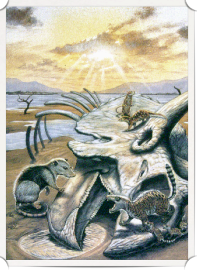


Dinosaur Extinctions



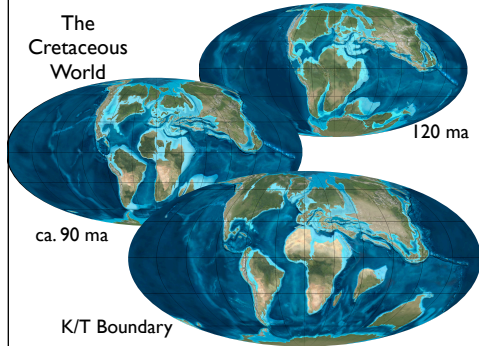
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It is a major mistake to just talk about 'Dinosaur' extinctions. At the end of the Cretaceous a good many organisms, from single celled forams through whole families of mammals, went extinct.

Instead of focusing on dinosaurs we need to look at the totality of the terminal Cretaceous extinctions.

2

The Cretaceous World



3



4

K/T Extinctions

The end of the Cretaceous and the end of 'dinosaurs' occurred about 65 million years ago at the boundary between the Cretaceous and Tertiary Periods.

We commonly call this the K/T boundary.

Most rational explanations imply some environmental and climatic changes, but they differ on the mechanisms that triggered the changes. There are many older ideas that are less rational.

5

Extinction Hypotheses

- Changes in the Atmosphere
 - High levels of CO₂ - carbon dioxide
 - Effect on embryos
 - Stagnant oceans
 - Low levels of CO₂
- Due to extensive volcanism
- Cataracts and blindness

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Extinction Hypotheses

- Changes in Climate
 - Too hot - gradual or abrupt
 - Too cold
 - Too much temp variation
 - Too wet
 - Too dry
- Destruction of ozone in upper atmosphere

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Extinction Hypotheses

- Competition
 - Mammals
 - Caterpillars
- Changes in DNA - too many mutations
- Egg shell thinning due to metabolic disorders
- Egg shell thickening
- Increasing entropy kill larger organisms
- Pandemic diseases

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Extinction Hypotheses

- Botanical Changes
 - Increase in angiosperms producing oxygen more efficiently meant dinosaurs burned themselves up
 - Rapid evolution of fungi which poisoned dinosaurs
 - Loss of 'old' habitats as new plants took over
 - Angiosperms became more numerous and their alkaloids were toxic to dinosaurs
- Increase in deciduous trees meant fewer leaves available during winter so herbivores stressed and died out

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Extinction Hypotheses

- Milankovitch or other cyclical extra-terrestrial effects
- Accumulation of infections, arthritis, bone fractures and caries
- Asteroid impact
- Mental disorders
- Lack of consciousness

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Extinction Hypotheses

- Changes in the oceans - tectonic activity
 - Draining of lakes and swamps
 - Flooding due to sea-level rising
 - Changes due to mountain building
 - Spillage of fresh Arctic water into oceans

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Extinction Hypotheses

- Overpopulation
- Increased number of parasites
- Over-predation by carnosaurus
- Overactive pituitary glands
- Overgrowth of horns, frills and spines
- Poisoning by uranium
- Magnetic reversals
- Decreased sexual activity
- Slipped disks
- Volcanism

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Extinction Hypotheses

- Dinosaur AIDs
- Alien interaction
- Constipation or Diarrhea
- Hay-fever
- Racial old-age and over-specialization
- Evolution of suicidal behaviors

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K/T Extinctions

Within the last few years two causal theories have become very popular and very public:

- a) massive volcanic activity or,
- b) asteroid impact.

The latter theory, most notably, has taken on a life of its own almost independent from scientific critique, as it appears to be taken for granted in the mass media. Any single theory or combination of theories about extinctions must be testable and falsifiable. They must be congruent with 'facts'. If they are not, then they are not theories but elegant fables.

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Can we test these hypotheses?

1. To what degree?
2. Can we distinguish between different extinction hypotheses?
3. Are there problems with these hypotheses?
4. How long did this "extinction boundary" really last?
5. Did all the animals that went extinct vanish simultaneously or did they vanish over a longer period of time?

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What actually happened at the K/T boundary?

1. The large dinosaurs and most small dinosaurs vanished. One lineage of avian dinosaurs survived but the major lineage of Mesozoic avians went extinct.



2. Many other land organisms went extinct, including pterosaurs and some mammals.



3. 50% to 80% of land plants vanished.

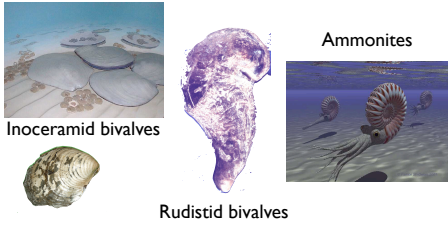
4. In the oceans a number of single-celled organisms disappeared.

