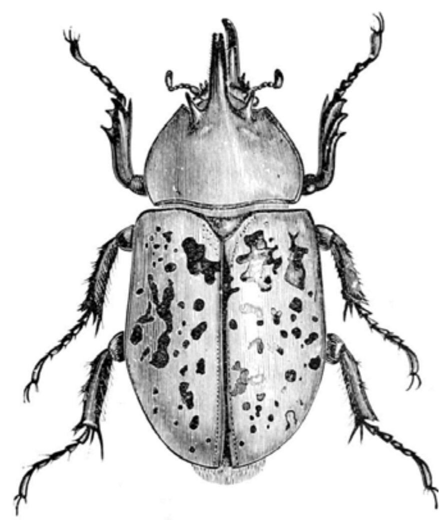
Lab 14. Variation in Traits: How Do Beetle Traits Vary Within and Across Species?

Introduction

Organisms differ from one another in several ways. When those differences are so great that organisms are unable to mate and produce fertile offspring, they are said to be of different *species*. Differences between species, or so-called *interspecies differences*, can be great or small. Some differences can be easily seen, such as different shapes of arms or legs. Others are not easy to observe, such as differences in the kinds of genes each species has. Differences also exist within a species; in other words, not all members of the same species are the same—for example, not all gray whales are the same. Indeed, just look around you. All of the students in this class look very different even though they are all members of the same species. Some of these differences are unique to individual organisms or a group of organisms, especially in some physical traits, like special markings. Other differences, like ones in types of genes or behaviors, are more common among a particular species but make them distinct from other species. Some differences among species help certain forms survive better in certain environments than others.

FIGURE L14.1

Eastern Hercules beetle



These differences and similarities, both within and across species, are known as *variation*. To understand the variation present in living things, scientists developed a system of classification—that is, grouping organisms together based on their differences and similarities. This system begins with a few large groups of organisms that share a few similar traits on the first level. The next level of classification splits those large groups into smaller groups using differences and similarities among the organisms in them. This second set of groups is then split up even further based on the variation among the organisms. Current classification systems use eight major levels to classify all the living things. Some of these levels also have sublevels, which further improves classification. *Taxonomy* is the branch of science that deals with classifying organisms.

Take the beetle as an example of this classification system. The name Beetle is given to an order of insects that all have elytra. The elytra are a hardened, sheathlike set of front wings, which usually cover the entire abdomen when the insect is not in flight. Beetles vary greatly in size. The largest is the Eastern Hercules beetle (*Dynastes tityus*), which grows to 16 cm (up to 6.3 inches) in length (Figure L14.1). Other species may be less than 0.1 cm (less than 0.04 inch) long.

FIGURE L14.2

European violet ground beetle

The Beetle order is split into a number of smaller groups, which involve more similarities in shape between the group members. These smaller groups follow a strict hierarchy. The major levels and sublevels smaller than order are called suborder, family, subfamily, and genus. A genus is the smallest group of importance in the naming of individual species, although in some classifications generic groups may be further split into subgenera. The scientific name of a species includes, first, its genus and, second, its specific name. For example, the European violet ground beetle (Figure L14.2) is called *Carabus violaceus*, meaning the species *violaceus* in the genus *Carabus*.

(Genus and species names are always printed in italics. The genus name is capitalized, and the species name is lowercase [starts with a small letter].) The full classification of this insect is shown in Table L14.1.

TABLE L14.1

Classification of the European violet ground beetle

Classification level	Name	Description
Phylum	Arthropoda	Arthropod
Class	Insecta	Insect
Subclass	Pterygota	Winged insect
Order	Coleoptera	Beetle
Suborder	Adephaga	Carnivorous beetle
Family	Carabidae	Ground beetle
Genus	*Carabus*	*
Species	*violaceus*	Violet ground beetle

The Beetle order embraces more species than any other group in the animal kingdom. At least 250,000 species are known. This represents more than one-quarter of all animal species and is far more than all mammal species combined. With all these different species, a lot of variation exists among beetles.

Your Task

Examine the amount and nature of the variation that exists within and across the three different species of beetle shown in the Lab Reference Sheet: The three species you can examine in the information sheets are the ground beetle (*Harpalus affinis*), the figeater beetle (*Cotinis mutabilis*), and the potato beetle (*Leptinotarsa decemlineata*).

