

GEOL 104 Dinosaurs: A Natural History  
Homework 6: The Cretaceous-Tertiary Extinction

DUE: Fri. Dec. 7

Part I: Victims and Survivors

Below is a list of various taxa. Indicate (by letter) if the taxon:

**A.** Was already extinct by the Cretaceous-Paleogene Boundary

**X.** Died out at the Cretaceous-Paleogene Boundary

**S.** Survived the Cretaceous-Paleogene Boundary (although it may have died out subsequently)

1) Inoceramids _____	2) Ammonoids _____
3) Plesiosaurs _____	4) Ichthyosaurs _____
5) Eutherians _____	6) Rudists _____
7) Allotherians _____	8) Champsosaurs _____
9) Coccolithophorids _____	10) Pterosaurs _____
11) Marine Crocodylians _____	12) Eutriconodonts _____
13) Ornithischia _____	Extra Credit) Saurischia _____

Part II: Causal Agents and Physical Evidence

There are three environmental changes at or near the K/Pg boundary that might have had the potential to produce the extinction events. These three potential **causal agents** were introduced in class, but here they are again:

- **Chicxulub Impact:** collision of a 10-15 km asteroid with the Earth at 65.5 Ma, blasting an enormous volume of ash and dust into the atmosphere. Expected effects:
  - Blotted out sunlight, stopping photosynthesis on land and sea, causing starvation of herbivores, causing starvation of carnivores
  - Possibly other short-term effects (blast wave, increased acid rain, wildfires, etc.)
  - Immediate effects would be **very intense** but very **short term** (< 1 day to a year or less)
- **Deccan Traps Volcanism:** eruption of vast lava fields in western India starting around 66 Ma, and lasting for a million years or less, sending huge amounts of ash and dust into atmosphere. Expected effects:
  - Blotted out sunlight, stopping photosynthesis on land and sea, causing starvation of herbivores, causing starvation of carnivores
  - Possibly also increased amounts of various pollutants into atmosphere
  - Immediate effects would be **intense** and extend over **hundreds of thousands of years** prior to K/T boundary
- **Maastrichtian Regression:** huge drop in global sea levels, exposing large areas of land previously submerged, starting around 69 Ma and ending around 65 Ma. Expected effects:
  - Change planetary albedo (reflectivity), changing both amount of heat absorbed by Earth and that heat's distribution
  - Change in oceanic circulation patterns
  - Decrease in oceanic productivity (how much nutrients are produced) because of loss of warm shallow seas
  - Increase in continentality of climate (more intense summers and winters), and thereby changing habitat range for different groups of plants and animals
  - Immediate effects would be **gradual** and extend over **millions of years**

These different causal agents would leave different types of records in the rocks. For each of the questions below, circle the appropriate answer as to which causal agent(s) (Asteroid Impact, Deccan Traps Volcanism, or Maastrichtian Regression) would leave such a record.

13) Ash from very short term but global forest fires:

- A. Asteroid Impact      B. Deccan Traps Volcanism      C. Maastrichtian Regression  
D. A & B, but not C      E. A, B & C

14) Replacement of one set of plant fossils over the last several million years of the Cretaceous:

- A. Asteroid Impact      B. Deccan Traps Volcanism      C. Maastrichtian Regression  
D. A & B, but not C      E. A, B & C

15) Iridium spike:

- A. Asteroid Impact      B. Deccan Traps Volcanism      C. Maastrichtian Regression  
D. A & B, but not C      E. A, B & C

16) Chemical evidence for decreased amount of photosynthetic activity (indicating reduction in sunlight):

- A. Asteroid Impact      B. Deccan Traps Volcanism      C. Maastrichtian Regression  
D. A & B, but not C      E. A, B & C

17) Tsunami deposits on the Atlantic & Gulf Coasts of the Americas:

- A. Asteroid Impact      B. Deccan Traps Volcanism      C. Maastrichtian Regression  
D. A & B, but not C      E. A, B & C

19) Extensive lava flows in India:

- A. Asteroid Impact      B. Deccan Traps Volcanism      C. Maastrichtian Regression  
D. A & B, but not C      E. A, B & C

19) Shocked quartz:

- A. Asteroid Impact      B. Deccan Traps Volcanism      C. Maastrichtian Regression  
D. A & B, but not C      E. A, B & C

Extra Credit) Earlier mass extinctions include the Permo-Triassic Extinction and the Triassic-Jurassic extinction. These two have likely causal agents that are most similar to which of the three proposed K/Pg causal agents?

[ Asteroid Impact | Deccan Traps | Maastrichtian Regression ] (Circle)

Part III: K/Pg Extinction Patterns in the Continental Realm

Let's look at the patterns of extinctions at the K/T boundary for major clades of continental vertebrates (i.e., land-dwelling and fresh water vertebrates), with emphasis on dinosaurian clades. For each taxon the habitat, the adult size, likely physiology (warm- or cold-blooded), food source (land or water), and food type are listed. (Note that sizes and diet features of the late Maastrichtian representatives are shown: earlier or later representatives may have been different from these forms).

