants).

5. If you know you can feed the insect, and your class has prepared an insect terrarium, take your specimen back to your classroom and deposit it into the terrarium. If you aren't sure you can feed the insect, release it before leaving its natural environment.

6. Always have students record all field experiences in their SCIENCE JOURNALS.

PHASE 2



PHASE 2

Mystery

PHASE 2: DAY 1

Materials:

1. SCIENCE JOURNAL—*from Day 1*
2. STUDENT GUIDE: PHASES 1 and 2—*class set*
3. INSECT IDENTIFICATION 1—*optional* ***M41*** *class set + overhead transparency*
4. INSECT CLUE FAX 1—***M70*** *class set*
5. T.E.A.M. ACTIVITY 1—***M52*** *+* ***M53*** *one set of strips per group*
6. T.E.A.M. ACTIVITY 1 RECORDING—***M54*** *one per group*
7. SCIENTIFIC DETECTIVE RECORD FORM—***M39*** *one per group + overhead transparency*
8. CLUE TRACKING—***M75*** *one per group or class set*
9. INSECT INVESTIGATION 1—***M66*** *one per group*
10. Activity supplies:

    Science Folders:
    - Construction paper—*one sheet of 11" x 17" per group*
    - Pencils and stapler

    INSECT INVESTIGATION 1 - A:
    - Candy (coated and crushable)—*minimum of 11 per group*
    - Pennies—*five per group taped together*
    - Rulers (meter or yardstick)—*one per group*

    INSECT INVESTIGATION 1 - B:
    - Masking tape—*one roll per group*
    - Padding materials (cotton balls, tissue, paper towels, etc.)

Teaching Tip

Be sure that the tape does not get so thick that it provides padding for the pennies.

Procedure:

You may wish to read these sections of the Student Guides aloud as a class.

1. Distribute a STUDENT GUIDE: PHASE 2 to each student. Direct them to read the three introductory news articles and the letter from Ms. Porter, Minister of Agriculture, Australia.

2. Read or tell:

Read or Tell

"Ms. Porter has asked for your help because she heard you are careful and hard-working scientific detectives.

"To help you better understand how you can help Ms. Porter, we will start each day with a group problem-solving activity. Please turn to page 4 in your STUDENT GUIDE and read about the T.E.A.M. activities you will do daily with your group."

3. After students read about the T.E.A.M. activities, answer any questions they may have. Emphasize that they must ensure that every member of their group participates in each activity. Brainstorm ways to include everyone and appropriate ways to handle disagreements.

Read or Tell

4. Read or tell:

> "As we learn about insects, I will record the information on an overhead transparency. Based on our discussions, I will add information every day, keeping track of what we are learning. You will record the same information in your SCIENCE JOURNAL as well."

Teaching Tip

6. See instructions for creating SCIENCE JOURNAL in SET UP DIRECTIONS, step 2, page 4.

7. Of course, if your groups have fewer than six members, some students will need to handle more than one T.E.A.M. strip.

If desired, don't use the T.E.A.M. ACTIVITY 1 RECORDING sheet; instead, have students cut apart the information on their strips and glue them to sheets of notebook paper, one labeled "Simple Metamorphosis" and one labeled "Complete Metamorphosis."

8. You may wish to make and use an overhead transparency of the various RECORDING sheets.

5. Divide your students into groups of four to six students. These groups will work together all through PHASE 2. If you elected to omit PHASE 1, have your students create their own individual SCIENCE JOURNALS at this time.

6. Distribute the construction paper to each group and have students make their group folders. Direct that each team store in this folder all individual SCIENCE JOURNALS as well as all important group information gathered during PHASE 2.

7. Distribute the T.E.A.M. ACTIVITY 1 strips and one T.E.A.M. ACTIVITY 1 RECORDING sheet to each group. Tell students that the objective of this activity is to determine which type of metamorphosis particular insects go through: simple or complete. Direct each group to record answers on its T.E.A.M. ACTIVITY 1 RECORDING sheet as each member reports his or her information. See the answer key on the following page.

8. After the activity:
   a. Discuss the definitions of simple and complete metamorphosis and where each insect belongs on the recording sheet.
   b. Have students prove their answers based on the information on the T.E.A.M. ACTIVITY 1 strips.
   c. Each group should correct any errors. Have each group store this sheet in its group folder.
   d. Using the answers from the RECORDING sheet and the fact that all insects in the same order experience the same type of metamorphosis, have students fill in the blank for each insect regarding type of metamorphosis in their MINI-FIELD GUIDE.

DAILY DIRECTIONS - 13

Answer key for T.E.A.M. ACTIVITY 1:

- **Simple metamorphosis**: aphids, American cockroaches, bush crickets, meadow grasshoppers, cicadas, Chinese mantid, squash bugs, Eastern blue darners (a type of dragonfly)
- **Complete metamorphosis**: cecropia moths, Japanese beetles, house flies, monarch butterflies, regal moths, comma butterflies, mud-dauber wasps, bumblebees

9. Distribute INSECT CLUE FAX 1 to each student. Have students in each group study the information and list clues on their group's CLUE TRACKING sheet, according to how certain they are that the information is really a clue. They should also record any possible clues from their STUDENT GUIDE: PHASE 1, pp. 1-3 on their CLUE TRACKING sheet.

10. Tell students that to better understand insects, they will be conducting experiments to determine how insects function.

11. Read or tell:

Read or Tell

> "As Ms. Porter mentioned, she sent an experiment for us to perform. The experiment will test the insect skeletal system to see if perhaps it gives us any clues as to whether or not insects can grow to be 21 centimeters long."

Distribute an INSECT INVESTIGATION 1 sheet and a SCIENTIFIC DETECTIVE RECORD FORM to each group.

Teaching Tip

Have students look on their rulers to see how long 21 cm is.

12. Be sure students do not throw the weight (the taped together coins) down to the tabletop; they should just let go of it right next to the meter stick, and it should fall straight down. Provide books or other sources so students can determine what a padded skeleton is called (endoskeleton). Ask:

Read or Tell

"Insects have exoskeletons. 'Exo-' means 'outside.' What, then, does 'exoskeleton' mean?" *(Elicit "The skeleton is on the outside.")* "'Endo-' means 'inside.' What, then, does 'endoskeleton' mean?" *(Elicit "The skeleton is on the inside.")*

"What types of animals have endoskeletons?" *(Reptiles, amphibians, mammals, birds.)*

"Which type of skeleton can survive the highest drops?" *(endoskeleton)*

Record in your SCIENCE JOURNAL and on the SCIENTIFIC DETECTIVE RECORD FORM (which I'll 'fax' to Ms. Porter) if you think a 21-cm insect could survive a fall as well as a 21-cm mammal, amphibian, or reptile."

Teaching Tip

13. Group members need only agree on the "fax" to Ms. Porter.

13. After discussing the results as a class, have students record their observations in their SCIENCE JOURNALS and fill out a SCIENTIFIC DETECTIVE RECORD FORM. Make sure they note if they think a 21-cm insect could survive a fall as well as a 21-cm mammal, amphibian, bird, or reptile. Collect the SCIENTIFIC DETECTIVE RECORD FORM from each group to "fax" to Ms. Porter.

14. Allow groups to discuss and decide if the experiment uncovered any new clue(s). If so, they should record it in the appropriate column on their group's CLUE TRACKING sheet.

15. For detailed teaching directions,see PHASE 1: Day 1, #9, on page 13 of this TEACHER GUIDE.

15. If you elected not to have your students complete Phase 1, but plan to include the INSECT IDENTIFICATION exercises in Phase 2, distribute INSECT IDENTIFICATION 1 and a MINI-FIELD GUIDE to each student. If your students have already completed Phase 1, omit this step, and proceed with today's debriefing.

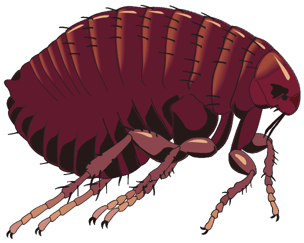
*16. Track clues that class consensus says are **"definitely clues"** and **"maybe clues"** on paper strips on a bulletin board. Move, add to, and discard clues as appropriate throughout PHASE 2.*

16. Using a blank transparency on the overhead do the following:
    a. Tell students that each day you will conduct a short debriefing session covering what they have learned.
    b. Ask students, "What have you learned today?"
    c. Note the ideas students share.
    d. Encourage students to add these notes to their SCIENCE JOURNALS.

17. Have students clean up for the day.

DAILY DIRECTIONS - 15

PHASE 2: DAY 2



Materials:

1. Activity supplies:
   - Large and small paper clips
   - Pencils
   - Small washers or other weights
   - Straight pins
   - Straws (plastic drinking type)—*100 per group*
2. CLUE TRACKING—*from Day 1*
3. INSECT CLUE FAX 1—*from Day 1*
4. INSECT CLUE FAX 2—***M71** class set*
5. INSECT IDENTIFICATION 2—*optional **M42** class set*
6. INSECT IDENTIFICATION 5—***M45** class set*
7. INSECT INVESTIGATION 2—***M67** one per group*
8. MINI-FIELD GUIDE—*from Day 1*
9. T.E.A.M. ACTIVITY 2 RECORDING—***M57** one per group*
10. SCIENCE JOURNAL—*from Day 1*
11. SCIENTIFIC DETECTIVE RECORD FORM—*from Day 1*
12. STUDENT GUIDE: PHASES 1 and 2—*class set*
13. T.E.A.M. ACTIVITY 2—***M55** + **M56** one set of strips per group*

Teaching Tip

If desired, don't use the RECORDING sheet for T.E.A.M. ACTIVITY 2; instead, have students cut apart the information on their strips and glue them to sheets of notebook paper, one labeled "Social Insects," one labeled, "Subsocial Insects," and one labeled "Solitary Insects."

Procedure:

1. Distribute T.E.A.M. ACTIVITY 2 strips and one T.E.A.M. ACTIVITY 2 RECORDING sheet to each group. Explain that the objective of the activity is to determine how insects live and behave in relation to the rest of their species: as social, subsocial, or solitary creatures. As a result of completing this activity, students will also be able to define these terms and give examples. Direct each group to record answers on its T.E.A.M. ACTIVITY 2 RECORDING sheet as each member reports his or her information.

2. After the activity, discuss the three different types of behavior, define the terms, and list the examples of each. This information will help your students better understand insect behavior. Use the key below to confirm your students' answers.

   Answer key for T.E.A.M. Activity 2:
   - **Social insects**: Texas leaf-cutting ants, hornets, paper wasps, honey bees, carpenter bees, termites
   - **Subsocial insects**: dung beetles, earwigs, carrion beetles, bess beetles
   - **Solitary insects**: praying mantis, meadow grasshoppers, wood nymph butterflies, cecropia moths, tree crickets, house flies, and Oriental cockroach

Read or Tell

3. Read or tell the following update from the island:

   "Ms. Porter was interested to hear about the results of your skeleton experiments. She still wonders if an insect 21 cm long could possibly survive with an exoskeleton. Still, she feels that she needs more information about this important aspect of insect structure. She suggested you try another experiment to test size limits. She also sent more information she has found out about Insect Island. She wonders if any of this information will give you more clues to help solve the mystery."

Teaching Tip

If you did the PHASE 1: Day 3 activity building paper and tape towers, ask students to make comparisons between the two activities. Suggested construction time limit for INSECT INVESTIGATION 2 is 30 minutes.

4. Distribute INSECT CLUE FAX 2 to each student and allow each group time to read and discuss the information. Have each group record possible clues on their CLUE TRACKING sheet.

5. Distribute an INSECT INVESTIGATION 2 sheet and a SCIENTIFIC DETECTIVE RECORD FORM to each group. Have groups do INSECT INVESTIGATION 2. Guide them into seeing that the structure they make must have crossbar-type infrastructures to support itself—which is more like an endoskeleton than an exoskeleton. Encourage groups to make structural changes so that their beetle can support itself with more stability.

6. Stimulate your students' thinking with the following questions:
   - Do they think an exoskeleton of the same size beetle as the straw beetle could support the weight of the insect?
   - What questions does this first question raise? (What is the exoskeleton made of? How strong is chitin? At what point does chitin weigh too much for an insect because of overall size of the insect or necessary thickness of the chitin?)

If you elected not to have your students complete PHASE 1, but are including the INSECT IDENTIFICATION exercises in PHASE 2, instead of INSECT IDENTIFICATION 5, you can introduce INSECT IDENTIFICATIONS 2 and 3 today. For the answer keys, see PHASE 1: Day 2, #6 on page 15, and Day 3, #10 on page 17.

7. Allow groups to discuss and decide if the experiment uncovered any new clue(s). If so, they should record it on their group's CLUE TRACKING sheet.

8. Give each student a copy of INSECT IDENTIFICATION 5. Have students work alone and then in their groups to identify today's insects, using their MINI-FIELD GUIDE and/or another field guide. Correct the sheets together as a class. Then, direct students to note whether today's insects are social, subsocial, or solitary.

Answer key for INSECT IDENTIFICATION 5:

(A) luna moth	(B) house fly
(C) spur-throated grasshopper	(D) American cockroach

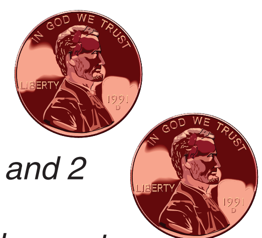
9. Debrief today's activities, noting on an overhead transparency ideas students share about what they have learned today. Encourage students to add these notes to their SCIENCE JOURNALS.

10. Have students clean up for the day.

PHASE 2: DAY 3

Materials:

1. Activity supplies:
   - Cardboard (4" x 6" or 10 cm x 15 cm)—*one piece per group*
   - Clay (in lumps of 2-ounces or 57-grams each)—*three per group*
   - Pencils and washers or weights
   - Pennies—*30 per group*
   - Rulers (30-cm or 12-inch)—*one per group*



2. CLUE TRACKING—*from Day 1*
3. INSECT CLUE FAXES 1 and 2—*from Days 1 and 2*
4. INSECT CLUE FAX 3—***M72** class set*
5. INSECT IDENTIFICATION 3—*optional **M43** class set*
6. INSECT IDENTIFICATION 6—***M46** class set*
7. INSECT INVESTIGATION 3—***M68** one per group*
8. T.E.A.M. ACTIVITY 3 RECORDING—***M59** one per group*
9. SCIENCE JOURNAL—*from Day 1*
10. SCIENTIFIC DETECTIVE RECORD FORM—*from Day 1*
11. T.E.A.M. ACTIVITY 3—***M58** one per group*

Teaching Tip

Help students recognize that sometimes the information about mouth parts will be offered much earlier on the "road" to a particular order on the KEY TO ADULT WINGED INSECT ORDERS. If desired, don't use the T.E.A.M. ACTIVITY 3 RECORDING sheet; instead, have students cut apart the information on their strips and glue them to sheets of notebook paper, one labeled "Sucking Mouth Parts" and one labeled "Chewing Mouth Parts."

