

Reading 9.1 – Mass Extinction

(text adapted from text from <http://en.wikipedia.org/wiki/Extinction>)

Do you think any species gone extinct while you have been alive? _____

How about over the past 100 years? Extinctions can be caused by many factors. You identified some of these factors in class. In this reading you will learn more about examples of species that have gone extinct and evidence that helps scientists identify possible causes were for those extinctions.

You might be surprised to learn that over 97% of species that ever lived are now extinct! Some of these species went extinct long ago. Others have gone extinct more recently.

Between the year 1500 and the year 2009, 875 extinctions have been documented. But scientists suspect that many more extinctions have occurred than have been recorded or observed.

One of the earliest documented species to go extinct was the Dodo bird, a native species that used to live on the island of Mauritius in the Indian Ocean.

It became extinct in the 1600s after humans settled the island it lived on, destroyed the forests where the birds made their homes, and invasive species that ate the Dodo bird's eggs.



image credit:

<http://en.wikipedia.org/wiki/Dodo>

Not all species go extinct because of human actions or invasive species. In class you studied other factors that might cause a species to go extinct. Some were complex, others were simple.

A simple explanation for all extinctions is that a species is unable to survive or reproduce in its environment. If it is also unable to move to a new environment where it can do this, it dies out and becomes extinct. A more complex explanation would take into account what environmental factors affected the survival of these species and how fast the extinction occurred.

Some extinctions seem unpredictable and to come on suddenly, such as when an otherwise healthy species is wiped out completely (like when pollution destroys an entire ecosystem). Other extinctions seem to be predictable and to come on more slowly, such as when a species gradually loses more and more population each season as it competes with individuals from other species for the same resources necessary for survival.

In general, extinctions become more frequent when changes in the environment occur more suddenly. This is because even though mutation can generate new genetic information, it often takes many generations to accumulate enough constructive mutations to result in adaptations that would allow the offspring to survive the very different environment. When the environmental change is large, the slow rate of evolution can't keep pace with the rate of environmental change.

Many environmental groups and some governments are concerned with the current rate of extinction of species on Earth. They suspect that these extinctions are indirectly being caused by human activity. Some human suspected causes include over-harvesting, pollution, habitat destruction,

introduction of invasive species, over-hunting, and climate change.

Some of these groups are trying to combat further extinctions through a variety of conservation programs. Some programs are aimed at conserving the natural ecosystems of endangered species to prevent further changes to the ecosystem by humans.

Question 1: In your opinion which of the causes listed in the paragraph above would be most likely to lead to extinction of native species in your area? _____

Question 2 Why?

Recent human history isn't the only time rapid environmental change that has occurred, and humans are not the only cause of environmental change.

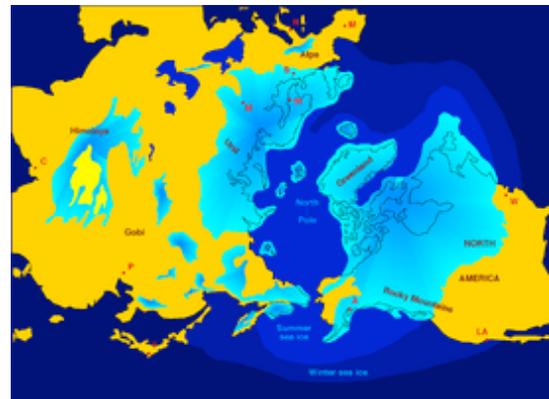
The last ice age occurred 26,000 to 13,300 years ago. During this period, many parts of the northern hemisphere were covered in ice year-round, and global temperatures were lower on average.

At the end of this ice age, global temperatures increased and the vast ice sheets melted quickly.

Many creatures that were alive during the ice age became extinct at its end (or shortly after). Some of these creatures included the Sabertooth cat and Woolly mammoth.

Two different types of saber-toothed cats lived in the Midwestern U.S. at the end of the last Ice Age. One type was the familiar saber tooth, represented by the genus *Smilodon*. These cats had the enlarged canines usually associated with the name saber-tooth. Their canines were up to 18 centimeters (7 inches) long. A mounted skeleton of *Smilodon fatalis* is shown in the photograph to the right.

image from
http://en.wikipedia.org/wiki/Ice_age#Causes_of_ice_ages



<http://www.museum.state.il.us/exhibits/larson/smilodon.html>

Preserved frozen remains of woolly mammoths, with much soft tissue remaining, have been found in the northern parts of Siberia. This is a rare occurrence, essentially requiring the animal to have been buried rapidly in liquid or semi-solids such as silt, mud and icy water which then froze. This may have occurred in a number of ways. Mammoths may have been trapped in bogs or quicksands, and they either died of starvation or exposure, or drowning if they sank under the surface. A stuffed and preserved set of these frozen remains can be seen in a St. Petersburg, Russia museum (shown in the photograph to the right).



image credit:

http://en.wikipedia.org/wiki/Woolly_mammoth

Some scientists have proposed that extinction of these species was primarily due to human activity. Other scientists suggest that their extinction was primarily due to large rapid changes in the environment due to the melting of the glaciers at the end of the last ice age.

