Reading - Fossil Record and Anatomical Changes

FOCUS NOTES ESSENTIAL QUESTION: What evidence do fossils provide for evolution?

FOCUS NOTE TEMPLATE (https://nkcschools.instructure.com/courses/98825/files/19771265?wrap=1) (https://nkcschools.instructure.com/courses/98825/files/19771265/download?download_frd=1)

The Fossil Record

Fossils are preserved remains or traces of living things. **Figure 1** shows fossils of crinoids, relatives of modern-day starfish. All the fossils that have been discovered and what we have learned from them make up the **fossil record**. The patterns in the fossil record are like data that scientists can analyze and interpret. The fossil record documents the diversity of the life forms, many now extinct, and shows how life forms existed and changed throughout Earth's history. The fossil record is a treasure trove of **evidence** about how organisms of the past evolved into the forms we see today.

like with our Natural Hazards project

Microevolution and Macroevolution Scientists can observe evolution taking place within populations of organisms. Small, gradual changes in the color or size of a certain population is called microevolution. *Micro*-means very small, and *evolution* means change through time. One example of microevolution is the northern population of house sparrows. They adapted to a colder climate by growing larger bodies than the southern population. This small change took less than 100 years. Usually, for multicellular organisms, it takes years to thousands of years for a new species to develop. Scientists turn to the fossil record to learn about macroevolution, or major evolutionary change.

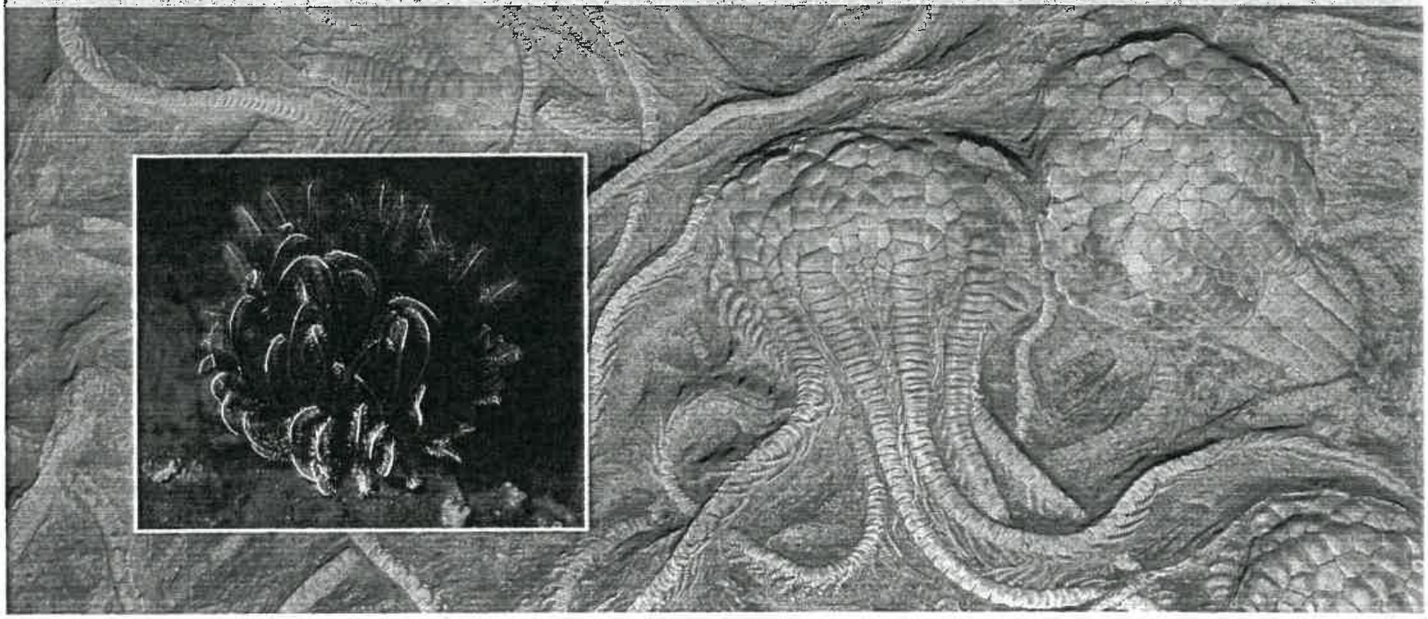
multicellular = eukaryotes

FIGURE 1

this is really fast in terms of evolution!