Procedure:

1. Distribute T.E.A.M. ACTIVITY 3 strips and one T.E.A.M. ACTIVITY 3 RECORDING sheet to each group. Explain that the purpose of this activity is to learn more about the types of mouth parts of various insects; that is, whether they are sucking or chewing mouth parts. Students will also practice taxonomy in this activity: They must find each insect in the MINI-FIELD GUIDE, find out its order, and look on the KEY TO ADULT WINGED INSECT ORDERS to determine if insects have sucking or chewing mouth parts. Direct each group to record answers on its T.E.A.M. ACTIVITY 3 RECORDING sheet as each member reports his or her information.

2. After the activity, discuss the differences between the structures of these insects and how it might affect what they eat. Confirm students' answers on where each insect belongs on the T.E.A.M. ACTIVITY 3 RECORDING sheet using the answer key (see next page). Have each group store the RECORDING in its folder.

Answer key for T.E.A.M. ACTIVITY 3:

- **Sucking mouth parts**: monarch butterfly, gypsy moth, comma butterfly, luna moth, wood nymph butterfly, regal moth
- **Chewing mouth parts**: mud-dauber wasp, Colorado potato beetle, lightning bug, Chinese mantid, Oriental cockroach, honey bee, broad-nosed weevil, yellowjacket, spur-throated grasshopper, bush cricket, ground beetle, Japanese beetle

3. Read or tell the following update from the island:

“Ms. Porter was interested to hear about your big beetles and what made them strong. She has sent us another fax giving more information she has found and asking you to test another aspect of insect structures. She hopes you will find the information helpful and that soon you will be able to solve the mystery.”

4. Distribute one copy of INSECT CLUE FAX 3 to each student.
   a. Allow groups to read and discuss the fax from Ms. Porter.
   b. Have groups record any clues they find in the fax on their CLUE TRACKING sheet.

5. Challenge students with INSECT INVESTIGATION 3 to make legs as long as possible that will support the weight of the pennies. Suggested time limit for this investigation: 30 minutes.

6. Ask the following questions to stimulate your students’ thinking:

Were the legs using 4 ounces of clay twice as tall as the legs using 2 ounces of clay? *(No.)* Why not? *(The legs had to be relatively thicker to support the heavier “insect.”)*

How much taller were the legs using 6 ounces of clay than the legs using 2 ounces of clay? *(About twice—even though the clay weighed three times as much.)* Why? *(Again, the legs had to be relatively thicker to support the heavier insect.)*

DAILY DIRECTIONS - 19

Read or Tell

7. Read or tell:

   As you saw from this activity, as leg length increased (doubled, approximately), weight had to increase even more (had to triple, approximately). This is a problem for large insects, not just in leg length but also in body length.

8. Have students record any possible clues they think this experiment suggests for solving the mystery of Insect Island on their CLUE TRACKING sheet and their personal thoughts in their SCIENCE JOURNALS.

9. Have each group prepare a SCIENTIFIC DETECTIVE RECORD FORM to “fax” to Ms. Porter.

10. Give each student a copy of INSECT IDENTIFICATION 6. Have students work alone and then in their groups to identify today’s insects, noting whether they have sucking or chewing mouth parts by circling the correct word. Correct the sheets together as a class.

    Answer key for INSECT IDENTIFICATION 6:

(A) bush cricket	(B) flower beetle
(C) honey bee	(D) broad-nosed weevil

11. Debrief today’s lesson, recording student comments on an overhead transparency. Encourage students to record these comments in their SCIENCE JOURNALS.

12. Have students clean up for the day.

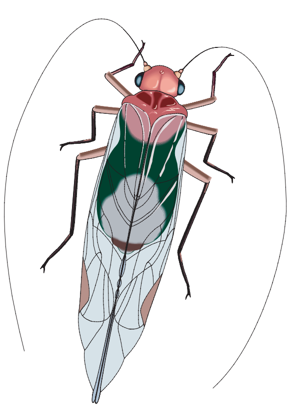
Teaching Tip

If you elected not to have your students complete PHASE 1, but are including the INSECT IDENTIFICATION exercises in PHASE 2, instead of INSECT IDENTIFICATION 6, you can introduce INSECT IDENTIFICATIONS 4 and 5 today. For these answer keys, see PHASE 1: Day 4, #9 on page 19, and PHASE 2: Day 2, #8 on page 28.

PHASE 2: DAY 4

Materials:

1. Activity supplies:
   - Clock with a second hand or stopwatch—*one per group*
   - Food colors (any shade)—*one squeeze bottle per group*
   - Meat tray (foam or plastic, smooth, flat surface, at least 21 cm long)—*one per group*
   - Paper towel (strong kitchen-type, not school-type)—*one sheet per group*
   - Pencils and rulers (30-cm or 12-inch)—*one of each per group*
   - Plates (10-inch, plastic or foam)—*three per group*
   - Scissors—*one pair per group*
   - Sponge (wet but not dripping)—*one per group*



DAILY DIRECTIONS - 20

2. CLUE TRACKING—*from Day 1*
3. INSECT CLUE FAXES 1 to 3—*from Days 1 to 3*
4. INSECT CLUE FAX 4—***M73** class set*
5. INSECT IDENTIFICATION 4—*optional **M44** class set*
6. INSECT IDENTIFICATION 7—***M47** class set*
7. INSECT INVESTIGATION 4—***M69** one set per group*
8. T.E.A.M. ACTIVITY 4 RECORDING—***M62** one per group*
9. SCIENCE JOURNAL—*from Day 1*
10. SCIENTIFIC DETECTIVE RECORD FORM—*from Day 1*
11. STUDENT GUIDE: PHASES 1 and 2—*from Day 2*
12. T.E.A.M. ACTIVITY 4—***M60** + **M61** one set of strips per group*

Procedure:

Teaching Tip

If desired, don't use the T.E.A.M. ACTIVITY 4 RECORDING sheet; instead, have students cut apart the information on their strips and glue them to sheets of notebook paper, one labeled "Camouflage," one labeled, "Mimicry," and one labeled "Aggression/Repulsion."

1. Distribute T.E.A.M. ACTIVITY 4 strips and one T.E.A.M. ACTIVITY 4 RECORDING sheet to each group. Explain to students that the objective of this activity is to determine how various insects protect themselves: with camouflage, mimicry, or aggression/repulsion. Through this activity, students will also learn the definitions of these terms. Direct each group to record answers on its T.E.A.M. ACTIVITY 4 RECORDING sheet as each member reports his or her information. See the answer key below.

2. After the activity, discuss the definitions of camouflage, mimicry, and aggression/repulsion as insect defenses and what each insect mentioned in today's activity uses as its defense. Have students prove their answers based on the information on the ACTIVITY 4 strips. Using the key below, have each group grade its T.E.A.M. ACTIVITY 4 RECORDING sheet, confirming or correcting the answers. Have each group store this sheet in its group folder.

   Answer key for T.E.A.M. ACTIVITY 4:
   - **Camouflage**: black-peppered moths, dead leaf butterflies, hawk moth caterpillars, locust borer, some planthoppers, question mark butterflies, walkingsticks, thorny treehoppers, grasshoppers, katydids
   - **Mimicry**: spicebush swallowtail butterflies, syrphid fly, robber fly, a kind of hover fly
   - **Aggression/Repulsion**: monarch butterfly, yellowjackets, honey bees, bombardier beetles, lubber grasshoppers, pipe vine swallowtail butterflies, tiger moths

Read or Tell

3. Read or tell the following update from the island:

   "Ms. Porter was very interested to learn the results of your clay-legged insects investigation. She also doesn't think that an insect so large could pump enough blood through its system to survive. So she faxed us an experiment to learn about insect circulation. She also sent another fax, with more information researchers have discovered about the island and with information you need to conduct today's experiment."

4. Distribute INSECT CLUE FAX 4 to each group. Allow groups time to read and discuss this latest information. Have groups record any possible clues in their CLUE TRACKING sheets and their SCIENCE JOURNALS.

5. Tell students that, as Ms. Porter mentioned today, they will be conducting an experiment to determine how effective insect circulation is. Give each group the supplies necessary to conduct INSECT INVESTIGATION 4.

Read or Tell

6. "Could a 21 cm long insect's heart pump hard enough to send it's hemolymph (blood) to its entire body? Specifically, how long does it take one drop of 'blood' to travel each distance?"

   a. Give each group three plastic plates and one meat tray with 21-cm smooth flat surface. Have students measure and cut out their four "insects" and place one insect on each plate or tray.
   b. Have groups discuss and predict how long it will take a drop of "blood" (food coloring) to travel to the edge of the insect when dropped from the specified height. Explain that the drop of food coloring represents a single drop of blood moving through the insect's body and that the force of the fall of the food coloring represents the strength of the insect's heart pumping. Have students record their predictions.
   c. Have each team thoroughly dampen but not soak their smallest insect with the sponge, and drop the specified amount of food coloring, from the specified height, onto their insect. Using a stopwatch or a watch with a second hand, have teams record the actual time on the INSECT INVESTIGATION 4 sheets.

Teaching Tip

If you have groups use stopwatches make sure that a "timer" in each group knows how to use a stopwatch. You can brief the timers while other group members "prepare the insects."

Teaching Tip

6d. If desired, challenge students to modify this experiment or create another one to see if they can find out more information.

Ensure that students count all food coloring drops—large and small.

7. Sample trial results: Insect a: 3 sec.; Insect b: 16 sec.; Insect c: 28 sec.; Insect d: 210 sec.

If a group has to repeat a trial, be sure they thoroughly dry the plate or meat tray and begin with a new "insect."

11. If you elected not to have your students complete PHASE 1, but are including the INSECT IDENTIFICATION exercises in PHASE 2, you can also introduce INSECT IDENTIFICATION 6 today. For the answer key, see PHASE 2: Day

c. Have each group repeat the test with the other three "insects" that they have measured, cut, and dampened. Have teams record both their predictions and the actual times for all "insects" in their SCIENCE JOURNALS.

d. Compare times as a class. Elicit from students that the larger area took much longer for the food coloring to travel through. Whether or not this is too long for an insect to survive is still a question. Obviously, the "heart" did not keep pumping as it would in a live insect and we have no way of knowing exactly how strong the heart would be in such an insect. But as the article in the fax stated "The pumping ability of insect hearts leaves a lot to be desired."

Make sure students understand that the cut towel represents the relative size of the insects. The drops of food coloring represent the amount of the insect's blood ("hemolymph") that one heartbeat pushes through the insect. The height from which the food coloring is dropped represents the strength of one pump of the insect's heart, which is less powerful (so less height) for a smaller insect because a smaller insect has a smaller heart.

7. After everyone has completed the experiment, allow each group time to share its results with the rest of the class. Discuss the problems students faced and how they were or were not able to overcome them. *The time the blood takes to travel through the largest insect is disproportionately long compared to the other insects' results.*

8. Have students record their observations and thoughts in their SCIENCE JOURNALS.

9. Allow groups time to discuss and decide if the experiment has given them any new clue(s) to help them solve the mystery. If so, direct them to record this information on their group's CLUE TRACKING sheet.

10. Then have each group complete a SCIENTIFIC DETECTIVE RECORD FORM to "fax" to Ms. Porter.

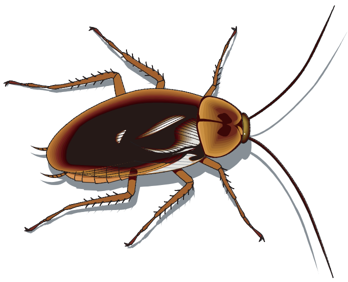
11. Give each student a copy of INSECT IDENTIFICATION 7. Have students work alone and then in their groups to identify today's insects. Correct the sheets together as a class. Then, direct students to note which of the insects they identified today use, mimicry, camouflage, or aggression/repulsion to protect themselves. Have students add this information to their MINI-FIELD GUIDE.

Answer key for INSECT IDENTIFICATION 7:

(A) mud-dauber wasp (B) regal moth
(C) viceroy butterfly (D) Chinese mantid

12. Using a blank overhead transparency, record what students share they have learned today. Encourage students to add these notes to their SCIENCE JOURNALS.

13. Direct students to clean up for the day.



PHASE 2: DAY 5

Materials:

1. Activity supplies: pencils
2. CLUE TRACKING—*from Day 1*
   (Students should use all clues and all five faxes today.)
3. INSECT CLUE FAXES 1 to 4—*from Days 1 to 4*
4. INSECT CLUE FAX 5—***M74*** *class set*
5. SCIENCE JOURNAL—*from Day 1*
6. T.E.A.M. ACTIVITY 5 - A: DEFENSE ATTORNEYS—
   M63 *one per group for half the class*
7. T.E.A.M. ACTIVITY 5 - B: PROSECUTING ATTORNEYS—***M64*** *class set for half the class*
8. T.E.A.M. ACTIVITY 5 - C: COCKROACH ON TRIAL—
   M65 *one per class*

Teaching Tip

Optional—have students research cockroaches before doing T.E.A.M. ACTIVITY 5.

Invite another class to attend the trial and have them vote after listening to the attorneys' arguments.

Procedure:

1. Tell the class that with all the information they have collected (including today's information), they should be able to solve the insect mystery by the end of today's class.

Read or Tell

2. Update from the island: Read or tell your class:

> "Ms. Porter was very interested to learn the results of your insect circulation experiment. You may have discovered some important information that will help Ms. Porter and the Ministry of Agriculture solve the mystery.

3. Without discussing the issue first, have the class vote on the question "Are Cockroaches Good or Bad?" Have each student write his or her name on the chalkboard in the appropriate column.
   a. Placing the large drawing of a cockroach on the "stand" as in a courtroom, explain that today the class is going to put the cockroach on trial.

b. Distribute the T.E.A.M. ACTIVITY 5 sheets.
c. Designate the groups who receive ***M63*** as Defense Attorneys and the groups who receive ***M64*** as Prosecuting Attorneys.
d. Allow time for "lawyer" teams to read and discuss the information they receive.
e. Then have each side make one statement each until they are ready to "rest the case."
f. Finally, allow students who wish to change their vote to do so.

4. Distribute one copy of INSECT CLUE FAX 5 to each student. Allow groups time to read and discuss the information and to review all other clues they have gathered.

5. Have groups write their recommendation regarding whether or not a resort would be safe to build, and whether Insect Island should be sold to Mr. Vanderpelt and label it "Fax to Ms. Porter: Our Group's Recommendation."