Survivors

Taxon	Habitat	Adult Size (kg)	Physiology	Food source	Food type
Aves	Flying	<1 – 5 (most <1)	Warm	Mostly water	Some plants; others meat; others insects
Crocodylians	Semi-aquatic	~10 – 50+	Cold	Water	Meat & fish
Champsosaurs	Semi-aquatic	10 – 25	Cold	Water	Meat & fish
Lepidosauers (lizards and snakes)	Land	<1 – 10 (most <1)	Cold	Mostly land	Most insects; some meat; some plants
Turtles	Land & semi-aquatic	<1 – 10	Cold	Land & water	Meat, fish, insects, plants
Eutherian mammals	Land	<1 – 5 (most <1)	Warm	Land	Some plants; others meat; others insects
Metatherian mammals	Land	<1 – 5	Warm	Land	Some plants; others meat; others insects
Allotherian mammals	Land	<1	Warm	Land	Plants
Prototherian mammals	Semi-aquatic	<1	Warm	Water	Insects
Amphibians	Semi-aquatic	<1	Cold	Land & water	Insects

Victims

Taxon	Habitat	Adult Size (kg)	Physiology	Food source	Food type
Ichthyornithiform	Flying	<1 – 3 (most <1)	Warm	Water	Fish

birds					
Enantiornithine	Flying	<1 – 5 (most <1)	Warm	Land	Some plants;
birds					others meat;
					others insects
Deinonychosauria	Land	10	Warm	Land	Meat
Oviraptorosauria	Land	10 – 175	Warm	Land	Omnivores
Therizinosauria	Land	500 – 3000	Warm	Land	Plants
Alvarezsauridae	Land	1 – 5	Warm	Land	Insects
Ornithomimosauria	Land	175	Warm	Land	Omnivores
Tyrannosauridae	Land	6000	Warm	Land	Meat
Abelisauroidae	Land	5 – 3000	Warm	Land	Meat
Titanosauria	Land	30,000	Warm	Land	Plants
Ceratopsidae	Land	6000	Warm	Land	Plants
Leptoceratopsidae	Land	50	Warm	Land	Plants
Pachycephalosauria	Land	200	Warm	Land	Plants
Hadrosauridae	Land	6000	Warm	Land	Plants
Thescelosauridae	Land	90	Warm	Land	Plants
Rhabdodontidae	Land	150	Warm	Land	Plants
Ankylosauridae	Land	3000	Warm	Land	Plants
Nodosauridae	Land	2500	Warm	Land	Plants
Pterosauria	Flying	5 – 200	Warm	Land & water	Meat, fish
Notosuchian	Land	10	Cold	Land	Plants
crocodylomorphs					
Peirosaurid	Land	50-100	Cold?	Land	Meat
crocodylomorphs					
Araripesuchidae	Land	5	Cold	Land	Meat
“Cladotherian”	Land	<1	Warm	Land	Some plants;
mammals					others meat;
					others insects
Symmetrodont	Land	<1	Warm	Land	Some plants;
mammals					others insects
Eutriconodont	Land	<1 – 5	Warm	Land	Omnivores
mammals					

20) Many scientists have said that there is a strong size bias in survivors vs. victims in the K/T boundary on land.

Look at the data on the previous page. In general, the majority of the survivor groups are

[ smaller | the same size | larger ] than the majority of the victims

- 21) Semi-aquatic animals [ mostly became extinct | mostly survived ] the K/T extinction.
- 22) The majority of the victims seem to have been [ warm-blooded | cold-blooded ] animals.
- 23) Count up the number of survivors which fed from the water and compare that to the number of victims that fed from the water. What do you observe?
- A. Most water feeders tended to survive.
  - B. Most water feeders tended to go extinct.
  - C. They are about equal in each group.

- 24) Now do the same for those that fed on food from the land. What do you observe?
- A. Most land feeders tended to survive.
  - B. Most land feeders tended to go extinct.
  - C. They are about equal in each group.

- Extra Credit) Now consider only taxa that massed 10 kg or more. Which of the following best describes the pattern for larger animals?
- A. Nearly all 10 kg or larger animals that survived lived in the water.
  - B. Nearly all 10 kg or larger animals that lived on land died out.
  - C. Both A & B are true.

- 25) Which best describes the diet as reflected in the survivors vs. the victims:
- A. The survivors were overwhelmingly meat-eaters, while the victims were almost all plant-eaters.
  - B. The survivors were overwhelmingly plant-eaters, while the victims were almost all meat-eaters.
  - C. Only insect-eaters survived.
  - D. Diet itself doesn't seem to be a determining factor.

- 26) Overall, circle which of the following types of animals had the worst survivorship (i.e., most likely to die out) at the extinction:
- A. Small, semi-aquatic cold-blooded
  - B. Small, terrestrial or flying warm-blooded
  - C. Large, semi-aquatic cold-blooded
  - D. Large, terrestrial or flying warm-blooded

- 27) Which of the following needs the largest total amount of food?
- A. Small cold-blooded

Name: \_\_\_\_\_

- B. Small warm-blooded
- C. Large cold-blooded
- D. Large warm-blooded

29) Small animals need less total amount of food than large ones. Cold-blooded animals need less total amount of food than warm-blooded ones of the same size. Given this information and your answer to questions 26 & 27, what might this indicate about conditions at the K/T boundary?

30) Just to make sure everyone is paying attention, at what point did the clade Dinosauria go extinct?