I never knew this !

A Glimpse of the Past Figure 1 Crinoids are relatives of starfish. We can learn a lot about the evolution of crinoids by looking at fossils of their extinct relatives. Some ancient crinoids grew more than 40 meters long!



How Fossils Form A fossil is the impression that an organism or part of an organism leaves in rock. That impression comes about in one of two ways. A mold creates a hollow area in the rock that is the shape of an organism or part of an organism. Or, a cast makes a solid copy of an organism's shape, sometimes containing some of the original organism.

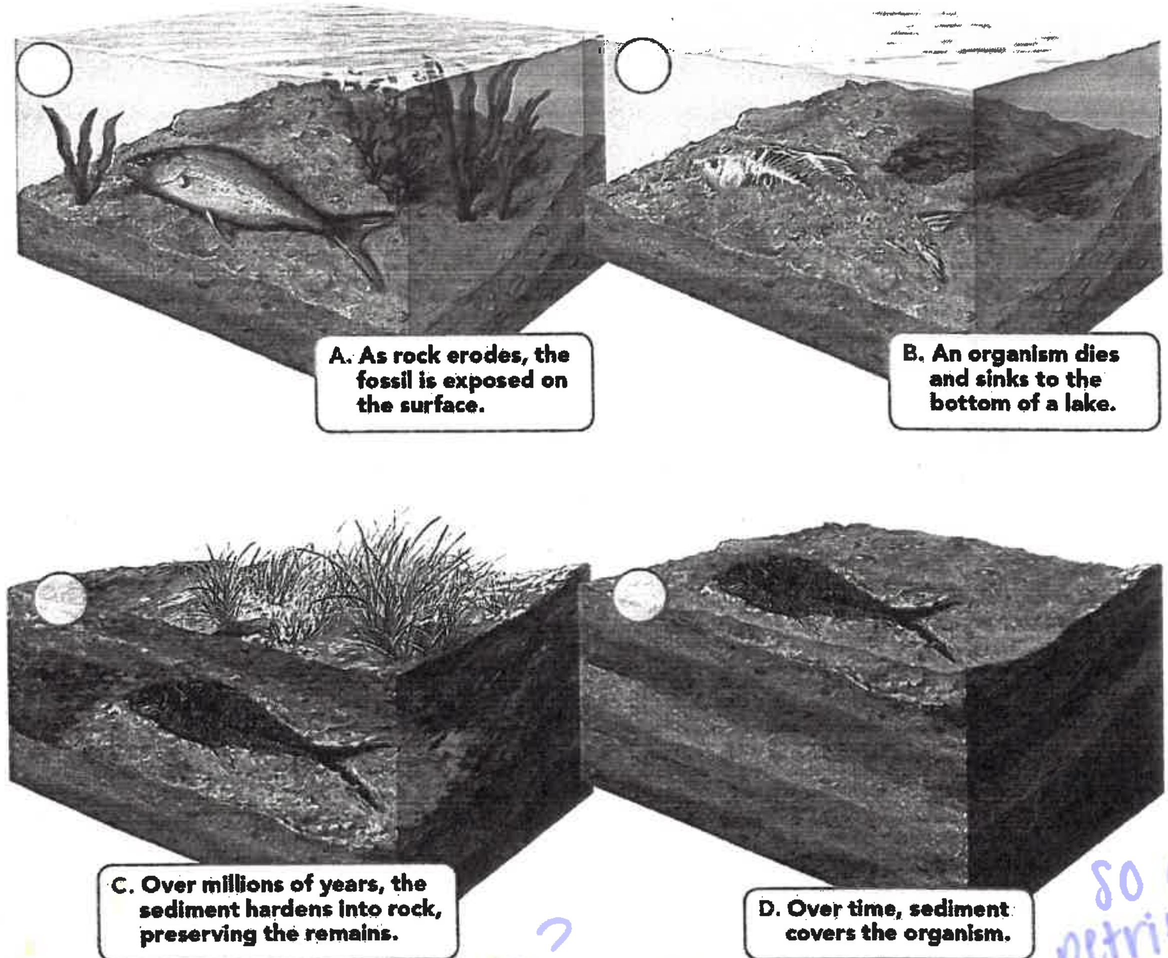
∞ rock cycle

Most fossils form when living things die and sediment buries them. Sediment is the small, solid pieces of material that come from rocks or the remains of organisms and settle to the bottom of a body of water. Over time, the sediment slowly hardens into rock and preserves the shapes of the organisms. Fossils can form from any kind of living thing, from bacteria to dinosaurs.