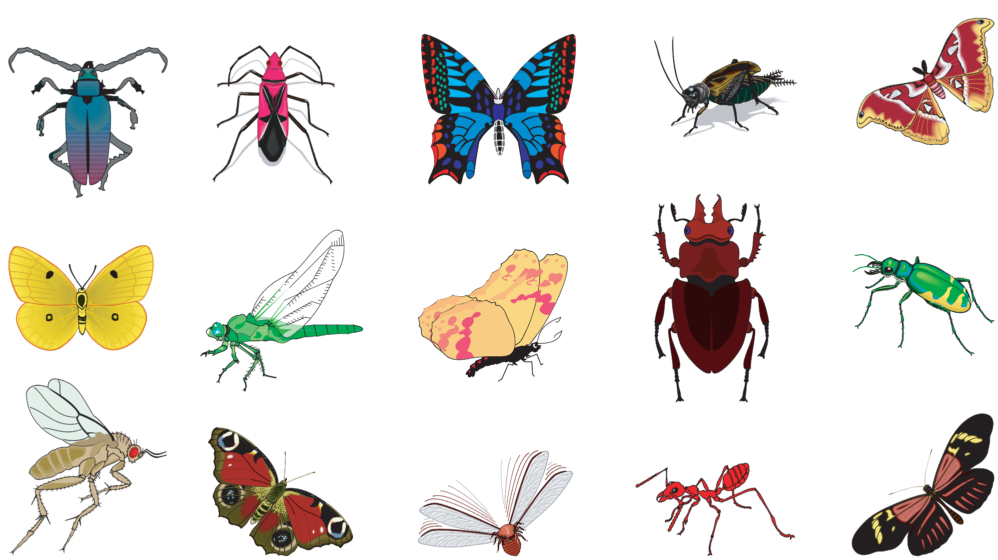
PHASE 3—OPTIONAL

Presentations, Challenge Projects, and Insect Gallery

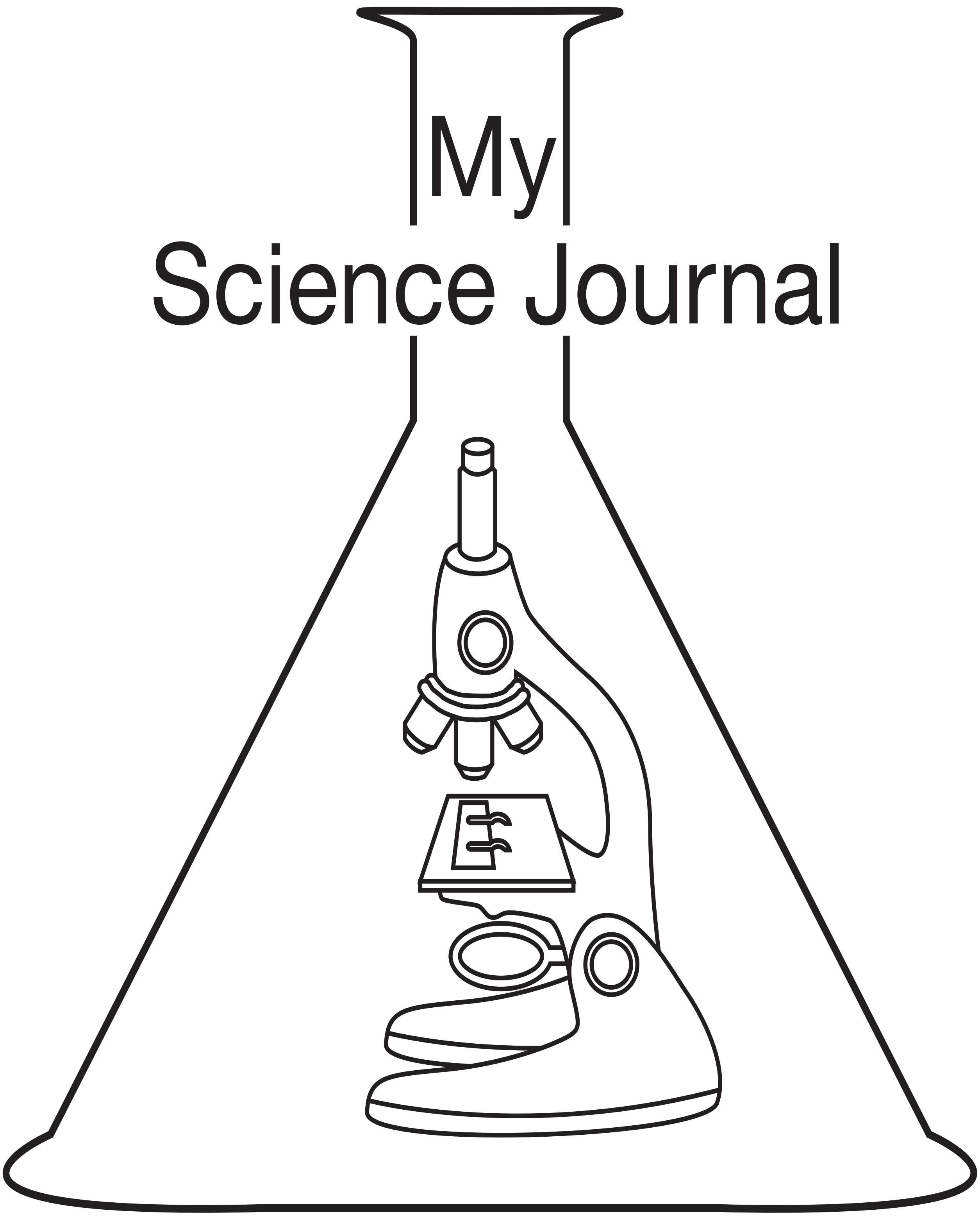
If desired, have groups of students present their recommendations to a "Ms. Porter, the Minister of Agriculture" (you, the school principal, or some other dignitary can assume this role).

If desired, assign or allow students to choose one of the CHALLENGE PROJECTS on page 4 of the STUDENT GUIDE: PHASE 1. You may also have students present these projects to "Ms. Porter."

A final alternative is to have students (in groups, pairs, or as individuals) create their own gallery of giant insects, inventing their own creatures and rendering them four to six feet tall. Require students to include the features of insects (e.g., six legs, antennae, etc.), name their insect, identify its order, write a description of it, and answer questions from other students, or from guests invited to view the insect gallery.



My Science Journal



Name: ______________________________

MASTER

YOUR SCIENCE JOURNAL

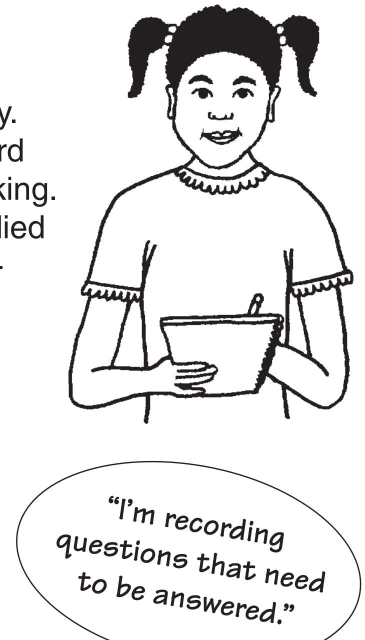
Scientists and detectives Scientists are really detectives who work diligently to solve a problem. Like detectives who work for the police department, scientists have tools they use to solve mysteries. For example, both scientists and detectives keep notebooks (or journals). Here they carefully document what they find, observe, question, or believe to be a possible solution to the mystery they are attempting to solve.

Keeping a journal As you work through the INSECT ISLAND mystery, you will keep a journal, just as a real scientist or a real detective does. This SCIENCE JOURNAL will be important because in it you will record *everything* you learn!

Making an authentic journal To keep an authentic—that is, a real and worthwhile—SCIENCE JOURNAL, you should include the following elements:

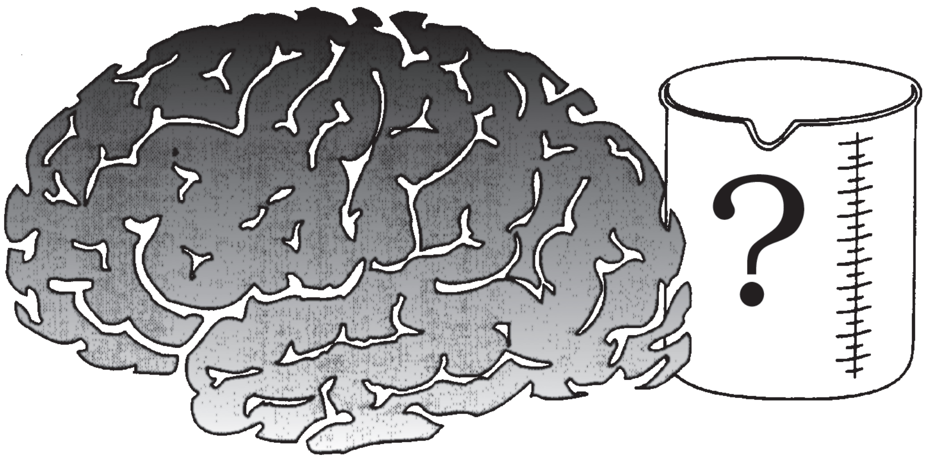
1. **Dates** Every time you write in your SCIENCE JOURNAL, you *must* include the date! This date will help you keep track of when you did activities and experiments and made observations.
2. **Complete descriptions** Descriptions of all activities, experiments, and observations must be very complete so that someone with no knowledge of insects or the activities and experiments you did could pick up your journal, read it, and understand *exactly* what you did.
3. **Illustrations** Have you heard the expression, "A picture is worth a thousand words"? Illustrations will help someone reading your journal to understand even more than they would from words alone. Illustrations do not have to be complex; they can be simple diagrams or sketches. These illustrations will not only help someone reading your journal; they will also help you when you look back at your notes.

   Scientists often take pictures at different points in their experiments. If you have a camera, you may also take pictures as you work through this INSECT ISLAND mystery.
4. **Important questions** Scientists use their journals to record carefully any questions that occur to them as they are working. These questions help them determine what should be studied further. You should include questions you have in your SCIENCE JOURNAL as you work through this mystery.
5. **Possible solutions** Scientists are always thinking about the solution to the problem troubling them. In their journals, they record possible solutions whenever one comes to mind. *Do the same thing in your SCIENCE JOURNAL.*



Good luck with your SCIENCE JOURNAL. It will help you keep track of most of your thoughts and actions as you solve this intriguing mystery.

Using your brain in sequential steps



1 **Question:** What do you wish to find out?

2 **Hypothesis:** What do you think the answer is?

3 **Experiment:** Design a procedure (experiment) to test your hypothesis.

4 **Data:** Conduct the experiment and keep accurate records of your results. Repeat the experiment a number of times. Record the information you collect (data) in a SCIENCE JOURNAL. (You may also wish to put some information on a graph.)

5 **Conclusion:** Summarize what you have discovered (concluded) as a result of doing this experiment.

SCIENTIFIC DETECTIVE RECORD FORM

1. What mystery are you trying to uncover? (the "**question**")

2. What do you expect to be the answer to this mystery? (the "**hypothesis**")

3. What clues have you uncovered so far, and what other clues will you look for to help solve this mystery? ("**data gathering**" and "**materials**")

4. How will you determine if what you suspect to be true about the mystery is correct? * (the "**experiment**" or "**method**")

5. After completing steps 1-4, what do you now believe is the answer to your mystery? (the "**conclusion**")

6. As a result of doing this experiment, does a new mystery come to mind? ("**extending the experiment**")

** If necessary, write on the back of this sheet*

CONSTRUCTION TEAM SIGN-UP

Name	Name
1.	19.
2.	20.
3.	21.
4.	22.
5.	23.
6.	24.
7.	25.
8.	26.
9.	27.
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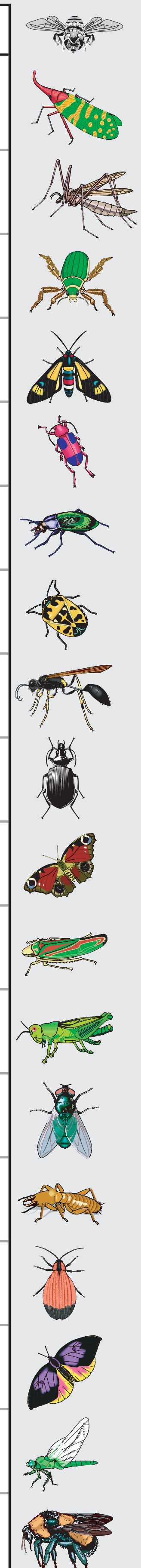


Master

INSECT IDENTIFICATION - 1

PART 1

Directions: Use the KEY TO ADULT WINGED INSECT ORDERS and the insects listed in the MINI-FIELD GUIDE to help you answer the following questions. Write the Latin names. Then write the common names in parentheses ( ).

1. Name the family, genus, and species of one member of the order Orthoptera:

   ____

2. Name the family, genus, and species of one member of the order Diptera:

   ____

3. Name the family, genus, and species of one member of the order Coleoptera:

   ____

4. Name the family, genus, and species of one member of the order Hymenoptera:

   ____

5. Name the family, genus, and species of one member of the order Lepidoptera:

   ____

PART 2

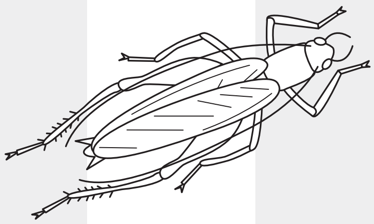
Directions: By reading the information on the KEY TO ADULT WINGED INSECT ORDERS along the paths to the insect order names, what can you say about the **body structure** of each of the five insects you have named?

INSECT'S COMMON NAME	FURTHER INFORMATION ABOUT THE INSECT'S BODY STRUCTURE
1	
2	
3	
4	
5	

MASTER

INSECT IDENTIFICATION - 2

Directions: Use your MINI-FIELD GUIDE to identify these four insects. Choose one interesting habit or body characteristic to list under “Comments.”

Common Name	Order	Family	Genus	Species	Comments
A 					
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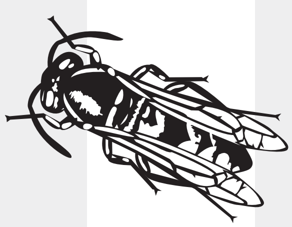
C 					
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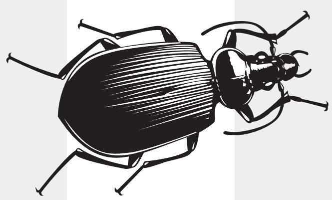
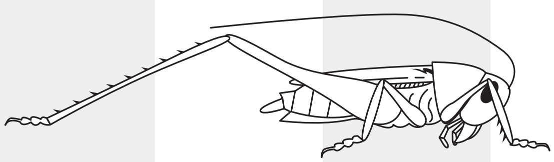
MASTER

Directions: Use your MINI-FIELD GUIDE to identify these four insects. Choose one interesting habit or body characteristic to list under “Comments.”

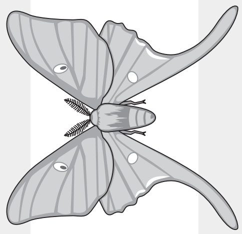
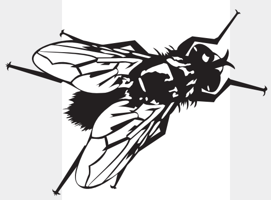
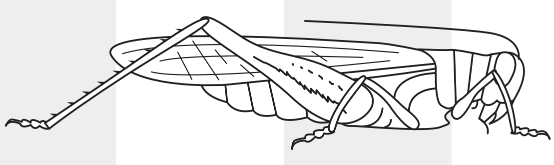
Common Name	Order	Family	Genus	Species	Comments
A					
B					
C					
D					

Directions: Use your MINI-FIELD GUIDE to identify these four insects. Choose one interesting habit or body characteristic to list under "Comments."