The guiding question of this investigation is, **How do beetle traits vary within and across species?**

Materials

You may use any of the following materials during your investigation:

- Lab 14 Reference Sheet with beetle information, or preserved samples of beetles
- Insect information websites such as *www.bugguide.net* and *http://species.wikimedia.org*

Safety Precautions

Follow all normal lab safety rules.

Investigation Proposal Required? ☐ Yes ☐ No

Getting Started

To answer the guiding question, you will need to observe variations between different examples of beetles within each species and across the species provided. To accomplish this task, you must first determine what type of data you need to collect, how you will collect it, and how you will analyze it. To determine *what type of data you will need to collect*, think about the following questions:

- What type of data can you collect from the Lab Reference Sheet?
- What information about the beetles are available from internet sources?
- What type of measurements or observations will you need to record during your investigation?

To determine *how you will collect your data*, think about the following questions:

- What will serve as a control (or comparison) condition?
- How will you make sure that your data are of high quality (i.e., how will you reduce error)?
- How will you keep track of the data you collect and how will you organize the data?

To determine *how you will analyze your data*, think about the following questions:

- What type of calculations will you need to make?
- What type of graph could you create to help make sense of your data?

Connections to Crosscutting Concepts, the Nature of Science, and the Nature of Scientific Inquiry

As you work through your investigation, be sure to think about

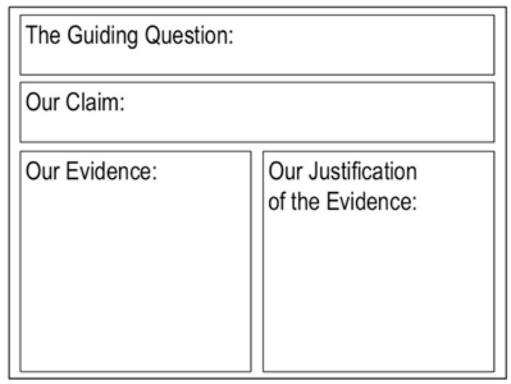
- the importance of looking for patterns in science,
- how organisms' structures are related to the functions they perform,
- the different roles observations and inferences play in science, and
- how scientific knowledge changes over time.

Initial Argument

Once your group has finished collecting and analyzing your data, you will need to develop an initial argument. Your argument must include a claim, evidence to support your claim, and a justification of the evidence. The claim is your group's answer to the guiding question. The evidence is an analysis and interpretation of your data. Finally, the justification of the evidence is why your group thinks the evidence matters. The justification of the evidence is important because scientists can use different kinds of evidence to support their claims. Your group will create your initial argument on a whiteboard. Your whiteboard should include all the information shown in Figure L14.3.

FIGURE L14.3

Argument presentation on a whiteboard



Argumentation Session

The argumentation session allows all of the groups to share their arguments. One member of each group will stay at the lab station to share that group's argument, while the other members of the group go to the other lab stations one at a time to listen to and critique the arguments developed by their classmates. This is similar to how scientists present their arguments to other scientists at conferences. If you are responsible for critiquing your classmates' arguments, your goal is to look for mistakes so these mistakes can be fixed and they can make their argument better. The argumentation session is also a good time to think about ways you can make your initial argument better. Scientists must share and critique arguments like this to develop new ideas.

To critique an argument, you might need more information than what is included on the whiteboard. You will therefore need to ask the presenter lots of questions. Here are some good questions to ask:

- What did your group do to collect the data? Why do you think that way is the best way to do it?
- What did your group do to analyze the data? Why did your group decide to analyze it that way?
- What other ways of analyzing and interpreting the data did your group talk about?
- Why did your group decide to present your evidence in that way?
- What other claims did your group discuss before you decided on that one? Why did your group abandon those other ideas?
- How sure are you that your group's claim is accurate? What could you do to be more certain?

Once the argumentation session is complete, you will have a chance to meet with your group and revise your original argument. Your group might need to gather more data or design a way to test one or more alternative claims as part of this process. Remember, your goal at this stage of the investigation is to develop the most valid or acceptable answer to the research question!

Report

Once you have completed your research, you will need to prepare an investigation report that consists of three sections that provide answers to the following questions:

1. What question were you trying to answer and why?

2. What did you do during your investigation and why did you conduct your investigation in this way?
3. What is your argument?

Your report should answer these questions in two pages or less. The report must be typed and any diagrams, figures, or tables should be embedded into the document. Be sure to write in a persuasive style; you are trying to convince others that your claim is acceptable or valid!