Many fossils come from organisms that once lived in or near still water. Swamps, lakes, and shallow seas build up sediment quickly and bury remains of living things. In **Figure 2**, you can see how a fossil might form. When an organism dies, its soft parts usually decay quickly or are eaten by other organisms. Only hard parts of an organism typically leave fossils. These hard parts include bones, shells, teeth, seeds, and woody stems. It is rare for the soft parts of an organism to become a fossil. People often see fossils after erosion exposes them. Erosion is the wearing away of Earth's surface by natural processes such as water and wind.

∞

FIGURE 2



Kinds of Fossils There are two types of fossils: body fossils and trace fossils. Each one gives us different information about the ancient organism it represents.

Body Fossils Body fossils preserve the shape and structure of an organism. We can learn about what a plant or animal looked like from a body fossil. Body fossils of trees are called petrified wood. The term *petrified* means "turned into stone." Petrified fossils are fossils in which minerals replace all or part of an organism. In petrified wood, the remains are so well preserved that scientists can often count the rings to tell how old a tree was when it died millions of years ago. Ancient mammoths frozen into ice, petrified dinosaur bones, and insects trapped in amber are other examples of body fossils.

Trace Fossils We can learn what an animal did from trace fossils. Footprints, nests, and animal droppings preserved in stone are all trace fossils, as shown in **Figure 3**.

FIGURE 3

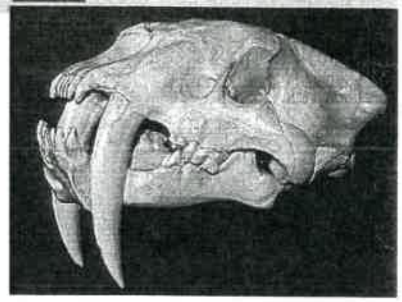
Turtle dropping

trace fossil

Mosquito in amber

body fossil

Smilodon, cat skull



body fossil

Dinosaur tracks

trace fossil

fossil record = shows evolution

Fossil Evidence of Evolution

Most of what we know about ancient organisms comes from the fossil record. The fossil record provides evidence about the history of life and past environments on Earth. The fossil record also shows how different groups of organisms have changed over time. Each new discovery helps to fill holes in our understanding of evolution.

∞ 4.6 billion in our notes

Early Earth When Earth first formed, more than 4.5 billion years ago, it was extremely hot. Earth was likely mostly melted. As Earth cooled, solid rocks became stable at Earth's surface. The oldest known fossils are from rocks that formed about a billion years after Earth formed. **Figure 4** shows a rock made of these fossils. Scientists think that all other forms of life on Earth arose from these simple organisms.