Common Name	Order	Family	Genus	Species	Comments
A 					
B 					
C 					
D 					

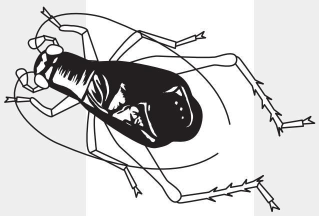
INSECT IDENTIFICATION - 5

Directions: Use your MINI-FIELD GUIDE to identify these four insects. Choose one interesting habit or body characteristic to list under “Comments.”

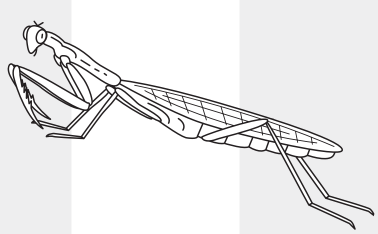
Common Name	Order	Family	Genus	Species	Comments
A 					
B 					
C 					
D 					

INSECT IDENTIFICATION - 6

Directions: Use your MINI-FIELD GUIDE to identify these four insects. Choose one interesting habit or body characteristic to list under "Comments."

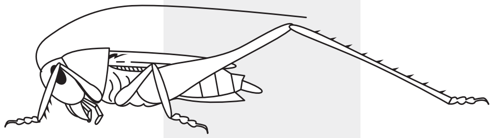
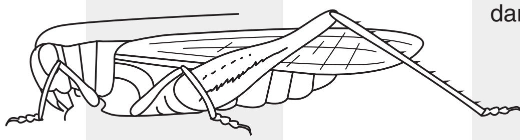
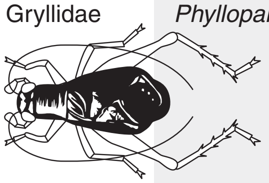
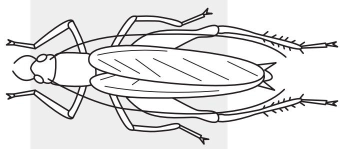
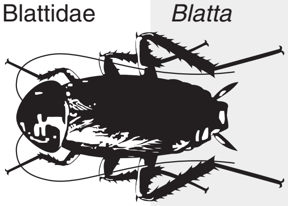
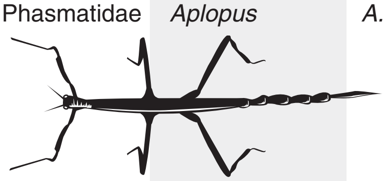
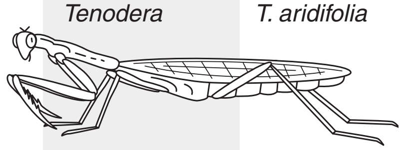
Common Name	Order	Family	Genus	Species	Comments
A 					
B 					
C 					
D 					

Directions: Use your MINI-FIELD GUIDE to identify these four insects. Choose one interesting habit or body characteristic to list under "Comments."

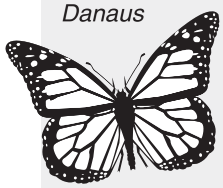
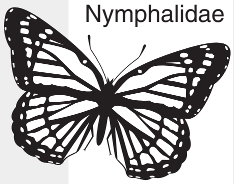
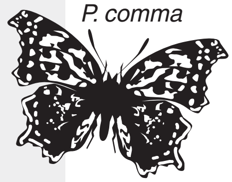
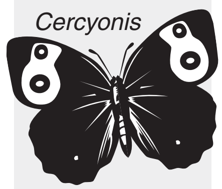
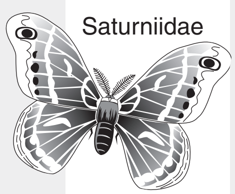
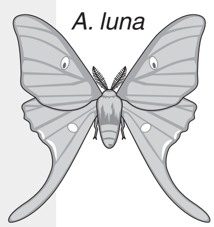
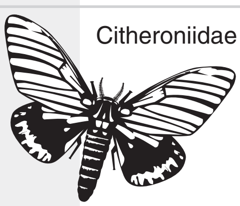
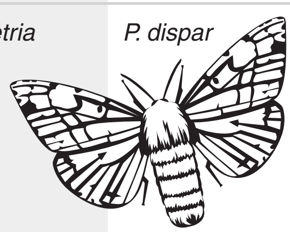
Common Name	Order	Family	Genus	Species	Comments
A 					
B 					
C 					
D 					

MINI-FIELD GUIDE - 1

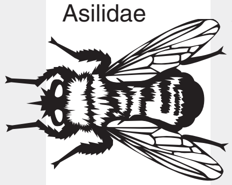
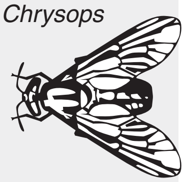
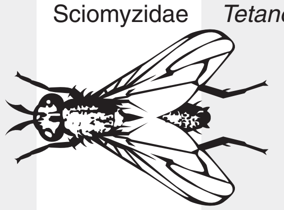
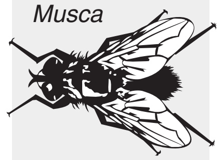
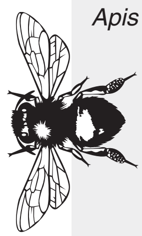
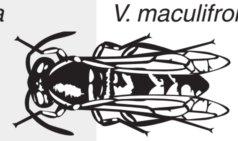
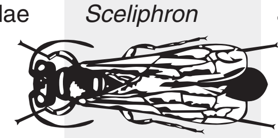
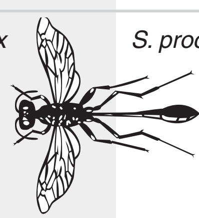
ORDER: ORTHOPTERA (GRASSHOPPERS, CRICKETS, MANTIDS, WALKINGSTICKS, COCKROACHES)

Common Name	Family	Genus	Species	Habits	Metamorphosis Type
Meadow grasshopper	Tettigoniidae 	*Conocephalus*	*C. brevipennis*	Usually found in grassy areas near streams and ponds or wet meadows; sings with buzzes and “zzzips”	
Spur-throated grasshopper	Acrididae 	*Schistocerca*	*S. americana*	Can cause great damage to crops	
Bush cricket	Gryllidae 	*Phyllopalpus*	*P. pulchellus*	Lives on bushes	
Snowy tree cricket	Gryllidae 	*Oecanthus*	*O. fultoni*	Lives on bushes; estimate the temperature in ½ F by counting its chirps for 13 seconds and adding 40	
Oriental cockroach	Blattidae 	*Blatta*	*B. orientalis*	Lives in buildings; this pest hides in cracks during the day and feeds on a variety of foods at night	
American cockroach	Blattidae 	*Periplaneta*	*P. americana*	Lives in buildings; this pest hides in cracks during the day, and feeds on a variety of foods at night	
Walkingstick	Phasmatidae 	*Aplopus*	*A. mayeri*	Found on bay cedar trees or other shore plants in Florida and Florida Keys	
Chinese mantid	Mantidae 	*Tenodera*	*T. aridifolia*	Preys on other insects	

MINI-FIELD GUIDE - 2

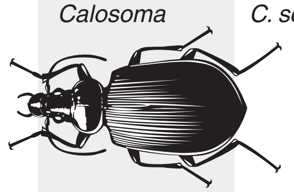
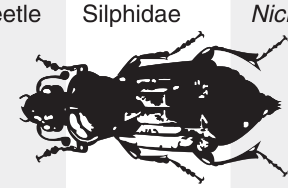
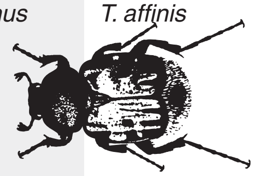
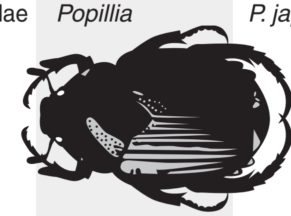
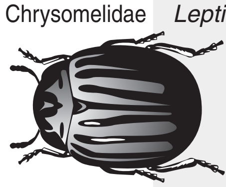
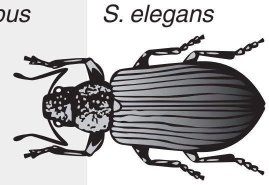
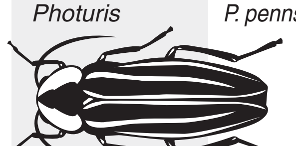
Order: Lepidoptera (Butterflies and Moths)					
Common Name	**Family**	**Genus**	**Species**	**Habits**	**Metamorphosis Type**
Monarch butterfly	Danaidae	*Danaus* 	*D. plexippus*	Larvae feed on milkweed plants	
Viceroy butterfly 	Nymphalidae	*Limenitis*	*L. archippus*	Larvae feed on willow and poplar trees	
Comma butterfly	Nymphalidae	*Polygonia*	*P. comma* 	Larvae feed mainly on elms and nettles	
Wood nymph butterfly	Satyridae	*Cercyonis* 	*C. pegala*	Larvae feed on grasses	
Cecropia moth 	Saturniidae	*Hyalophora*	*H. cecropia*	Has a wingspread of 13-17 cm (5-6 in.); has reduced mouth parts and adults do not feed	
Luna moth	Saturniidae	*Actias*	*A. luna* 	Has reduced mouth parts and adults do not feed	
Regal moth 	Citheroniidae	*Citheronia*	*C. regalis*	Larvae feed chiefly on walnut or hickory trees and pupate underground; adult wing-spread of 13-17 cm (5-6 in.)	
Gypsy moth	Liparidae	*Porthetria*	*P. dispar* 	Larvae often cause much damage to forest trees; male adults are good fliers; females do not fly	

MINI-FIELD GUIDE - 3

Common Name	Family	Genus	Species	Habits	Metamorphosis Type
ORDER: DIPTERA (FLIES)					
Robber fly	Asilidae	*Laphria* 	*L. sacrator*	Preys on other insects; this species resembles a bumblebee	
Deer fly	Tabanidae	*Chrysops* 	*C. vittatus*	Aquatic larvae; adults are strong fliers	
Marsh fly	Sciomyzidae	*Tetanocera* 	*T. plebeja*	Aquatic larvae prey on aquatic snails; adults live in the marshy areas near streams and ponds where they breed	
House fly	Muscidae	*Musca* 	*M. domestica*	Common household pest; breeds in filth; can carry many diseases	
ORDER: HYMENOPTERA (WASPS AND BEES)					
Honey bee	Apidae	*Apis* 	*A. mellifera*	Very valuable insects because they make honey, beeswax, and pollinate many plants; also considered a pest	
Yellowjacket	Vespidae	*Vespula* 	*V. maculifrons*	These wasps build papery nests; females can give painful stings	
Mud-dauber wasp	Sphecidae	*Sceliphron* 	*S. caementarium*	Makes nests of mud or in natural holes in the ground; leaves spiders in nest for larvae to eat	
Thread-waisted wasp	Sphecidae	*Sphex* 	*S. procerus*	Nests in the ground; leaves grasshoppers in nest for larvae to eat	

MINI-FIELD GUIDE - 4

ORDER: COLEOPTERA (BEETLES AND WEEVILS)

Common Name	Family	Genus	Species	Habits	Metamorphosis Type
Ground beetle	Carabidae	*Calosoma* 	*C. scrutator*	Feeds on pest larvae; climbs trees or shrubs in search of caterpillars	
Carrion beetle	Silphidae	*Nicrophorus* 	*N. marginatus*	Burrows under and buries dead mice for adult and larvae to eat; also eats decaying vegetation	
Two-spotted ladybird beetle	Coccinellidae	*Adalia* 	*A. bipunctata*	Adult and larvae eat pest insects, including aphids, scale insects, and mites; often hides indoors for the winter	
Flower beetle	Scarabaeidae (Scarabs)	*Trichiotinus* 	*T. affinis*	Feeds on pollen; living in soil, larvae may damage plant roots	
Japanese beetle	Scarabaeidae (Scarabs)	*Popillia* 	*P. japonica*	Severely damages lawns, fruits, pastures, and shrubbery; larvae feed on roots; adults feed on main plant	
Colorado potato beetle	Chrysomelidae	*Leptinotarsa* 	*L. decemlineata*	Serious pest of potatoes	
Broad-nosed weevil	Curculionidae	*Scythropus* 	*S. elegans*	Larvae grow in the fruit of nut-producing trees	
Lightning bug (or firefly)	Lampyridae	*Photuris* 	*P. pennsylvanica*	Flashes light signals to find a mate; larvae live in hidden places such as underground or under bark	

(Cut this sheet into strips. Give each team member a different strip. You will need one set per team.)

T.E.A.M. ACTIVITY 1 - A

1a. **Aphid** nymphs like to eat rose bush leaves.

Young **American cockroaches** look like adult American cockroaches.

Cecropia moths go through four different life stages.

Among known insects, 15 percent of them go through **simple metamorphosis**.

1b. An alien from another planet could tell that a young **bush cricket** is related to an adult bush cricket.

In **complete metamorphosis**, the larva looks quite different from the adult insect.

A larva of a **Japanese beetle** is called a grub.

Meadow grasshopper young are called nymphs.

1c. **Cicadas** go through three different life stages.

For **complete metamorphosis**, insects pass through four different life stages: egg, larva, pupa, and adult.

A larva of a **house fly** is called a maggot.

A pupa of a **monarch butterfly** is called a chrysalis.

MASTER

(Cut this sheet into strips. Give each team member a different strip. You will need one set per team.)

T.E.A.M. ACTIVITY 1 - B

1d. A larva of a **regal moth** is called a caterpillar.

Among known insects, 85 percent of them go through **complete metamorphosis**.

An alien from another planet would think a **comma butterfly** caterpillar is an entirely different, unrelated creature from the adult comma butterfly.

The **Chinese mantid** goes through three life stages.

1e. In **simple metamorphosis**, the nymph looks almost the same as the adult insect, except the nymph is smaller and has less-developed wings.

The **mud-dauber wasp** goes through four life stages.

All the insects in the same **order** go through the same type of metamorphosis.

Squash bugs lay their eggs in the squash plant family so their nymphs will have food.

1f. In **simple metamorphosis**, insects pass through three different life stages: egg, nymph, and adult.

Bumblebees feed their larvae nectar.

An **Eastern blue darner** nymph lives in water.

Larvae means more than one larva.

T.E.A.M. ACTIVITY 1 RECORDING

Complete Metamorphosis	Simple Metamorphosis

MASTER

T.E.A.M. ACTIVITY 2 - A

2a. **Solitary** insects do not usually care for their young.

Dung beetles provide food for their own eggs.

A **praying mantis** does not care for its young in any way.

Texas leaf-cutting ants work together to raise fungus for food.

2b. Some species of **carpenter bees** build nests in wood and care for their young.

Most insects are **solitary**.

Subsocial insects care for their own eggs or larvae in some way.

The **meadow grasshopper** interacts with other members of its species only by chance or to mate.

2c. **Earwigs** of some species live together in colonies but work alone to feed their young until they can take care of themselves.

