

FACT PATTERNS: A FILM GUIDE

OVERVIEW

This activity supports the HHMI short film *The Origin of Species: The Making of a Theory*. Students are challenged to identify “fact patterns,” or patterns that emerge from a collection of different facts and observations. As students watch the film, they check off observations made by Charles Darwin and/or Alfred Russel Wallace. They then compare the patterns of facts and observations made by the two naturalists and answer questions about what these patterns suggest.

KEY CONCEPTS AND LEARNING OBJECTIVES

- A. Darwin and Wallace *independently* discovered the natural origin of species and formulated the theory of evolution by natural selection based on distinct sets of observations and facts.
- B. The natural origin and evolution of species explain the diversity of life, the distribution of species, and the sequence of change found in the fossil record.
- C. Natural selection acts on variation among individuals within populations. The differential survival and reproductive success of individuals with certain traits can cause populations to change from one generation to the next.
- D. Not all hypotheses can be tested in controlled laboratory experiments. The study of evolution often involves gathering multiple lines of evidence to understand events that occurred in the past.
- E. A scientific theory is a well-substantiated explanation for a set of observations. Theories are supported, modified, or replaced as new evidence appears.

Students will be able to:

- evaluate claims based on information and evidence presented in the film; and
- participate in a collaborative discussion of their interpretation of the evidence.

CURRICULUM CONNECTIONS

| Curriculum | Curriculum Topics |
|------------------------|--|
| AP (2012-13 Standards) | 1.A.1, 1.A.2, 1.A.4 |
| IB (2009 Standards) | 5.4, D2 |
| NGSS | MS-LS2-2, MS-LS2-4, MS-LS4-1, MS-LS4-2, MS-ESS2-3, HS-LS4-1, HS-LS4-5, MS-LS2.A, MS-LS2.C, MS-LS4.A, MS-LS4.B, MS-LS4.C, HS-LS4.B, HS-LS4.C |
| Common Core | CCSS.ELA-Literacy.SL.8.1, CCSS.ELA-Literacy.L.8.6, CCSS.ELA-Literacy.RST.6-8.4, CCSS.ELA-Literacy.RST.9-10.4, CCSS.ELA-Literacy.RST.9-10.2, CCSS.ELA-Literacy.SL.9-10.1, CCSS.ELA-Literacy.L.9-10.6, CCSS.ELA-Literacy.L.9-10.2, CCSS.ELA-Literacy.RST.11-12.4, CCSS.ELA-Literacy.SL.11-12.1, CCSS.ELA-Literacy.L.11-12.4, CCSS.ELA-Literacy.L.11-12.6 |

KEY TERMS

adaptation, archipelago, common ancestry, competition, descent with modification, evolution, extinction, fossil, natural selection, populations, reproductive success, species, variation

TIME REQUIREMENT

This activity was designed to be completed during one 50-minute class period, including watching the film. The activity may take longer depending on the amount of class discussion.

SUGGESTED AUDIENCE

This activity is appropriate for middle school life science and all levels of high school biology.

PRIOR KNOWLEDGE

It might be helpful for students to be familiar with the mechanisms of evolution, including natural selection.

MATERIALS

Students will need the student worksheet and access to a computer to watch the film.

SUGGESTED PROCEDURE

Before Viewing the Film

Give students the handout and introduce the activity. Explain that a fact pattern is a collection of facts and observations. In this activity, students will be tracking the observations made by Darwin and Wallace that support the natural origin of species and evolution by natural selection.

After Viewing the Film

As a class, discuss which observations students credited to Darwin, Wallace, or both. Ask students what fact patterns they discern. To help students with the next part of the activity, briefly discuss how a few of the observations support evolution by natural selection.

Have students select a partner to complete steps 3 and 4 of the activity.

TEACHING TIPS

- Teachers might need to define “fauna” for students.
- Students could watch the film and complete the chart for homework or during a study period. During class, discuss which observations made by Darwin and Wallace support the natural origin of species or evolution by natural selection.
- Additional background information and details about the work of Wallace and Darwin is provided in the In-Depth Guide. Consider providing students with a copy of the *Background Information* in the guide.
- Discuss with students that in the early to mid-nineteenth century, most people in the Western world, including most scientists, believed that every species was designed by God and placed on Earth in a fixed, ideal form. Such preconceptions made it difficult for many to make the kinds of observations and connections that Darwin and Wallace made. Although the evidence was there, many people weren’t able to see the patterns.

- Review the paragraph evaluation rubric with students before they write answers to Question 4.
- To extend the activity, have students consider the following questions either as a class discussion or as individual work:
 - How did observations from different places and made at different times lead Darwin and Wallace to the same conclusions?
 - In the film, Darwin references fossils and Wallace vestigial structures. How do fossils and vestigial structures both provide evidence of common ancestry?
 - How did Darwin and Wallace answer the question, “Why are certain animals found where they are found?”