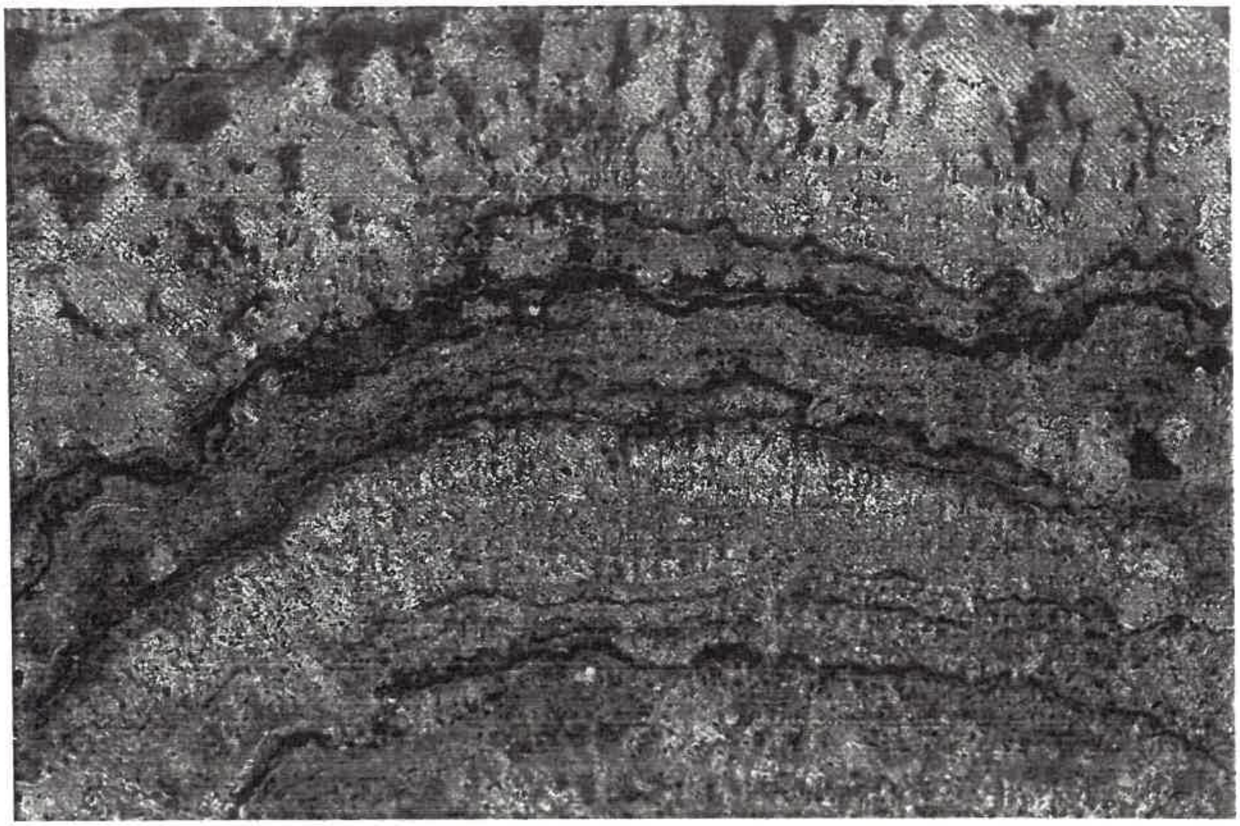
∞ Frankenstein

Scientists cannot yet pinpoint when or where life first evolved. Scientists hypothesize that life first evolved in Earth's ocean. The early ocean contained reactive chemicals. Under the right conditions, sunlight and lightning can change those chemicals into molecules similar to those found in living cells. More research will help scientists to settle the question of the origin of life on Earth.

FIGURE 4 - Stromatolites are rock-like structures formed by layers of fossilized bacteria. Dating as far back as 3.4 billion years ago, they are the oldest evidence of life forms on Earth. Ancient bacteria in water produced thin sheets of film that trapped mud. Over time, these thin sheets formed

microfossils—fossils too small to see without a microscope. Eventually, the sheets built up into the layers you see here.

! I didn't know bacteria could fossilize!



Fossils and Evolution Through Time The fossil record provides evidence that life on Earth has evolved. Rock forms in layers, with newer layers on top of older layers. When we dig deeper, we see older rocks with fossils from earlier time periods. The oldest rocks contain fossils of only very simple organisms. Younger rocks include fossils of both simple organisms and also more complex organisms. Looking at fossils in rocks from different time periods, scientists can reconstruct the history of evolution. **Figure 5** shows the evolution of the elephant, reconstructed from the fossil record.

the law of superpositic

this is our evidence

The fossil record also shows how Earth's climate has changed. Some plant fossils reveal surprises, such as palm trees in Wyoming and giant tropical ferns in Antarctica. Fossils and preserved remains are also evidence of how climate change influences evolution.

FIGURE 5

Evolution of the Modern Elephant Figure 5 Scientists have reconstructed the evolutionary history of the elephant with evidence from the fossil record.

Are these based on modern day animals?

EXAMPLE

! the size difference here is surprising to me

ya = years ago; mya = millions of years ago

Comparisons of Anatomy

The structure of an organism's body is called its anatomy. Similarities in anatomy are clues that organisms evolved from a common ancestor. Evidence from the fossil record and observations of modern organisms help us to reconstruct evolutionary history.