Social insects use the same nest as others of their species and cooperate with each other to care for their young.

A **termite** colony includes workers to care for their young.

The **wood nymph butterfly** only interacts with members of its own species by chance or to mate.

2d. Some **carrion beetles** take care of their larvae.

Some **social insects** have workers take care of their young.

The **cecropia moth** interacts with other members of its species only by chance or to mate.

The **tree cricket** does not care for its young in any way.

2e. **Solitary insects** only interact with members of their own species by chance or to mate.

Ants appoint workers to care for their young.

Bess beetles provide food for their larvae.

Hornets work together to build nests by chewing wood to form the pulp they need.

2f. Several female **paper wasps** work together to build a new nest.

The **house fly** interacts with members of its own species only by chance or to mate.

Some **subsocial insects** leave food for their eggs when they lay the eggs.

The **Oriental cockroach** only interacts with other members of its own species by chance or to mate.

T.E.A.M. ACTIVITY 2 RECORDING

Solitary	Subsocial	Social

MASTER

T.E.A.M. ACTIVITY 3

3a. Sucking or chewing mouth parts?

Monarch butterfly *Mud-dauber wasp* *Gypsy moth*

3b. Sucking or chewing mouth parts?

Colorado potato beetle *Lightning bug* *Chinese mantid*

3c. Sucking or chewing mouth parts?

Oriental cockroach *Honey bee* *Comma butterfly*

3d. Sucking or chewing mouth parts?

Broad-nosed weevil *Yellowjacket* *Spur-throated grasshopper*

3e. Sucking or chewing mouth parts?

Bush cricket *Luna moth* *Ground beetle*

3f. Sucking or chewing mouth parts?

Japanese beetle *Wood nymph butterfly* *Regal moth*

MASTER

T.E.A.M. ACTIVITY 3 RECORDING

Sucking Mouth Parts	Chewing Mouth Parts

MASTER

(Cut this sheet into strips. Give each team member a different strip. You will need one set per team.)

T.E.A.M. ACTIVITY 4 - A

4a. **Monarch caterpillars** eat milkweed plants that make them toxic even after they become butterflies.

Certain **honey bees** in a hive form a "rapid deployment force" whose job is to be always ready to defend the nest.

A kind of **robber fly** looks like a honey bee.

Black-peppered moths are hard to see on the trunks of trees in polluted areas.

4b. The **dead leaf butterflies** of India are brown like the dead leaves they rest among.

Mimicry is a defense in which a harmless insect looks like a more harmful insect.

The **walkingstick** looks so much like a stick that predators sometimes walk right over it!

Green **hawk moth caterpillars** rest on the leaves they feed on, but gray and brown hawk moth caterpillars rest on twigs.

4c. The **syrphid fly** has coloration and a loud buzz similar to a yellowjacket.

Some **tiger moth** species are able to produce ultrasound that "jams" bat sonar so bats can't find and eat them.

The undersides of the **question mark butterfly** look like a ragged dead leaf, so when it rests with its wings folded up, it blends in with its surroundings.

Camouflage is a defense for which an insect looks like its surroundings to help it avoid detection by an enemy.

T.E.A.M. ACTIVITY 4 - B

4d. Some species of **grasshopper** hide bright-colored forewings (front wings) under brown hind (back) wings when resting.

The green color of **katydids** makes them hard to find among grass or leaves.

A drop of the defensive fluid of the **bombardier beetle** is probably more powerful than a drop of a skunk's defensive fluid.

Some **planthopper species** look like single blossoms of flowers, and groups of them line up to look like a cluster of flowers on their food plants.

4e. **Yellowjackets** are brightly colored to warn predators that they sting.

Aggression is a defense in which an insect attacks or otherwise takes action to stop an enemy.

The **thorny treehopper** appears to simply be another thorn on a tree or bush.

The **locust borer**, a large, yellow and black long-horned beetle, lives on goldenrod flowers.

4f. **Repulsion** is a type of aggression and is a defense in which an insect tastes or smells bad; when it is eaten it may sicken or kill its attacker.

The harmless **spicebush swallowtail butterfly** looks like the poisonous **pipevine swallowtail butterfly**.

One species of **hover fly** looks so much like the yellowjacket that it has even fooled entomology students.

If a bird eats a **lubber grasshopper**, it becomes sick and will refuse to touch another one in the future.

T.E.A.M. ACTIVITY 4 RECORDING

Camouflage	Mimicry	Aggression/Repulsion

DEFENSE ATTORNEYS

Cockroaches Are Good

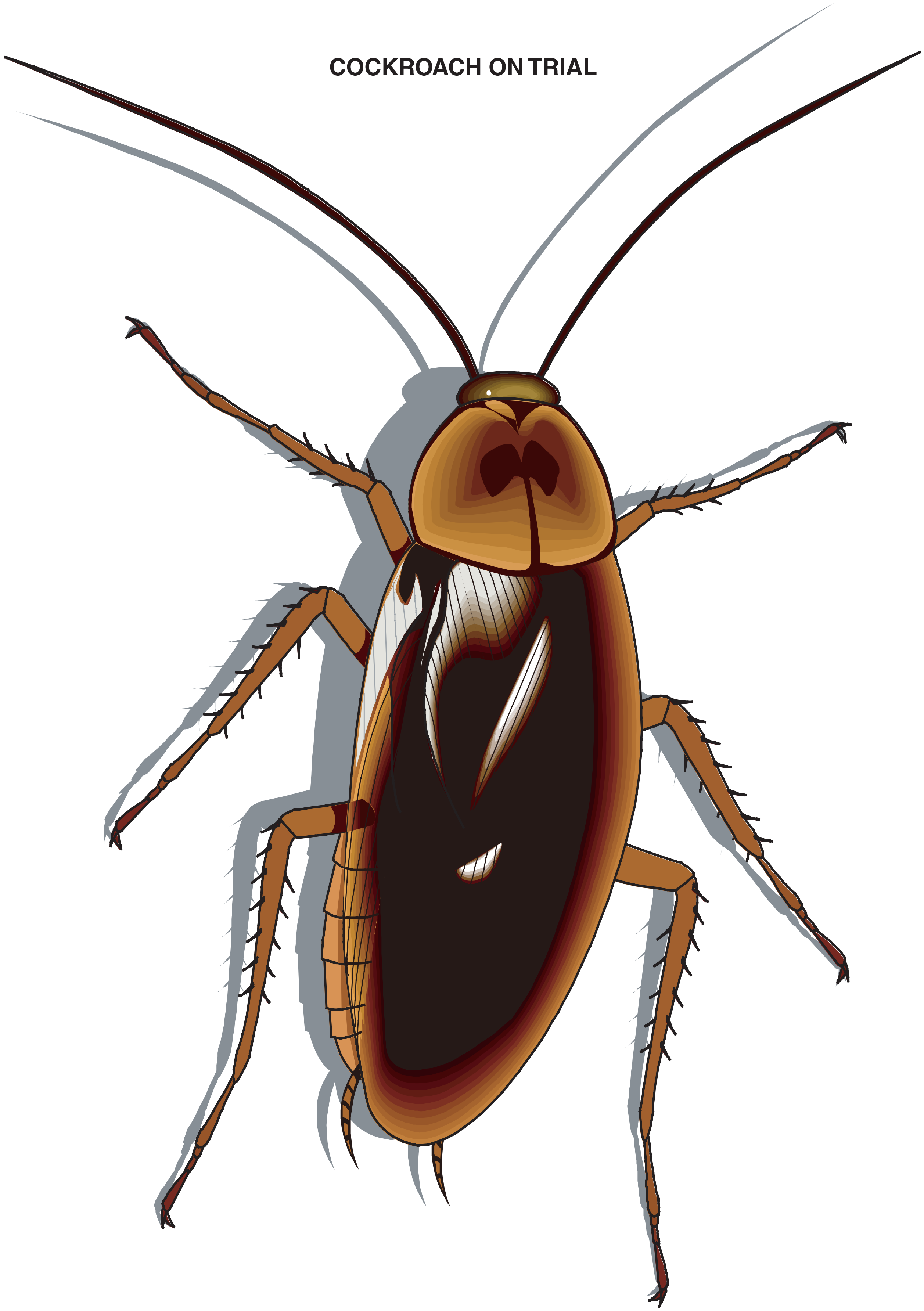
- The world would be overwhelmed with garbage if it weren't for cockroaches.
- These insects are some of nature's best recyclers.
- They help break down discarded food and other biodegradable matter, helping fungi and bacteria do their recycling jobs.
- Humans have enough trouble disposing of their garbage without condemning their six-legged helpers.
- Cockroaches are intelligent, too.
- They can learn to navigate mazes and experts estimate that their IQs are not far below octopuses'.
- They work hard to make their living.
- They keep themselves well-groomed.
- They are the oldest and most successful beings on this planet!

PROSECUTING ATTORNEYS

Cockroaches Are Bad

- Cockroaches get into everything.
- Emergency room workers at one hospital even reported that they removed a cockroach from each of a middle-aged woman's ears! You can bet she doesn't like cockroaches.
- Cockroaches cause other health problems as well.
- They contaminate human food with their germs.
- Their feces cause allergies and asthma in some humans.
- They smell bad.
- Cockroaches cost money. Americans spend millions of dollars every year trying to get rid of them so that people can live and work in germ-free, allergen-free buildings.
- Cockroaches are truly a nuisance and a health threat!

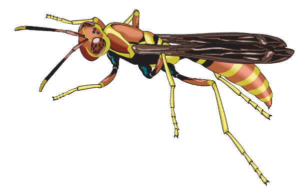
COCKROACH ON TRIAL



INSECT INVESTIGATION 1

Problem: Which type of skeleton best protects an animal from falls?

Background information: An insect's skeleton is on its outside. This hard outer shell is made of chitin (KIE-tun), and it is called an "exoskeleton." In this experiment, you will drop a weight from greater and greater heights onto a model insect (a candy). The greater the height, the harder the hit. Find out how hard an impact the "exoskeleton" can survive. Then devise a way to protect it.



Materials:

- 11 candies (coated and crushable)
- 5 pennies (taped together, but don't pad them with the tape)
- 1 ruler (meter/yardstick)
- Padding materials (cotton balls, facial tissue, paper towels, etc.)
- 1 roll of masking tape

Part A Procedure:

1. Hold the meter stick steady, perpendicular to a table top, with the zero end down.
2. Place the first candy on the desk top immediately in front of the meter stick.
3. Hold the weight so that the bottom of it is (10 cm/4 inches) above the table.
4. Allow it to drop to the table (do not throw it down). Does the candy skeleton crack?
5. If not, repeat steps 1-4, holding the weight (10 cm/4 inches) higher each time.
6. Record the weight-drop height at which the candy "skeleton" cracks in the chart below.
7. Repeat the entire test with nine other candies.

Candy/Trial #	1	2	3	4	5	6	7	8	9	10
Cracked at height										

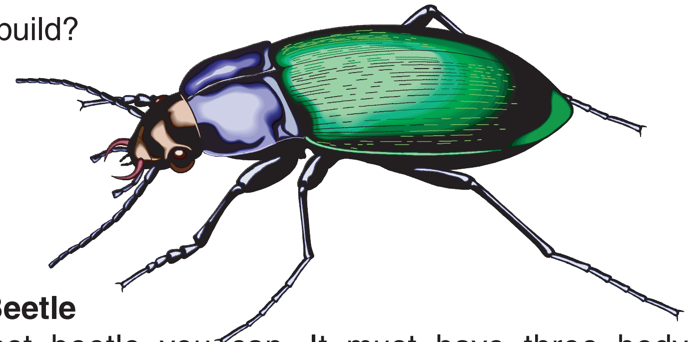
8. Circle the highest weight-drop height at which a candy cracked.
9. Find the average weight-drop height at which the candy exoskeletons cracked. Do this by adding all the heights you recorded in the chart above and dividing the total by 10. Record your answer here: ____

Part B Procedure:

1. Using some padding material and tape, devise some protection for your insect's exoskeleton. The protection you devise must not make the candy "insect" larger than 2.5 cm (1 inch) on any side.
2. Test your new insect's skeleton by dropping the weight from the highest height you circled in Part A step 8. If the exoskeleton cracks, get some more candy and try a new protection plan.

Conclusion: Find out what a padded skeleton is called. Which kind of skeleton is better for protecting an animal from falls? Write any possible clues this activity has given you on your CLUE TRACKING SHEET. Write your personal thoughts in your SCIENCE JOURNAL. Complete a SCIENTIFIC DETECTIVE RECORD FORM and "fax" it to Ms. Porter.

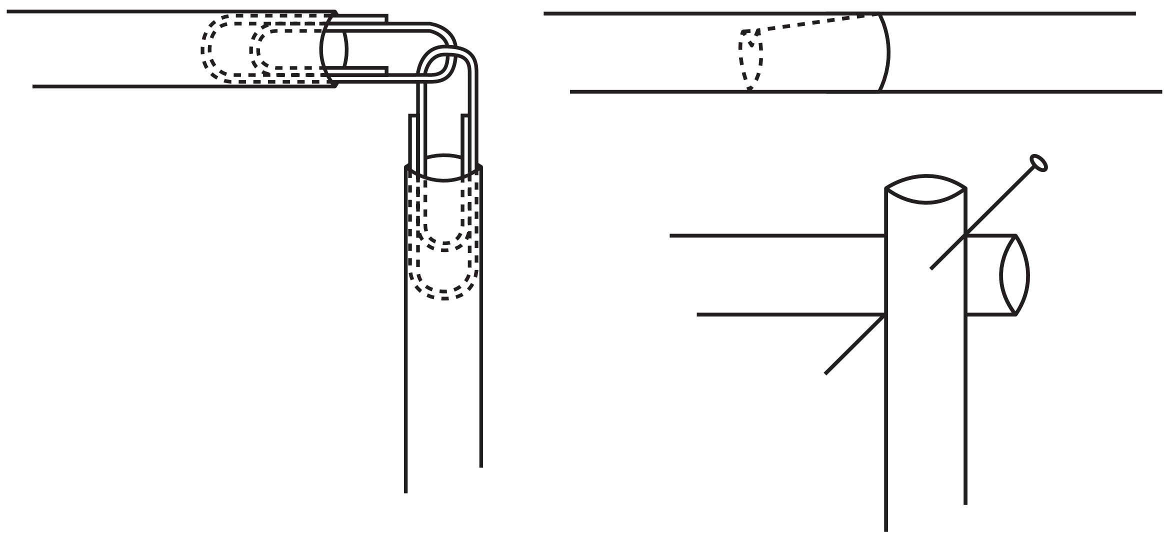
INSECT INVESTIGATION 2



Problem: How large a "beetle" can you build?

Materials:
- 100 straws (plastic drinking type)
- Paper clips (large & small)
- Straight pins
- Washers or other weights

Part A Procedure: **Building a Better Beetle**
1. Using the straws, build the biggest beetle you can. It must have three body sections—head, thorax, and abdomen—and six legs.
2. Put the straws together using one or all of the following methods:
3. Make sure your beetle can stand on its own.