Question 3 How might advances in human hunting technologies and techniques during this time have led to the extinction of these species?

Question 4 How might the climate changes that occurred at end of the ice age have led to the extinction of these species?

Question 5 What other factors might have contributed to the extinction of these species?

Scientists determined when these species went extinct by studying the fossil record. In general, rocks and fossils that are buried deeper in a sedimentary layer are older than rocks and fossils closer to the surface. By studying the location of sedimentary rocks and the composition of those rocks, scientists can determine roughly when the individual died.

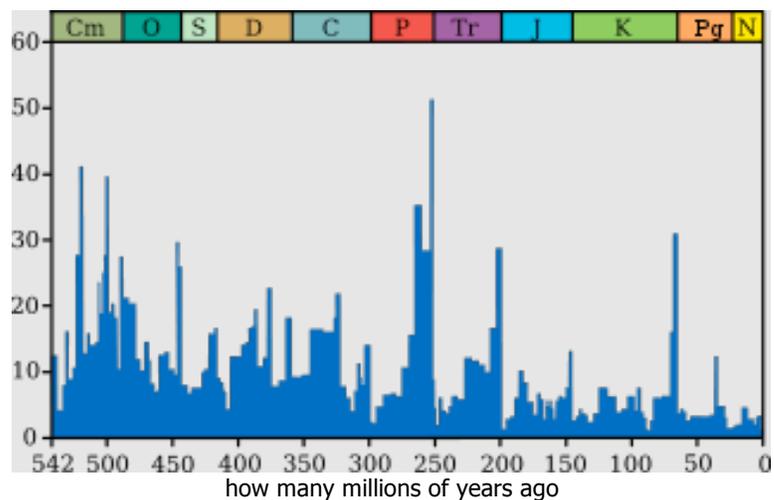
By studying the fossil record, scientists have determined that there have been some very major extinction events in Earth's past. They have noted that there are sometimes layers of sedimentary rock that show a sharp decrease in the number of species that left fossils in a relatively short period of time. Scientists refer to such an event as a **mass extinction event**.

On the right is a graph of Marine extinction intensity through time over the past 540 million years. The blue graph shows the apparent percentage (not the absolute number) of marine animals becoming extinct during any given time interval. It does not represent all marine species.

Notice the largest spike in this graph occurred a little over 250 million years ago. The next big spike to occur appears just over 200 million years ago, and the most recent spike occurred about 65.5 million years.

Image credit:
http://en.wikipedia.org/wiki/Extinction_event#Extinction_events

Percentage of marine species that went extinct vs,
 how many millions of years ago



We are going to investigate the two most recent spikes. These are the two most recent mass extinction events in the fossil record. They each have been given names. The most recent one, called the Cretaceous-Tertiary mass extinction event, is also referred to as C-T (or K-T). Another major extinction event before C-T is the Triassic-Jurassic mass extinction event, (also referred to as T-J).

Question 6 Label these spikes on the graph:

- the C-T mass extinction event which occurred approximately 65.5 million years ago.
- the T-J mass extinction event, which occurred approximately 200 million years ago.

Non-avian Dinosaurs (those that are not birds) are found only in rocks that are older than the C-T and older than the T-J event boundaries. This indicates that non-avian dinosaurs became extinct immediately before or during the C-T mass extinction event. In addition to the extinction of dinosaurs, mosasaurs, plesiosaurs, pterosaurs, many species of plants and invertebrates also became extinct at

this event (or shortly before it).

Some scientists have proposed that the C-T extinctions were caused by some catastrophic environmental change. Possible causes of a major change in the past that have been proposed include either a massive asteroid impact or increased volcanic activity.

Both of these events would have had major effects on all ecosystems on Earth, affecting the amount of dust in the atmosphere, the amount of sunlight reaching the ground, and the average air temperature. Both would have affected most types of plant growth.

Other researchers don't believe that the species that went extinct did so suddenly. They believe the C-T boundary marks the end of a slower environmental change, such as gradual change in sea levels or a gradual shift in climate.