5. Many larger marine animals vanished (rudistid clams, ammonites, many vertebrates including plesiosaurs, ichthyosaurs and mosasaurs).



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Some of the major mollusks that went extinct at the Cretaceous/Tertiary Boundary



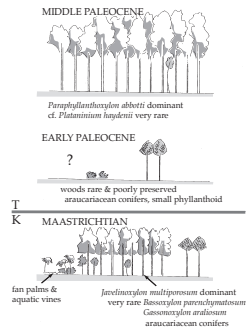
17

Cretaceous

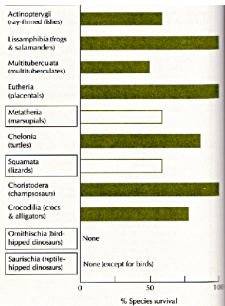
Tertiary



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19



Groups that survived the Terminal Cretaceous Extinctions

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Meteorite Impact at the K/T Boundary -
Uniformitarianism vs. Catastrophism

1. An asteroid impact is a relatively catastrophic extinction mechanism, its effects being felt almost instantaneously.
2. Volcanism is a comparatively gradual extinction mechanism, that played out over thousands or hundreds of thousands of years.
3. The conflict between gradual and catastrophic mechanisms is an ancient one for explaining various phenomena in Earth.

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Asteroid Impact Hypothesis

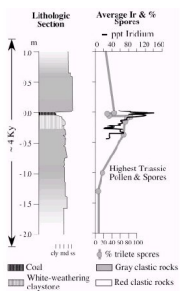
- A. Explanations invoking extraterrestrial causes are commonly voiced - supernova, high radiation.
- B. Most are untestable.
- C. In 1980 Walter Alvarez from U.C. Berkeley discovered high concentrations of Iridium in the boundary clay between Cretaceous and Tertiary sediments. Alvarez was looking in marine sediments in northern Italy.
- D. Similar Iridium "spikes" have been found at the K/T boundary at more than 100 localities world-wide, in both continental and marine sediments.
- E. Iridium spikes have also been found in fluvial and lacustrine sediments .
- F. This was the first physical evidence of an extraterrestrial event .

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How did Alvarez interpret the Iridium evidence?

- A. Small amounts of Iridium shower the Earth as micro meteorite impacts.
- B. But the concentrations at the K/T boundary were either 30 times greater than average, or the rate of accumulation was more than 1 million years.
- C. Other evidence based on the fossil record and radiometric dates argue that the boundary clay could not have taken 1 million years accumulate.
- D. The alternative explanation is that the iridium was deposited very suddenly - by a supernova or an asteroid impact.
- E. Some scientists argued against the Alvarez hypothesis, pointing out that volcanism also sends Iridium into the atmosphere and that the global Iridium anomaly might be explained by volcanic activity.

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Triassic/Permian
Iridium Spike

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Additional evidence in favor of the Impact hypothesis

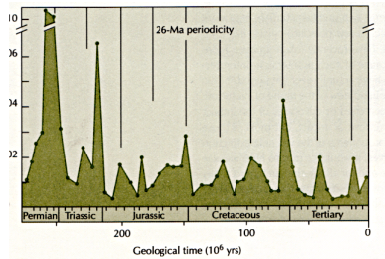
- A. Glassy spheres - distinct chemical composition
- B. Shocked mineral grains - produced in impacts
- C. Diamonds - found together with Iridium in certain class of meteorites
- D. Soot found in the K/T boundary sediments
- E. An impact crater dated at 65 million years was discovered, near Chixulub on the Yucatan peninsula. However, this crater is 300ka too young to be a terminal Cretaceous event and there are no extinctions associated with it!

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Hypothesized Associated Environmental Effects

- A. The heat of impact was followed by acid rain that killed off microscopic plankton in upper layers of the oceans
- B. Dust and water choked the atmosphere for days or months, killing off many plants, herbivores, carnivores
- C. Temperatures dropped initially and the continents froze over for a period of months or years
- D. Over the longer term, temperatures rose from the "greenhouse effect", disrupting the food chain

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Raup/Sepkowsky Hypothesis

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Factoids

- Dinosaur extinctions in the northern part of North America started 7 million years before the end of the Cretaceous and accelerated rapidly in the final 300ka.
- In North America the number of dinosaur genera dropped from 32 to 19 during the last 10 million years of the Late Cretaceous
- So, 40% of dinosaur genera lost in NAM during that time
- The actual dinosaur record right at the K/T boundary is far poorer than it is below the record - making it nearly impossible to say how long the 'final extinction' took
- Rudists actually went extinct before the end, apparently victims of sea-level dropping.

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