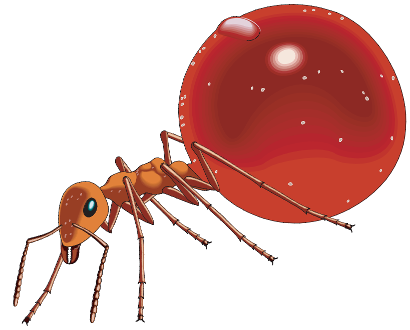
4. Before beginning to build, read Part B below. Make sure your beetle will do well when you start testing its strength by adding weights to it.

Part B Procedure: **Testing Your Beetle**
1. Pull a large paper clip so that it forms an S-shaped hook.
2. Hang the paper clip from a straw in your beetle's thorax.
3. Hang one washer on the paper clip. Can the straw support it? If so, continue hanging washers on the paper clip until the beetle can no longer stand. If necessary, use more paper clips to link on more washers.
4. Try to make your beetle even stronger.
5. Retest your beetle.

Conclusion: What seemed to make your beetle stronger? On your CLUE TRACKING SHEET write any possible clues this activity has given you to help answer the question. Write your personal thoughts in your SCIENCE JOURNAL. Complete a SCIENTIFIC DETECTIVE RECORD FORM to "fax" to Ms. Porter using the information you have learned doing this activity.

INSECT INVESTIGATION 3

Problem: Does an insect's weight affect its leg length?



Materials:
- 1 piece of cardboard (4" x 6" or 10 cm x 15 cm)
- 3 lumps of clay (2-ounces or 57-grams each)
- 30 pennies
- 1 ruler (30-cm or 12-inch)

Part 1 Procedure:
1. Using **one** lump of 2-oz. (57 g) clay, build **six** legs of equal length to support the piece of cardboard. Then spread **10** of the pennies on top of the cardboard. *Make the legs as long as possible.*
2. Record the length of one leg to the nearest millimeter (mm) in the chart below.
3. Take apart your "insect" to prepare for Part 2. Make a new lump of the six legs so that you have a lump of 2-oz. clay again.

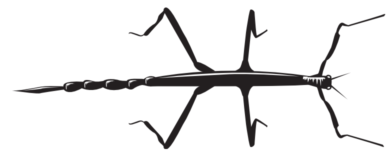
Part 2 Procedure:
1. Using **two** lumps of 2-oz. clay (4 oz. total), build six legs of *equal length* to support the piece of cardboard and spread **20** of the pennies on top of the cardboard (more pennies because this is a larger "insect" whose body weighs more than in Part 1). *Make the legs as long as possible.*
2. Record the length of **one** leg to the nearest millimeter in the chart below.

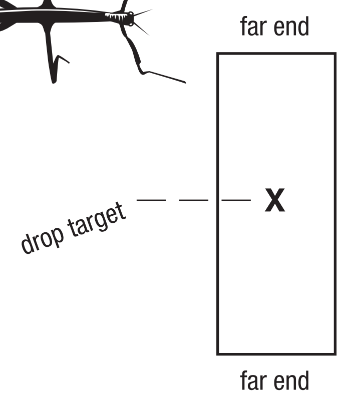
Part 3 Procedure:
1. Using **all** the clay (6 oz. total), build **six** legs of *equal length* to support the piece of cardboard. Then spread **all 30** of the pennies on top of the cardboard. *Make the legs as long as possible.*
2. Record the length of **one** leg to the nearest millimeter in the chart below.

Part	Total weight of clay (oz.)	Length of leg (mm)
1		
2		
3		

Conclusion:
How much does the length of the legs increase compared to the weight of the clay and the "insect"? How might this affect a real insect?
Write any possible clues on your CLUE TRACKING SHEET.
Write your personal thoughts in your SCIENCE JOURNAL.
Complete a SCIENTIFIC DETECTIVE RECORD FORM as a group to "fax" to Ms. Porter.

Problem: Could the heart of a 21-centimeter insect pump hard enough and fast enough to send its hemolymph (blood) to its entire body?





Materials:
- 1 clock with a second hand or stopwatch
- 1 squeeze bottle of food coloring
- 1 meat tray (smooth, flat surface, at least 21-cm long)
- 1 sheet of paper towel (strong kitchen-type, not school-type)
- 3 plates (10-inch, plastic or foam)
- 1 ruler (30-cm or 12-inch)
- 1 pair of scissors
- 1 sponge (wet, but not dripping)

Procedure:
1. Measure "insects" **A**, **B**, **C**, and **D** on the paper towel and carefully cut them out.
2. Put **A**, **B**, and **C** each on a plate and **D** on the meat tray.
3. Read steps 4-8, then predict and record a hypothesis for what will happen to each insect on each plate. Record this hypothesis on the chart for each insect.
4 Use the wet sponge to make the toweling completely damp, but not dripping wet.
5. Stand the ruler next to insect **A** without touching it.
6. Hold the bottle of food color at the indicated height **above the middle** of the insect.
7. Drop the indicated number of drops of food color into the middle of the insect. (The drops represent the amount of blood one heartbeat pushes through the insect. The force from the fall represents the strength of the insect's heart pumping one beat.) Start timing the traveling of the food color as soon as the first drop hits the insect.
8. In the chart, record the number of seconds it takes for any food coloring to reach **one far end** of the insect. *(Do not count splashes.)* This time represents the amount of time one drop of blood takes to reach the edge of the insect—such as one of its feet.
9. Repeat steps 4-8 for insects **B**, **C**, and **D**.

INVESTIGATION CHART 4	Insect A	Insect B	Insect C	Insect D
Size of toweling	1 cm x 3 cm	3 cm x 9 cm	5 cm x 15 cm	7 cm x 21 cm
Height to drop from	3 cm	9 cm	15 cm	21 cm
Number of drops	3	9	15	21
Predicted time (in seconds)				
Actual time (in seconds)				

Conclusion: Write any possible clues this activity has given you on your CLUE TRACKING SHEET. Write your personal thoughts in your SCIENCE JOURNAL. Complete a SCIENTIFIC DETECTIVE RECORD FORM to "fax" to Ms. Porter.

Dear Students,

Here are a few more details to help you start your investigation into this mystery. Insect Island covers an area of about nine square miles. An undamaged coral reef surrounds the island. Coconut palm trees grow along sandy white beaches. The climate is always warm and humid. Most of the island consists of jungle-covered mountains.

Dolphins leaped on either side of the boat's bow as our investigating team headed toward land. Clouds of exceptionally large mosquitoes made our first day of investigating miserable. The investigating team chose to leave the island; they will return as soon as possible with protective gear.

In the meantime, I have found information about an insect's nervous system that should interest you. An insect's individual nerve cells are similar to a mammal's, but insects have far fewer nerve cells for their size than mammals. For example, a large cockroach's nervous system has a few hundred thousand neurons (nerve cells) while a mouse of the same size would have over a billion neurons. The nervous system of a very large insect might not be able to respond fast enough to its environment for the insect to survive.

I am also curious to know how an insect's skeleton affects its chances for survival. My research reveals that a larger animal is more likely to suffer injury from **impact** (falling or being hit) than a smaller animal. How well can the insect skeleton withstand falling or being hit? With this question in mind, I am sending instructions for you to conduct an experiment about skeletal strength. I am looking forward to hearing the results.

K. Porter

K. Porter
Minister of Agriculture, Australia

CLUE FAX 2

Dear Students,

I was pleased to learn the results of **INSECT INVESTIGATION 1.** I can see that you are top-notch scientists.

Did you know that although the exoskeleton is more likely to be damaged from impact than an endoskeleton, the exoskeleton is a very efficient way for a small animal to protect itself? For one thing, it doubles as the insect's skin. Also, an exoskeleton is basically a tube, and a tube is stronger than a solid rod of the same weight. However, as the exoskeleton tube gets larger, the material it is made of must get thicker, or the exoskeleton will collapse on itself. At a certain point, the exoskeleton would become too heavy for the insect to move.

Therefore, for land animals, endoskeletons are more efficient at large sizes. My question is "How large is too large for an exoskeleton?" Does the size matter? Some Hercules beetles are heavier than a mouse. At any rate, I thought it might be helpful for you to build the largest and strongest beetle you possibly can. Therefore, I have sent instructions for building and then conducting an experiment with a model beetle.

Before I close, I want to pass on news from our research team. Although members had to brave heavy rain, they report that the island shows no evidence of insects eating too many leaves. They saw Ridley turtles and a banded sea snake. They have seen no **carnivorous** (meat-eating) birds or mammals. They reported, however, that a dead mouse left out as bait disappeared overnight. Unfortunately, because of the heavy rain, they did not see what or who took it. Could it have been a large beetle?

I am looking forward to your next report.

K. Porter

K. Porter
Minister of Agriculture, Australia

Dear Students,

Exciting news from Insect Island! Our investigating team has discovered a species of large walkingsticks. While in the United States walkingsticks may grow to be as large as 15-17 cm (6-7 inches) long, these walkingsticks are about 30 cm (12 inches) long! They seem to be related to *Aplopus mayeri*. Our team would like you to give this insect a Latin-sounding name, remembering that *Aplopus* is its genus. Insect Island certainly seems to have the climate and food supply to support at least one large insect.

Keep in mind that all walkingsticks are very slender, about the thickness of a pencil at the most. A slender rod has very little **surface area** (the area of its surface if you laid it all out) compared to a rounder object such as a beetle. And the more surface area, the larger the inside area (the volume). The larger the volume, the more the inside of the insect will weigh. In other words, a 21-cm beetle may be too heavy to support its weight. But maybe not. Remember, chitin is a very strong, yet very light, material.

I do see one more potential problem, though: a 21-cm beetle's legs would have to be quite thick to support its weight. Yet if its legs were too thick, maybe it couldn't move.

I am sending **INSECT INVESTIGATION 3** to help you see the relationship between size, strength, and weight.

K. Porter

K. Porter
Minister of Agriculture, Australia

Dear Students,

Thank you for your fax regarding the clay legs experiment. As you can see, the weight of the legs increases faster than the length. Note that this situation is true for all creatures. And although insects are, of course, not made of clay, their body weights increase at a faster rate than their leg and body lengths.

Unfortunately, our research team members on Insect Island encountered high winds, which prevented them from collecting as much data as we all would have liked. Still, they did see a sea eagle soaring overhead and saltwater crocodiles. And, perhaps more importantly, they found a bag of trash that had a Brazilian newspaper in it.

I also thought it might help you to know how insect blood circulation works. Humans have one circulatory system that circulates blood and exchanges air for fresh oxygen (called “respiration”). Insects have totally separate systems for circulating blood and exchanging air for fresh oxygen.

Humans have a **closed circulatory system**, in which the blood travels in an orderly circuit through **blood vessels** from the heart, through the body, and back again, carrying both food and oxygen to the body. Insects have an **open circulatory system**. Insect blood, called **hemolymph**, travels from the heart forward to the head and returns to the heart by seeping back through the open spaces between the other internal organs. Extra pumping organs and the movements of the insect’s other organs also help push the blood back to the heart. The blood carries food to the body, but insects breathe through openings in their exoskeletons.

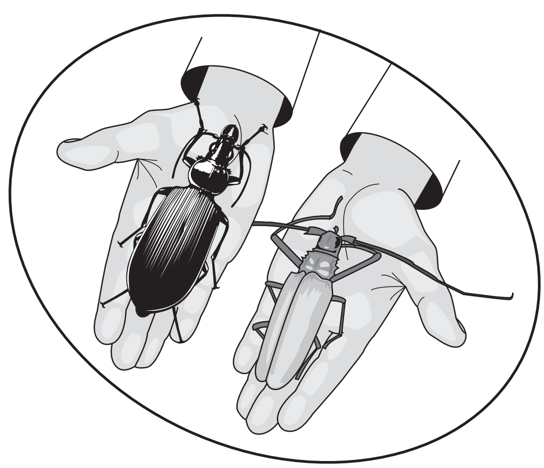
Finally, the human heart is much stronger for the body size it has to serve than the insect heart. The insect heart, called the **dorsal blood vessel**, is a simple, muscled tube. The flow of hemolymph it creates is far from impressive. It is definitely designed for a smaller creature. The question is “How small?”

I am enclosing instructions for making a model insect heart. This experiment may provide more clues to help you solve the mystery. Good luck!

K. Porter

K. Porter
Minister of Agriculture, Australia

P.S. Oh yes! I almost forgot to mention that I found a photograph of a person holding two huge beetles! They are *Titanus giganteus* and *Callipogon armillatus*. They are as long as the man’s hands! He had collected these specimens in French Guiana. See for yourself!



CLUE FAX 5

Dear Students,

News from the front! Our investigating team members tried leaving lights on all night to attract insects to their campsite. They had many visitors, but the largest beetle was only a 2-cm (about 3/4-inch) specimen. So if the 21-cm beetles exist on Insect Island, they lead a very secretive life.

Thank you for faxing me the results of the circulation experiment. These results give us more key information to consider.

In addition, I am reading a book about island life. It says that insects and other animals tend to arrive on islands (on the wind, floating logs, etc.), but they rarely leave. The more restless individuals leave or die trying, however. This pattern leaves the "lazy" individuals to breed, leading to an even lazier population. Over time, these insects may lose their ability to fly. They don't need to fly; nor do they want to fly.

In general, most islands have fewer species and fewer relationships among species than we find on mainlands. This situation makes the species more vulnerable to extinction. For example, if the food source for one species of beetle dies out, the beetle species may not have other food choices. That species could also then die out. Perhaps a large insect may have trouble finding enough food in a limited ecosystem such as that found on an island. Still, the climate is right for large insects to thrive, and the investigating team has certainly found evidence of other large species.

I know this is considerable information to think about, but I must have your answer today to this question: "**Is it possible that 21-cm beetles exist?**" I must report your answer immediately to my superiors. Many thanks for all your hard work.

K. Porter

K. Porter
Minister of Agriculture, Australia

CLUE TRACKING # ________________

Maybe a clue	Date	Definitely a clue	Date

NOTES

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STUDENT GUIDE

Student Name: ____________________

INSECT ISLAND

Phase 1

CLASSIFYING AND IDENTIFYING INSECTS

With so much diversity in this world, we must give each animal a distinct name so that as scientists we know exactly what another scientist is talking about. This classifying process is called **taxonomy**.

- All living things fit into one of five **kingdoms**: protists, bacteria, plants, fungi, and animals.
- The animal kingdom is divided into 36 **phyla** (**a phylum**).
- Each phylum has **classes**.
- Each class is made up of **orders**.
- Each order is made up of a number of **families**.
- Families are made up of close relatives called **genera** (**a genus**).
- Finally, each genus is made up of unique types of animals called **species**.

How to Classify an Insect * Classifying an insect is much like finding someone's address by knowing her or his name. However, with an insect you have to find the address before you find the name. Let's look at an example. On your own paper copy the information below. In the blanks, fill in information about yourself.