∞ biology

Embryological Development An **embryo** is a young organism that develops from a fertilized egg (called a zygote). The growing embryo may develop inside or outside the parent's body. The early development of different organisms in an embryo shows some striking similarities. For example, chickens, fish, turtles, and pigs all resemble each other during the early stages of development. These similarities in early development suggest that organisms are related and share a common ancestor.

∞ dangerous

big evidence

embryologic phases diagram

Scientists can also analyze fossilized eggs to learn about development in species from long ago. **Figure 6** shows the model of a duck-billed dinosaur embryo, known as a Hadrosaur, compared to an x-ray of a chicken embryo. You can see many similarities in their early development.

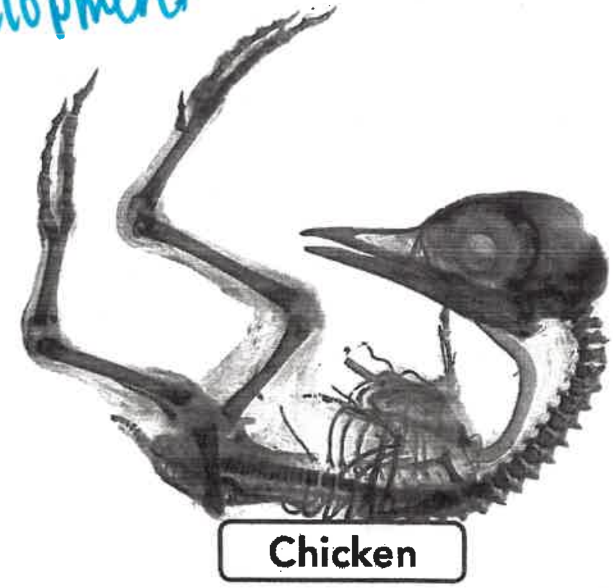
Homologous Structures Similar structures that related species have inherited from a common ancestor are known as **homologous structures** (hoh MAHL uh gus). Bats, dogs, dolphins, and even flying reptiles have homologous structures in their limbs. Although the structures look very different now, you will see the bones that these animals all have in common.

Hes one species to another evidence?

FIGURE 6

HOMO = SAME HETERO = DIFFERENT

similarities in the early development



cats and dogs

Beginning and End of a Species

Natural selection explains how variations can lead to changes in a species. A new species forms when one population remains isolated from the rest of its species long enough to evolve such different traits that members of the two populations can no longer mate and produce offspring capable of reproduction. **Figure 7** shows an example of a turtle species that has evolved seven different subspecies. Over time, the subspecies could form separate species.

Gradual Change Some species in the fossil record seem to change gradually over time, such as the elephants in **Figure 5**. The time scale of the fossil record involves thousands or millions of years. There is plenty of time for gradual changes to produce new species. The fossil record contains many examples of species that are halfway between two others.

Rapid Change At times, new, related species suddenly appear in the fossil record. Rapid evolution can follow a major change in environmental conditions. A cooling climate, for example, can put a lot of stress on a population. Only the individuals adapted to cooler conditions will survive. Through natural selection, the population may rapidly evolve to a new species.

