MASS EXTINCTIONS: LIFE'S REVOLUTIONS

Abstract—Like death and taxes for humans, extinction is the inevitable lot of species, as many drawers of fossils in museums attest. However, there were times in Earth history when extinction reached unusually catastrophic levels, and the nature of life on this planet was irrevocably altered. These mass extinctions have long been known to fossil collectors. The so-called "Big Five" extinctions are Late Ordovician, Late Devonian, end-Permian, Late Triassic and end-Cretaceous. There are many lesser extinctions as well (Hallam & Wignall, 1997). This account deals only with the Permian-Triassic and Cretaceous-Tertiary mass extinctions, with emphasis on Gondwanan evidence.

Topics include **End-Permian Mother of Extinctions** (non-marine at Graphite Peak, Antarctica), **Permian-Triassic death from Earth or sky?** (extinction mechanisms), **Earliest Triassic postapocalyptic greenhouse** (Australian and Antarctic paleosols), **Early Triassic coal gap** (again Australian and Antarctic paleosols), **End-Cretaceous New Zealand fallout** (marine Woodside Creek, N.Z), **The last dinosaurs** (Montanan paleosols).

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> *"On the day you read this, the population of our planet will increase by 230,000. In 1998 about 137 million human beings will be born, and some 53 million of us will die. That amounts to a net population gain of 84 million."*
>
> **– T.R. Reid, National Geographic (Oct. 1998)**

The Big Six Mass Extinctions

	Event	Cause	Crater (diameter)	Key victims	References
6	End-Quaternary	human overpopulation	–	mammals, birds	Leakey & Lewin, 1996
5	End-Cretaceous	asteroid impact (single)	Chicxulub Crater (180–320km) Yucatan Peninsula, Gulf of Mexico	dinosaurs, ammonites	Grady, 1997
4	Late Triassic	asteroid impact (double)	Manicougan Crater (100km) Canada	mammal-like reptiles, gymnosperms	Benton, 1993
3	End-Permian	massive CO_2 poisoning	–	fusulinid Foraminifera, *Glossopteris*	Erwin, 1993 Bowring & Martin, 1999
2	Late Devonian	asteroid impact (multiple)	Siljan Crater (52km) Belgium	marine inverts	McGhee, 1994
1	End-Ordovican	climatic change	–	marine inverts	Scotese *et al.*, 1999

Theories of asteroid impacts causing mass extinctions go back essentially to the "now famous Alvarez *et al.* (1980) paper in the pages of *Science* . . . which ignited a scientific firestorm . . ." (Mc Ghee, 1994). Luis W. Alvarez (1911–1988), the Nobel-Prize-winning particle physicist from the University of California, Berkeley, opened a new and highly fertile niche for Earth scientists and evolutionary biologists with that seminal paper. A cosmopolitan flood of fieldwork and research papers has followed.

Hypothesis and fact mingle richly, still, in the field of extinctions and asteroids. Little is proven. But, just as there arose from the theories of continental drift and plate tectonics in the 1960s and 1970s, so again has the scope for insight into evolutionary patterns and diversity fluctuations taken a quantum step foreward.

The relative sizes of the six events, their positions in geological time, and their evident effect on the broad pattern of plant evolution, are figured on p. 54.

An asteroid of 10km in diameter—spanning a small city—can form an impact crater more than 150 km across. Such a bolide would rank, in size, somewhere between those that wiped out the mammal-like reptiles (Late Triassic) and the dinosaurs (end-Cretaceous).

> *"They had nothing. No future. So they stuck to the small things. They laughed at ant-bites on each other's bottoms. . . . at overturned beetles that couldn't right themselves. . . . At a particularly devout praying mantis. At the minute spider who lived in the crack in the wall . . . and camouflaged himself by covering his body with bits of rubbish—a sliver of wasp wing. Part of a cobweb. Dust. Leaf rot. The empty thorax of a dead bee."*
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> **– Arundhati Roy, "*The God of Small Things*" (1997)**

> *"Humanity in a way represents the collective brain of Mother Earth. Human consciousness, which contains unlimited potential for spiritual growth, must now move beyond the narrow confines of race and nationality, creed and ideology, and increasingly reflect global concerns."*
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> **– Karan Singh, former member of Indira Ghandi's cabinet, in "*Save the Earth*" (1991)**

Photo: Greg Retallack

Fig. 1 Aerial view of Graphite Peak in the central Transantarctic Mountains. The Permain-Triassic boundary (arrow) at the top of the coal-bearing Buckley Formation is in the foreground ridge just below the two cuesta-forming sandstone beds of the lower Fremouw Formation. The dark rock surrounding the sedimentary sequence are intrusions of Early Jurassic Ferrar Dolerite.