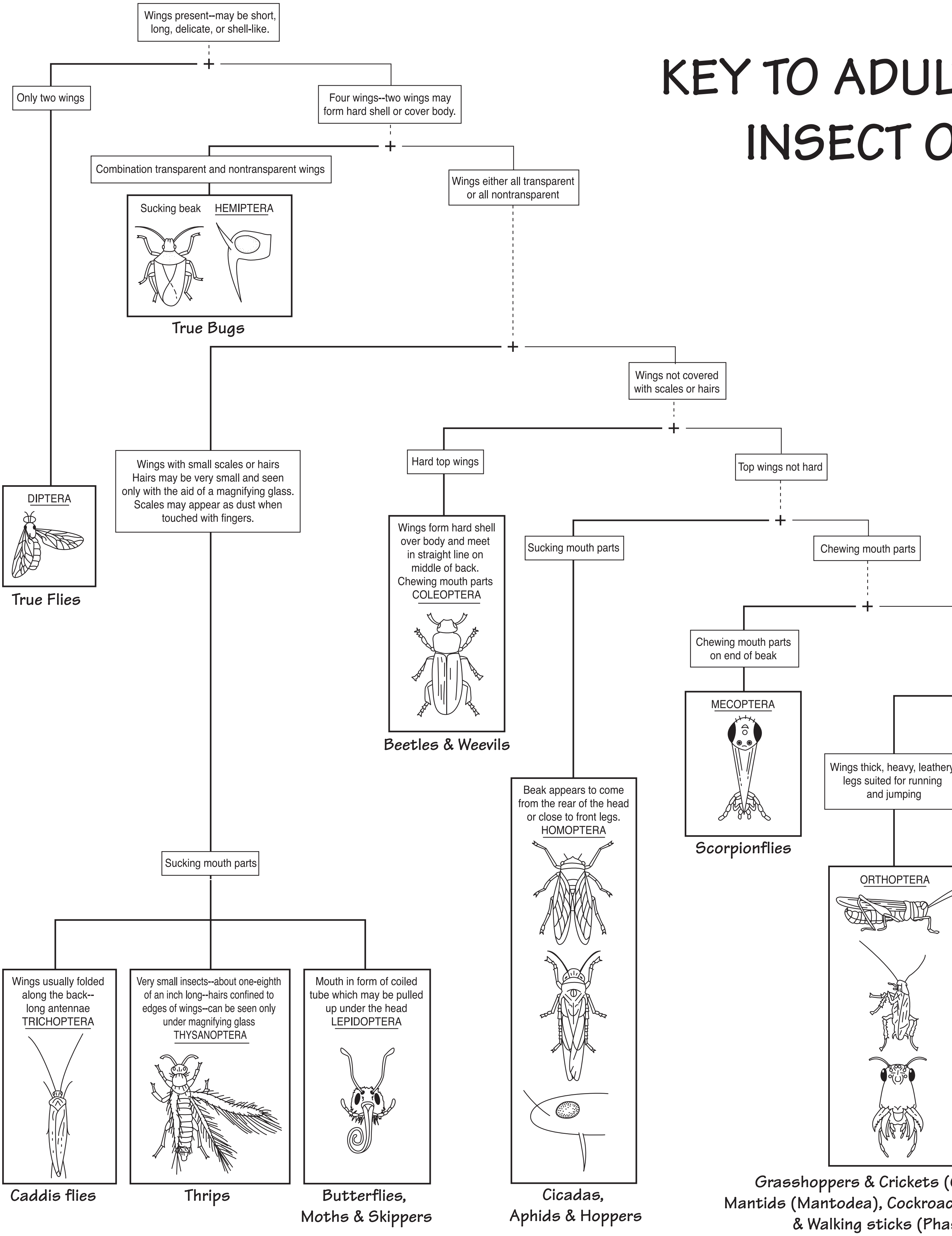
Postal Classification		Insect Classification	
Country	____________	Kingdom	Animalia
State	____________	Phylum	Arthropoda
City	____________	Class	Insecta
Street name	____________	Order	Lepidoptera
Street number	____________	Family	Papilionidae
Last name	____________	Genus	*Graphium*
First name	____________	Species	*G. marcellus* **

Within the class **Insecta** to which the *G. marcellus* (the zebra swallowtail butterfly) belongs, there are 26 orders. In this simulation, you will be asked to identify many insects' order, family, genus, and species, using the KEY TO ADULT WINGED INSECT ORDERS (on the next two pages) with the MINI-FIELD GUIDES (teacher's handouts), using both the common and Latin names.

NOTE: * *Thank you to Gary Dunn of the Young Entomologists' Society for this idea.*

** *Scientists usually include the first initial of the genus when giving the species' name. In this case, the G from Graphium is used.*

KEY TO ADUL
INSECT O



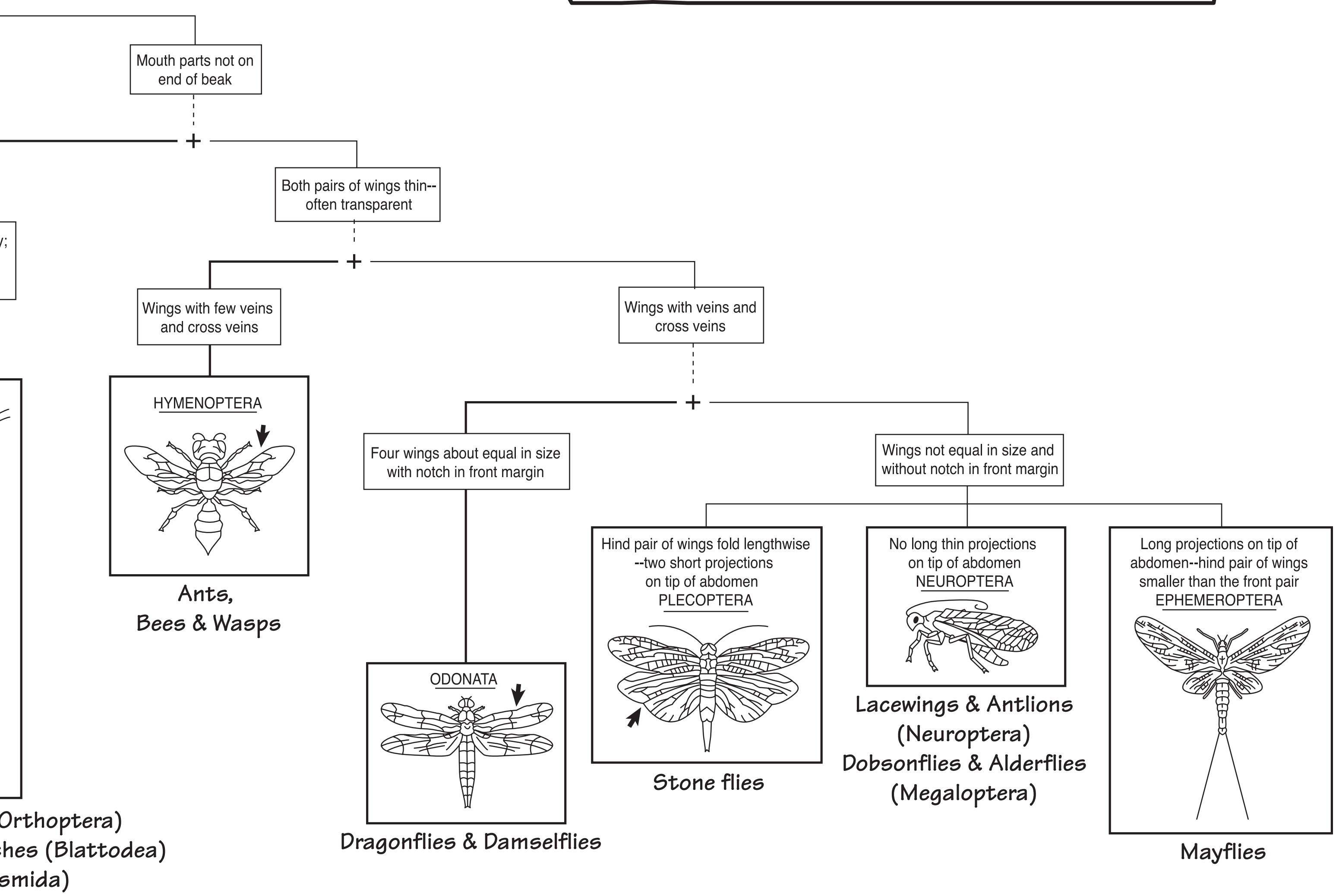
LT WINGED
ORDERS

HOW TO USE THIS IDENTIFICATION KEY

With this key you can identify adult insects of common winged orders. Use other keys to identify wingless or immature insects.

The appearance of insects wings varies greatly. They can be delicate membranes, thick and leathery, or hardened, shell-like structures.

Using this key like a road map to identify an insect, start at the top and follow the broken line to the first “crossroad” (+). At the crossroad, you must choose to go one of two or three ways. Always try the heavy line (“road”) first as it is the most likely possibility. If the description at the end of this “road” fits your specimen and you see an order name, you have identified the order of your specimen. If the description does not fit your specimen, then go back to the crossroad (+) and take another road. Repeat this process until you identify the order of your specimen. (Adapted from “A Key to Adult Insects, Part 1: Specimens With Wings” by Gary Dunn, Young Entomologists Society, Inc. 1915 Peggy Place, Lansing, MI 48910-2553 Telephone 517

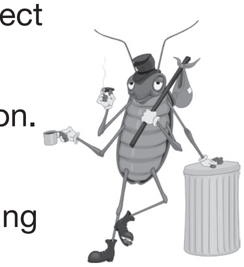


Phase 3

CHALLENGE PROJECTS

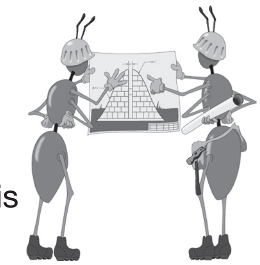
1. Explore and report on how insects are controlled and used in organic gardening. Include a description of the danger insecticides pose to the environment.
2. Research, write, and illustrate a book for younger students showing and explaining the differences between insects and spiders.

3. Investigate ancient insects. Make a clay model of one and display it with a brief summary of its characteristics and known habits.
4. Draw pictures of at least five different insects in their natural environments, showing how they use camouflage to protect themselves. Label your pictures with both the correct Latin and common names of these insects.



5. Design another experiment related to this simulation. Test it with some friends.

6. With a few friends, write and act out a play depicting the life cycle of a particular insect.
7. Listen to music intended to depict the behavior of insects, such as Rimsky-Korsakov's "Flight of the Bumblebee". Explain in writing how you think the music does and does not accomplish its goal. **Or** choose other music that reminds you of a particular insect. Play it for your class and explain how and why it makes you think of that insect.



8. Design a game that reviews the information you learned in this simulation.
9. Write a fictional diary from the point of view of a particular insect. Describe what a day in your life is like.

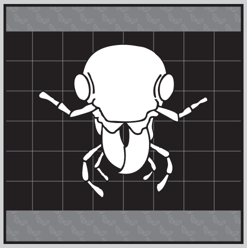
10. Make a wanted poster for an insect that causes harm (from a human point of view).

11. Make three detailed drawings of what you imagine Insect Island looks like. Draw one picture of what it looks like from an airplane and two pictures of up close scenes.

12. After receiving your teacher's approval, develop any project related to this topic that interests you.

DUE DATE: ______________________________

Student Name: ______________________



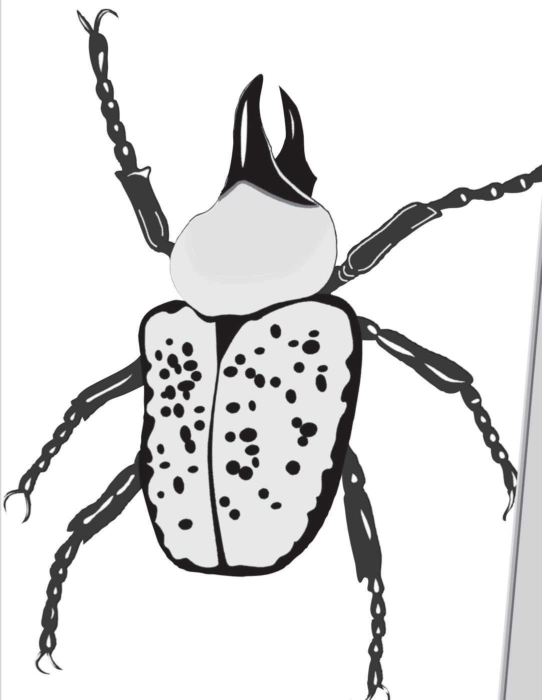
INSECT ISLAND

Phase 2

STUDENT GUIDE

INTRODUCTION

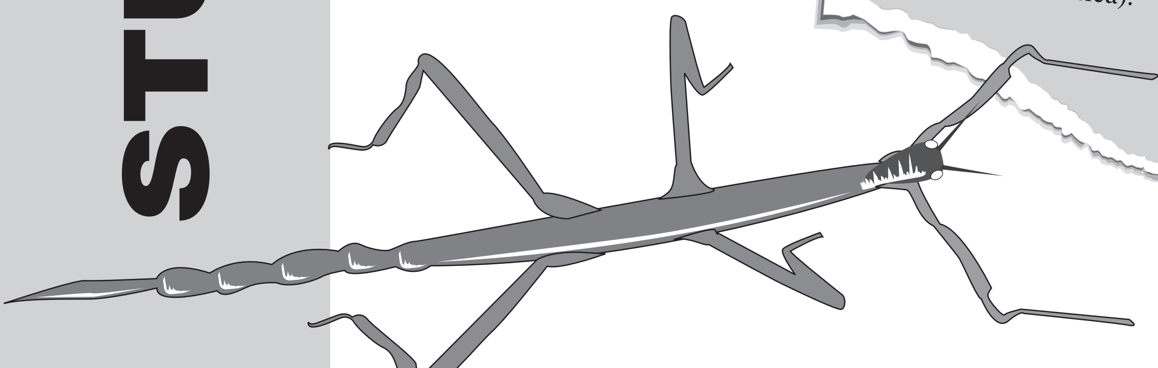
The following newspaper articles are written from information gathered across the country and around the world. Read them carefully. Take note of their common theme—Insects are limited in their size by their body structure. Then consider the following question: **How much does body structure limit insect size?** When you have read the three articles, read the letter from Ms. Porter on page 3. As you will see, in this simulation, you each will become a "science detective" and work with an investigative team to solve the mystery of Insect Island.



Goliath beetle: Incredible insect

PRETORIA (South Africa)—The Goliath beetles of Africa shake their antennae at those who worry that an insect cannot be very large. And although they are not large enough to play soccer with a human or drive a car, they are very imposing. One species, *Goliath regalis*, is about the size of a child's fist and may weigh as much as 4 ounces (112 grams), according to Gary Dunn of the Young Entomologists' Society (East Lansing, Michigan).

Scientists have also documented walkingsticks at up to 12 inches (300 mm) long, according to Brian Fitzek of the Entomological Society of America (Lanham, Maryland). But big bugs are usually found in tropical regions where warm, constant temperatures and high humidity mean that insects do not have to waste energy staying warm and moist. Instead, some use the saved energy to grow longer and heavier, according to Chuck Bellamy of the Transvaal Museum (Pretoria, South Africa).