When this massive asteroid impact hypothesis was first proposed, it was not widely accepted. This was largely due to the fact that no visible impact crater could be found on the surface of the Earth to coincide with this event. Even with weathering and the gradual filling in of sedimentary materials, it seemed as if there should have been some trace of a crater left by such an impact.

Scientists have recently discovered a very large impact crater, buried beneath the soil of Mexico and the Gulf of Mexico using satellites that employ radar to penetrate the ground and show the structure of the rock beneath the surface. It appears to have been made by a 10-20 km wide asteroid. As the map shows below, the size of the crater is massive. Its ring is surrounded by a series of caves, and changes in the composition of the rock.

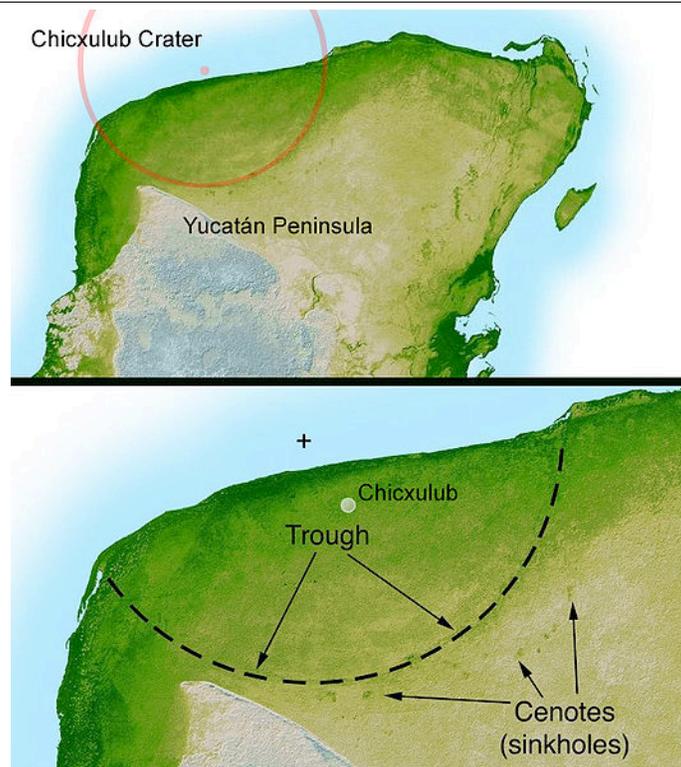


Image and text credit: http://en.wikipedia.org/wiki/Chicxulub_crater

Imaging from NASA's Shuttle Radar Topography Mission STS-99 reveals part of the 180 km (110 mi) diameter ring of the crater; clustered around the crater's trough are numerous sinkholes, suggesting a prehistoric oceanic basin in the depression left by the impact.

The evidence related to this crater helps support the claim of a massive asteroid impact being at least partially responsible for the environmental change that led to the extinction of the dinosaurs.

In addition, rock formations around the world, similar to the one shown on the right, provide additional evidence for the massive meteor impact affecting ecosystems all around the Earth.

The photograph shows a badlands rock formation near Drumheller, Alberta Canada where erosion has exposed the C-T boundary. The rock that marks the layer between the boundaries contains 1000 more times iridium than the upper and lower layers. Iridium is rare on earth, but is a common element found in some meteors. This iridium layer at the C-T boundary has been found in rocks on every continent around the world.



Image credit:

http://en.wikipedia.org/wiki/K-T_extinction

During or shortly before the T-J mass extinction event, 20 percent of all marine families, many large

amphibians were wiped out and half of species known to have been living on Earth went extinct at that time. This event also changed environmental conditions so much, that dinosaurs then evolved to assume the dominant role in most ecosystems (until the C-T mass extinction event).

Several explanations for this earlier T-J mass extinction event have been suggested, but all have unanswered challenges.

Proposed explanation	Current weaknesses with this explanation
Gradual climate change or sea-level fluctuations occurred.	This does not explain the suddenness of the extinctions in the marine realm.
Another asteroid impact.	No impact crater has been found to coincide with the T-J boundary
Massive volcanic eruptions.	Evidence of the corresponding release of huge amounts of carbon dioxide or sulfur dioxide that would cause either intense global warming (from the former) or cooling (from the latter) is still being sought.

Currently, scientists continue to search for geological evidence to help narrow down these possibilities and determine the most likely cause of the T-J mass extinction.

Question 8 Which explanation do you think was the mostly likely cause of the T-J mass extinction event?