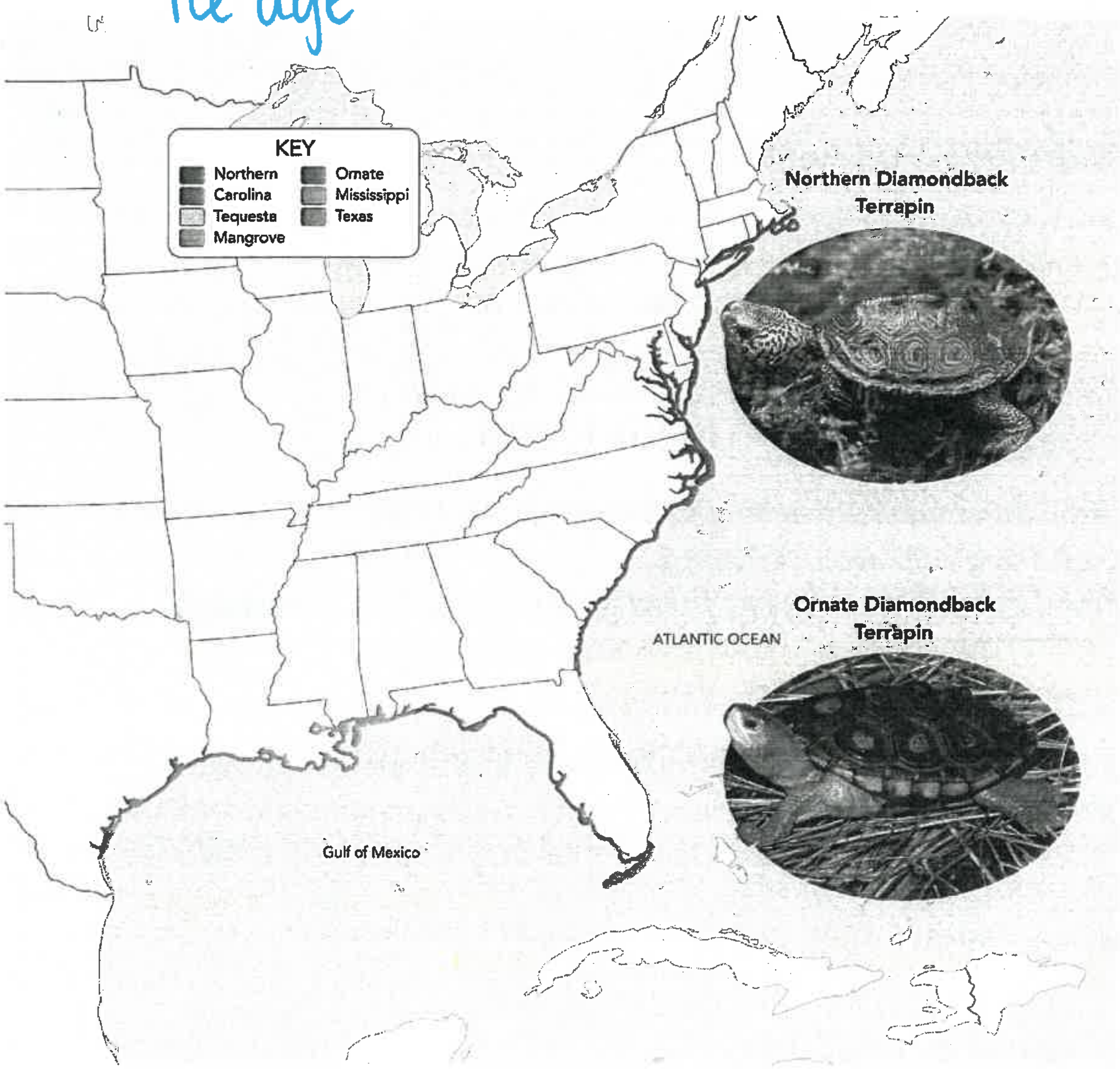
Will humans be extinct in a few million years, or would we have evolved?

Extinction A species is extinct if it no longer exists and will never again live on Earth. A rapid environmental change is more likely to cause a species to become extinct than to bring about a new species. The fossil record shows that most of the species that ever lived on Earth are now extinct.

Extinction (cont.)

New predators, climate change, disease, and competition with other species are a few factors that can lead to extinction. According to natural selection, if a species fails to develop the adaptations necessary to survive the changing conditions in an environment, that species will not survive and reproduce. Small populations that breed slowly and cannot relocate are more likely to become extinct. The fossil record shows that volcanic eruptions, asteroids striking Earth, and sudden climate change can kill off many species in a short time. ∞ dinosaurs

ice age



Factors that lead to extinction

Human Influence on Extinction Some extinctions are direct results of human activities. Other species struggle to survive human-caused pollution, such as oil spills. Many scientists think we are currently living in a time period of rapid extinction. A large percentage of the species on Earth could be driven to extinction by human activities and human-caused climate change. **Figure 8** shows some of the estimated 56 species of Hawaiian honeycreepers known to have existed on the islands. Today, all but 18 species are now extinct. Rat predators, disease-carrying chickens, malaria-laden mosquitos, and pigs trampling their habitat are all factors driving these tropical birds to extinction.

Human Impact on Honeycreepers Figure 8 Many Hawaiian honeycreeper species evolved from one or more finches that traveled to the islands thousands of years ago. Most honeycreeper species are now extinct or endangered.