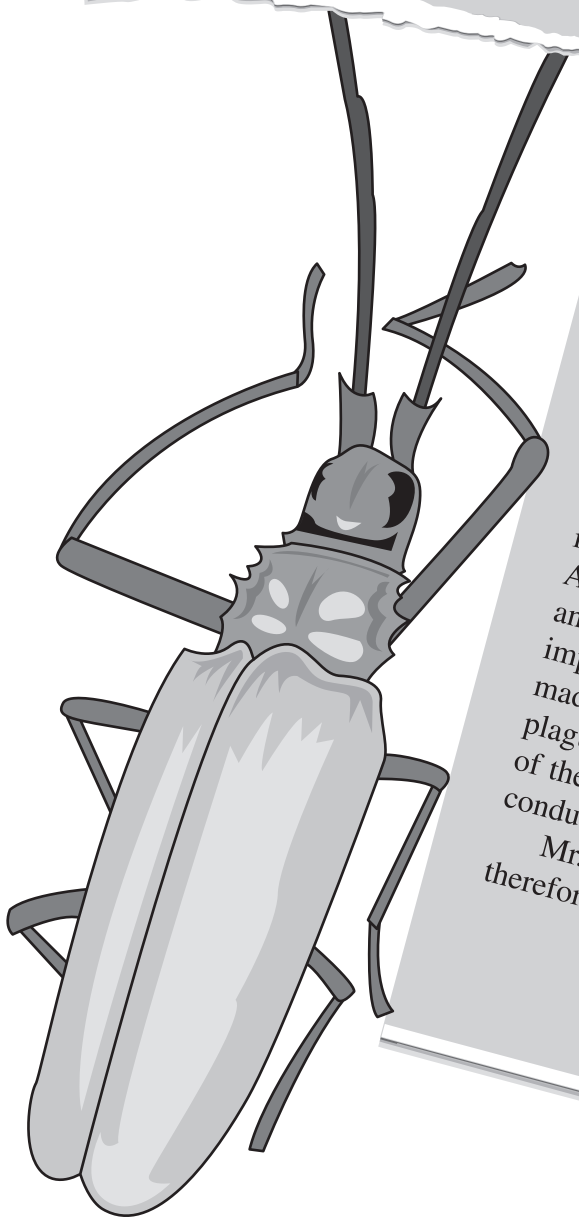


interact
Learn Through Experience

Insect size limited by body structure

URBANA (Illinois)—"Six-foot ants walking on their hind legs and beetles the size of compact cars devouring whole trees are the stuff of horror movies, not the real world," says Mavis Bernbeam of the University of Illinois. Why? Body structure. An insect's outer shell, called an exoskeleton, is made of a tough material called chitin (KIE-tin). Chitin is perfectly suited to a small animal, but a larger animal would require an exoskeleton that would be too thick and heavy for it to move. In addition, other insect body systems, such as respiration and circulation are best suited to a smaller creature.

There are some insects that surprise us by how unusually large they are, however, like the New Zealand wetapunga, a beetle that can grow to over 8.5 cm long and weigh over 100 grams. In general, however, the exoskeleton limits growth, and horror-movie-sized insects are just that—only possible through the magic of Hollywood.



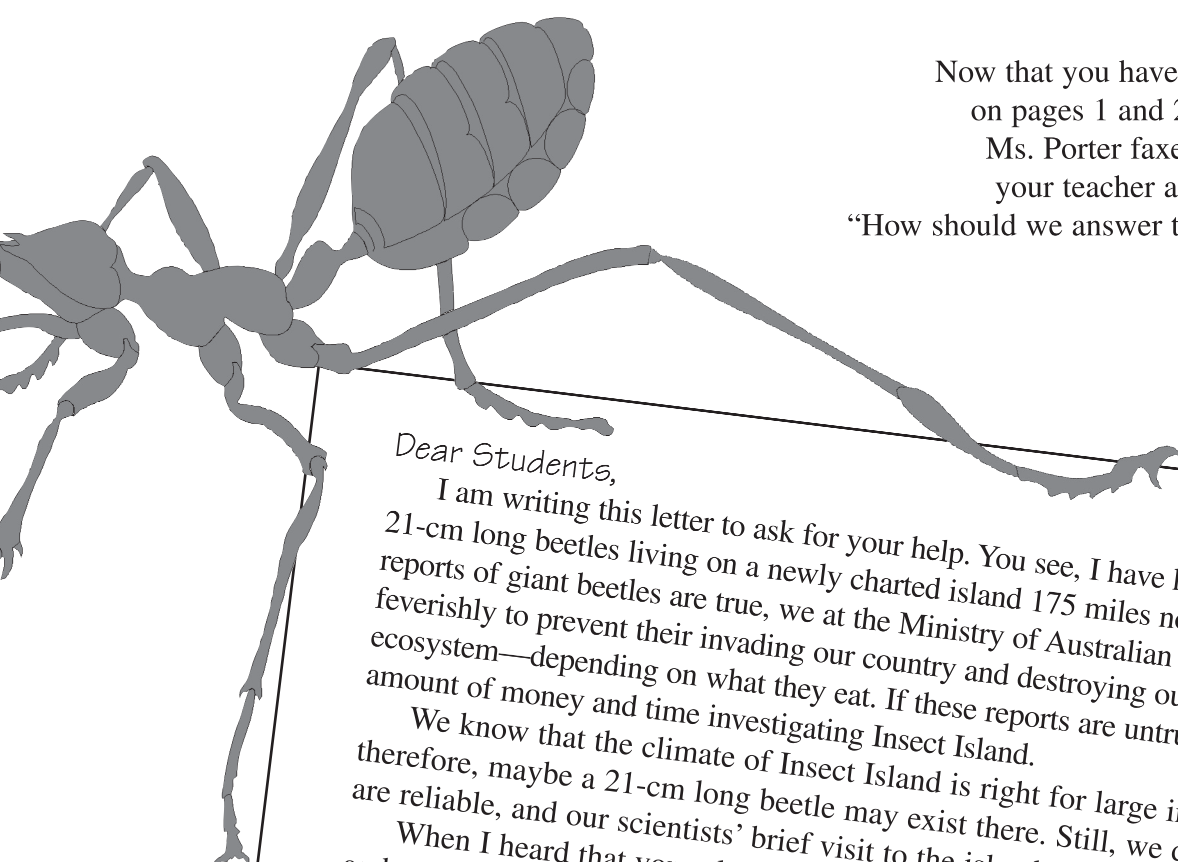
Wealthy Investor Plans Island Reso

Concerns raised over big bugs

CANBERRA (Australia)—One of the world's wealthiest men,
Vanderpelt usually gets what he wants. And what he wants these days
Island, a newly discovered island 175 miles northwest of the city of
Vanderpelt has offered the Australian government 100 million U.S. do
purchase the perfect paradise. He has already commissioned an architect to
a resort hideaway for the rich and famous.

But Kylie Porter, Minister of Agriculture, released a statement yeste
condemning the project. She claims that the crew of the South American merch
ship who discovered the island reported seeing 21-cm long beetles in its jung
Such insects, Ms. Porter insisted, are possible in the warm and humid climate
Insect Island and "could be attracted to lights on ships bringing visitors to th
island. If these insects came aboard at night uninvited and unnoticed, mainlan
Australian agriculture could suffer from an onslaught of unwelcome, but huge
and hungry stowaways." She went on to say, "We must study the ecological
implications of Mr. Vanderpelt's proposal before any responsible decision can be
made. We must not rush to grab money that will eventually be spent fighting a
plague of crop-hungry insects. Furthermore, we must ensure that the ecosystem
of the island is preserved." She is sending a team of scientists to Insect Island to
conduct a thorough investigation and is also consulting with outside scientists.

Mr. Vanderpelt insisted that such large beetles would be too heavy to walk and
therefore impossible. He said, "My generous offer stands!"



Now that you have read the newspaper articles on pages 1 and 2, please read this letter that Ms. Porter faxed to you when she heard of your teacher and class. Then ask yourself, “How should we answer this letter from Ms. Porter?”

Dear Students,

I am writing this letter to ask for your help. You see, I have heard reports regarding 21-cm long beetles living on a newly charted island 175 miles northwest of Darwin. If the reports of giant beetles are true, we at the Ministry of Australian Agriculture must work feverishly to prevent their invading our country and destroying our crops, our cattle and our ecosystem—depending on what they eat. If these reports are untrue, we may waste a great amount of money and time investigating Insect Island.

We know that the climate of Insect Island is right for large insects to thrive; therefore, maybe a 21-cm long beetle may exist there. Still, we don’t know if the reports are reliable, and our scientists’ brief visit to the island revealed nothing.

When I heard that your class is especially good at conducting scientific investigations and solving scientific mysteries, I had to write you and plead for your help.

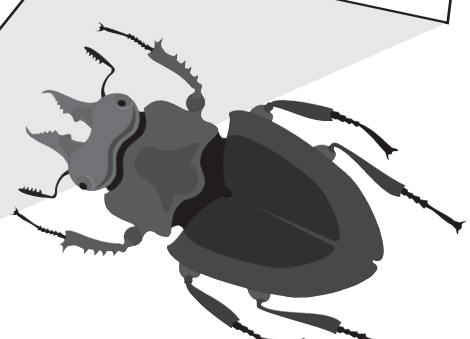
Please advise me as to whether or not the Ministry of Agriculture should spend more money investigating these reports by answering this question as soon as possible: **“Are 21-cm beetles possible?”** Keep in mind that I am under great pressure to allow the government to accept John J. Vanderpelt’s $100 million offer for the purchase of Insect Island. I need to have this problem solved quickly or it’s insecticide for my career! Therefore, if you can’t help me soon, I will have to bring in some entomologists from the University.

Please let me know as soon as possible if you will be able to help me.

Sincerely,

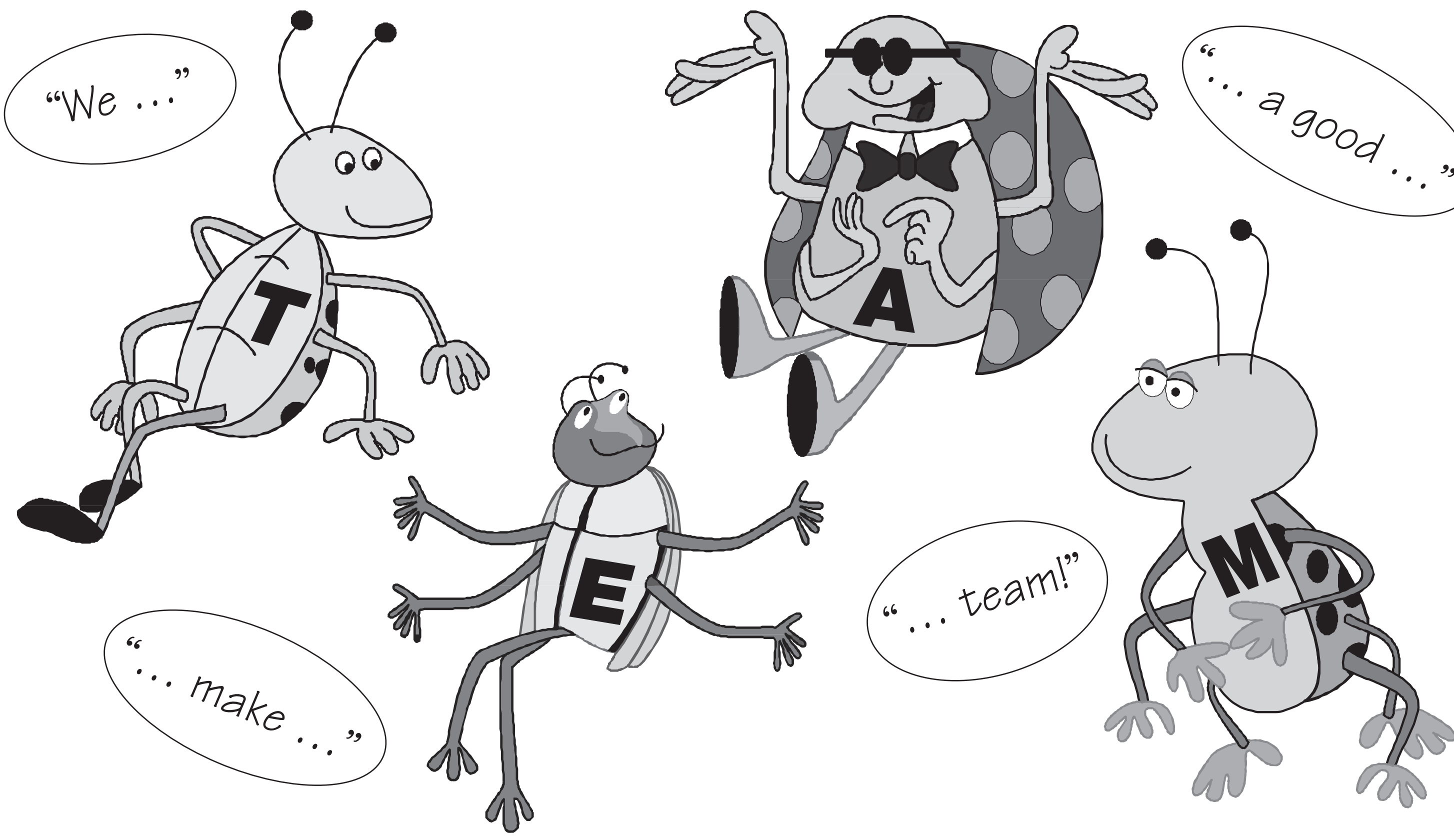
K. Porter

K. Porter
Minister of Agriculture, Australia



WHAT ARE T.E.A.M. ACTIVITIES?

For the next few days, you will be doing T.E.A.M. ACTIVITIES with your group members. T.E.A.M. stands for **T**ogether **E**veryone **A**ccomplishes **M**ore. Each T.E.A.M. ACTIVITY will not only give you important information about the Insect Island that you will need to solve the mystery; it will also give you the opportunity to work together with other group members to solve a problem. As you do each activity, you will discover two things: that everyone in the group has something to offer, and that many brains working together help tremendously when you are trying to solve a problem.



HOW DO YOU DO T.E.A.M. ACTIVITIES?

1. Your team's goal is to solve the problem presented to your group.
2. Each group member will receive some special information that no one else in your team has.
3. Each group member will need all the information (clues) to solve the problem.
4. Each group member will share information only one way—*orally*.
5. No one may take or look at another group member's clues.
6. Each group member will participate! (Of course, clues may be repeated orally, if needed.)
7. Once all members have individually shared their clues, each group member should continue to contribute in solving the activity.
8. Each group member will take a turn to talk and give ideas or opinions.
9. And what is the most important skill all group members must practice? *Listening!* It is very important that everyone listen carefully while other members of the group are talking since we can all learn from one another.

Good luck on your T.E.A.M. ACTIVITIES! You will enjoy uncovering the information each day and then using it to solve the Insect Island mystery.