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Table 1. Observations on the natural origin and evolution of species.

| | Observation | Darwin | Wallace |
|-----|--|--------|---------|
| 1. | Fossils of extinct animals turn up where similar animals live today. | X | |
| 2. | You can tell which island a Galápagos tortoise comes from by the shape of its shell. | X | |
| 3. | Each Galápagos island has a different kind of mockingbird. | X | |
| 4. | Islands that are near each other have similar but distinct animals living on them. | X | X |
| 5. | Birdwing butterflies are found throughout the Malay Archipelago, but species differ slightly from island to island. | | X |
| 6. | Animals have distinct geographic ranges, but more-similar species tend to live closer to each other. | | X |
| 7. | Some species possess vestigial structures, such as finger bones in the flippers of manatees and similar bones in whale flippers. | | X |
| 8. | Monkeys and orangutans are found on Borneo, while other islands in the region are home to tree kangaroos but no monkeys. | | X |
| 9. | Animals living on islands in the eastern part of the Malay Archipelago are similar to Australian fauna, while animals on western islands are similar to Asian fauna. | | X |
| 10. | Individuals within a given species vary in small ways. | X | X |
| 11. | Animal populations are kept in check because a massive number of young animals die in every generation. | X | X |

2. Based on their independent observations, Darwin and Wallace arrived at the same conclusions about the origin of species. For each of the conclusions below, identify— by number—the observations from Table 1 that these conclusions were based on.
- Species change over time. **1 & 7 (directly); 2, 3, 4 & 5 (indirectly)**
 - Species come from other preexisting species. **1, 6, 7 & 9 (also 2, 3, 4, & 5)**
 - Small variations within species can confer advantages to certain individuals that allow them to survive, reproduce, and pass their traits on. **10 & 11 (directly); 2, 3, 4, 5 (indirectly)**

d. The distribution of species can reflect Earth's geological history. **1, 6, 8 & 9**

4a. Darwin: Write a paragraph that explains Darwin's theory of evolution by natural selection based on the facts and observations listed in the chart.

The paragraph should include observations that support each of the four conclusions (a. – d.).

Sample Paragraph:

Darwin proposed that species change over time and that species come from preexisting species. He based these conclusions on evidence, including his observation that fossils of extinct species are found where similar species live today and that each island of the Galápagos has a different kind of mockingbird. Darwin also observed that individuals within a species vary slightly from one another and that animal populations are kept in check because a massive number of young die in every generation. This led him to conclude that small variations within species can confer advantages to certain individuals that allow them to survive, reproduce, and pass their traits on. Darwin's conclusion that the distribution of species can reflect Earth's geological history is supported by his observations that each island of the Galápagos has a different kind of mockingbird and that similar but distinct creatures live on nearby islands.

4b. Wallace: Write a paragraph that explains Wallace's theory of evolution by natural selection based on the facts and observations listed in the chart.

The paragraph should include observations that support each of the four conclusions (a. – d.).

Sample Paragraph:

Wallace independently reached conclusions similar to Darwin's. Wallace's observations led him to propose that all species are related to one another, and that species come from nearby pre-existing species. He observed that similar species tend to live close to one another and he observed that birdwing butterflies are found throughout the Malay Archipelago, but that species differ slightly from island to island. After observing that some species possess vestigial structures, such as finger bones in the flippers of manatees and similar bones in whale flippers, Wallace concluded that species change over time. He also observed that animal populations are kept in check because a massive number of young die in every generation and individuals within a species vary in small ways. These observations—massive death plus variation—led Wallace to conclude that small variations within species can confer advantages to certain individuals that allow them to survive, reproduce, and pass their traits on. Wallace's conclusion that the distribution of species can reflect Earth's geological history is supported by the following observations: animals have distinct geographic ranges; monkeys and orangutans are found on Borneo, while other islands in the region are home to tree kangaroos but no monkeys; and animals living on islands in the eastern part of the Malay Archipelago are similar to Australian fauna, while animals on western islands are similar to Asian fauna.

SAMPLE PARAGRAPH RUBRIC

The following rubric, aligned with the Common Core standards, can be used to evaluate the students' paragraphs. Teachers are encouraged to use rubrics provided by their schools. Additional rubrics are available at <http://www.smarterbalanced.org>.

| | 1 | 2 | 3 | 4 |
|--|---|--|---|---|
| Purpose & Organization WHST.9-10.2a | Neither a clear purpose nor clear organization is present. | The paragraph's purpose is not clear and/or the organization is weak. | The paragraph has a clear purpose, but the organization is not optimal. | The paragraph has a clear purpose and the organizational structure supports that purpose throughout. |
| Supporting Facts & Details WHST.9-10.2b | Little or no evidence is included. | Only some evidence, details and facts are included in an attempt to support the main idea. | Adequate evidence, details, and facts are included and generally support the main idea. | Multiple lines of evidence, details and facts are included and elaborated to effectively strengthen the arguments or main idea. |
| Transitions WHST.9-10.2c | Transitions between ideas are lacking. | Transitions are infrequent or ineffective. | Transitions are present but are not strong. | Transitions between sentences and ideas flow well. |
| Precise Language & Jargon WHST.9-10.2d | Wording is confused or unclear. | Simple terms are used and piece is mostly clear. | Some scientific terms are used, but the piece is easy to understand. | Precise scientific language is used correctly; the piece is clear. |
| Conventions | Errors are found throughout and make the piece difficult to understand. | Many errors in punctuation, capitalization, spelling and sentence structure. | Some errors in punctuation, capitalization, spelling and sentence structure. | Few or no errors in punctuation, capitalization, spelling and sentence structure. |