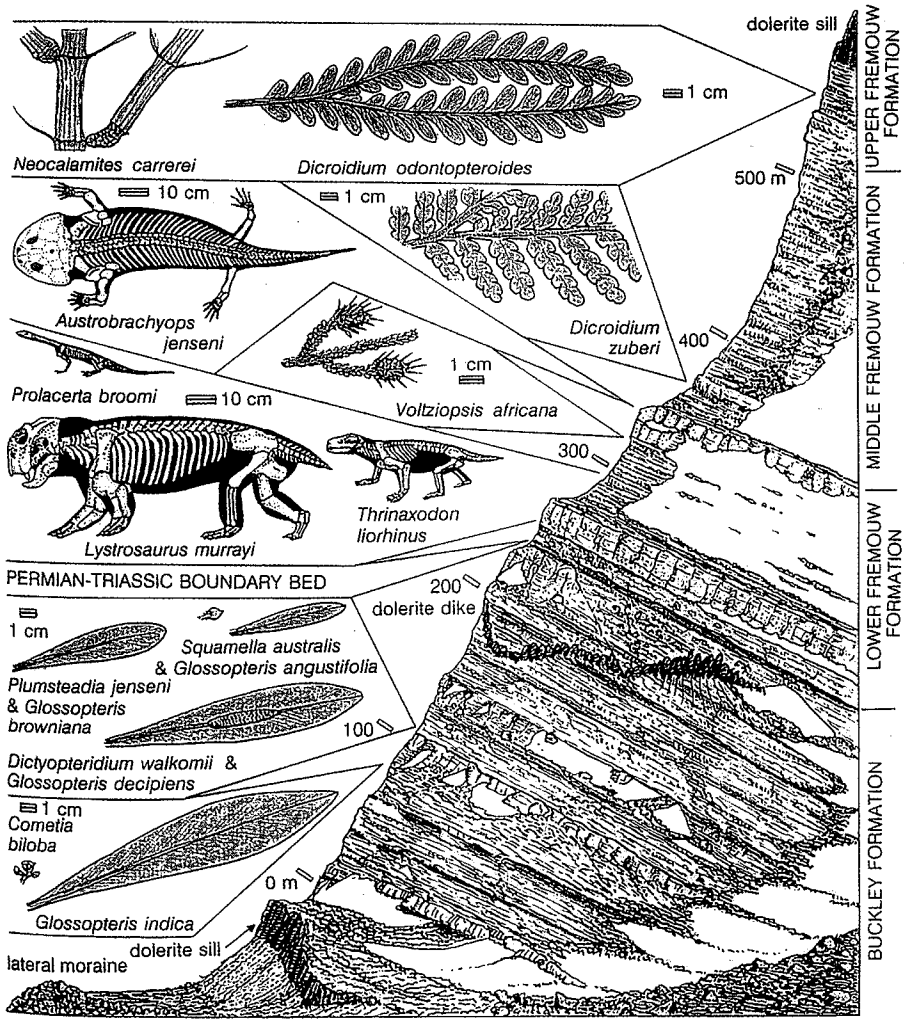

Fig. 2 Outcrop sketch and selected fossils of the Permian-Triassic boundary section at Graphite Peak, central Transantarctic Mountains (from Retallack, 1998). The Permian-Triassic boundary bed provides a fingerprint of the biggest of all mass extinction events, as do equivalent beds around the world.

The Buckley Formation glossopterid flora —of Late Permian age—flourished virtually at the South Pole (see pp. 36–37).