NATIONAL GEOGRAPHIC

RESOURCE LIBRARY
ACTIVITY : 25 MINS

Adaptive Radiation

Students analyze characteristics of six pterosaurs to determine the role of adaptive radiation in their evolution from a common ancestor.

GRADES

9 - 12+

SUBJECTS

Biology, Ecology, Geology

CONTENTS

1 PDF, 6 Images

OVERVIEW

Students analyze characteristics of six pterosaurs to determine the role of adaptive radiation in their evolution from a common ancestor.

For the complete activity with media resources, visit:
http://www.nationalgeographic.org/activity/adaptive-radiation/

Program

DIRECTIONS

1. Discuss convergent and divergent evolution.
Review the difference between convergence and divergence. On the board, sketch paths coming together (convergence) and one path splitting in two directions (divergence). Tell

students that as part of evolution, species can converge and diverge over time. Just as species that are not closely related—such as birds, bats, and pterosaurs—can over time develop characteristics such as wings to help them survive, species can also diverge. A new species of pterosaur can break off from a population, as new features evolve that set species apart from one another. Allow students to ask any questions. Then explain that, in this activity, students will explore what happens as part of divergent evolution. Then they will use presentation software to create a summary slide about how divergent evolution relates to pterosaurs.

2. Analyze pterosaur skull structure.

Divide students into pairs. Give each pair the two-page Pterosaur Species handout. Have them glance at the pictures of the pterosaur heads briefly. Ask: *What do you notice about the heads?* Accept a variety of ideas and descriptions, and guide students to the simple realization that these animals are both very similar and very different. Ask students to relate the characteristics of the skulls to each animal's likely food and habitat. Note that the beaks vary; some have teeth, are pointed, are duck-like, or are rounded. Guide students to recognize that different mouths enable access to different foods; note that *Tapejara* could likely scoop from a stream and *Pterodaustro* would have had a food filtering ability, while the toothed pterosaurs were likely able to tear at prey or vegetation. This variation in form is the result of environmental selection, where animals have over time adapted to different environmental conditions, including food sources.

3. Determine how closely related the pterosaurs are.

Next have students determine how closely these different animals are related, by thinking about whether these animals seem to have evolved from a common ancestor, or whether they are more distantly related. Have students compare descriptions of the skeletal structure of the shoulders, wings, and tail in the Anatomy column. Ask: *What characteristics do the pterosaurs have in common?* (The first four have the same fixed shoulder, long palm, and no tail; the difference is in the wingspan. The last two have no tail and a short tail, respectively.)

4. Analyze images from the gallery for common characteristics.

Show students the six images in the gallery, and have them look closely at the wings. Ask: *What characteristic do all of these share?* (Students should recall that all six have an elongated fourth finger.) *What's the function of this long finger?* (With the membrane attached, the pterosaurs could extend their wings to glide and fly.) Explain that this is a key characteristic that shows a common ancestry among pterosaurs.

5. Consider the differences among the gallery images.

Have students discuss with their partners how they might group these pterosaurs. Guide students to see that all but one of the animals can be placed in one group with fixed shoulder, long palm, and either no tail or a short tail. These five lived from 160 million years ago (mya) to 71 mya. This group, however, has a tremendous variety in skull form, and they lived much later than *Dimorphodon* from 200 mya, with its loose shoulder, short palm, and long tail.

6. Consider the geography of adaptive radiation.
Explain that *adaptive radiation* is a term that describes when many organisms resulting from one earlier ancestor are subjected to different environmental selection as they spread over a broad area. Have students look in the habitat column at the geographic distribution of these pterosaurs. Ask: *What environmental pressures may have resulted in these pterosaurs spreading across several continents?* Point out that because of Pangaea, the position of the continents varied over the time that pterosaurs lived, so consider that distances traveled, though far, were not as far as a present-day globe would represent.

7. Summarize ideas about the relationship between the six pterosaurs.
Have partners work together on a computer to develop a presentation slide explaining adaptive radiation using pterosaurs as an example. Have students include at least three key ideas about adaptive radiation and the relationships among the six pterosaurs. Allow students to use the information in the chart, the image gallery, and notes from the discussion as reference.

Informal Assessment

Assess students' completed presentation slides based on what points they chose to include on the slide and how they describe similarities and differences between the six pterosaurs. Students can refer to the similarities of the six pterosaurs' body structures to illustrate their close evolutionary relationship and the differences in their skull structure to illustrate their divergent evolution and adaptive radiation.

Extending the Learning

Have students revisit the images of the six pterosaurs before watching the film *Flying Monsters 3D*. Ask them to consider their own questions that may be answered in the film, such as "Why does Tapejara have such a large head crest?" As students watch the film, have them note different hypotheses for why pterosaurs may have developed differently.

OBJECTIVES

Subjects & Disciplines

Biology

- Ecology

Earth Science

- Geology

Learning Objectives

Students will:

- analyze characteristics of species to determine how closely related they are
- explain the meaning of

Teaching Approach

- Learning-for-use

Teaching Methods

- Discussions
- Information organization
- Visual instruction

Skills Summary

This activity targets the following skills:

- Critical Thinking Skills
  - Analyzing
  - Applying
  - Understanding

National Standards, Principles, and Practices

NATIONAL SCIENCE EDUCATION STANDARDS

- **(9-12) Standard A-2:**

Understandings about scientific inquiry

- **(9-12) Standard C-3:**

Biological evolution

Preparation

What You'll Need

MATERIALS YOU PROVIDE

- Paper
- Pens

REQUIRED TECHNOLOGY

- Internet Access: Optional
- Tech Setup: 1 computer per small group, Presentation software, Projector
- Plug-Ins: Flash

PHYSICAL SPACE

- Classroom

GROUPING

- Large-group instruction
- Small-group instruction

BACKGROUND & VOCABULARY

Background Information

The earlier pterosaurs had long tails and flight membranes, called uropatagia, connecting the tails with the hind legs. This arrangement gave the pterosaurs stability in flight, but it also meant that they couldn't walk very well. According to the fossil record, these early pterosaurs varied relatively little in their designs: size, teeth, and head crests. This situation changed once the Pterodactyloids evolved in the middle Jurassic Period. These animals had no tails and thus no membrane connecting to the hind legs. They could therefore walk much better. In addition, their wing structure, though it made flight more unstable, also made it more maneuverable. Consequently, the Pterodactyloids were able to be more flexible in their lifestyle choices, and they evolved to fill many more niches than their forebearers could. Pterosaur designs took off in many directions, leading to a stunning variety of animals.

Prior Knowledge

["evolution", "classification", "convergent evolution"]

Recommended Prior Activities

- Exploring Vertebrate Classification

Vocabulary

Term	Part of Speech	Definition
classification	*noun*	grouping based on physical and genetic characteristics.
evolution	*noun*	change in heritable traits of a population over time.

For Further Exploration

Websites

- National Geographic Entertainment: Flying Monsters 3D