END PERMIAN EXTINCTIONS

i23 Life's greatest crisis < maybe not, mobility replaced sedentary >

> 'So careful of the type?' but no. / From scarped cliff and quarried stone / She cries, 'A thousand types are gone: / I care for nothing, all shall go.' —Alfred Tennyson (1809-1892), *In Memoriam A.H.H. [Arthur Henry Hallam]*, May 1850, LVI, (before Darwin's *Origin*, 1859).[1]

Extinctions are not strange given our modern awareness. Easily more than 99 % of all species that ever lived are extinct. Add now the present extinction event. This, which may become the greatest of all time, has, as its primary agent, us. Counter though, we are the cause of an explosion in evolution that includes our inadvertent broadcasting of mutagens and our deliberate bioengineering of transgenic fertile chimeras (farmers in 22 countries use transgenic seed to grow soy, maize, oil-seed rape, cotton, rice and vegetables).[2] Survivors of the great extinction events favor "mostly the kinds of organisms we call pests" writes Catherine E. Badgley. But this unconscious egalitarianism is possibly the one thing we can be sanguine about in nature and so be phlegmatic about David Jablonski's forecast that, as the largest animals don't make it, "It will be a good time to be a cockroach." Too for new and most of the old viral, bacterial, and fungal lineages.[3]

Charlotte Schubert gives an example of how evolved, tight interactions, among species also presage startling ecological shifts, should changed circumstances cause even one member species to fail: "In the 1700s and 1800s, fur traders purged the Pacific Ocean of many of its sea otters. That resulted in a ripple effect far beyond the livelihood of the hunters. The mainstay of the sea otter's diet, the sea urchin, experienced a population boom. As a result, the urchins' grazing of seabeds caused declines in kelp forests, which serve as a primary breeding ground for fish and many other marine creatures."[4]

According to Niles Eldredge, unremarkable vagaries of environmental change allow mammals species to have existences of one to two million years. Marine invertebrates fare better on average: clam, coral, and crab species mostly endure well over five million years.[5] But Edward O. Wilson in 1993 estimated that Earth is losing some 30,000 species a year.[6] Given that 10,000,000 species exist, the number is great but is not enough to last a thousand years. We are the cause of this 6th Phanerozoic Great Extinction Event. Monoagriculture, ranching, paving over, and dumping is a reordering of ecology that close to 7,000,000,000 (up per year by 80,000,000) people (estimate of world population of ten thousand years ago is 60,000) impose. Can we manage to keep alive the 40,000 species of animals and plants that are currently used for food, shelter, clothing and fuel?

Each large and small extinction event in the past may be laid to a special cause(s). However recovery has been independent, James W. Kirchner and Anne Weil noted in 2000, of severity or rate of extinctions and is correlatable only with rates of origins of species. A revelation is that ecologies need about 10 million years to reach stability.[7]

Before us, life's greatest crisis, after which low biological diversity lasted some 6 million years, was 251 million years ago—the end of the Permian. Then went extinct half of all invertebrate marine families (96% of marine species), 70% of all higher land-animal species, and the forests suffered die offs. This event is used to establish the boundary between the Mesozoic and the Paleozoic periods (***Figure i23.1***). Its legacy is, greater diversity within relatively fewer classes. (Which is to say: before, more numerous classes, most with less diversity.) For example, persisting are four classes of echinoderms: sea urchins, starfishes, sea cucumbers, and crinoids. In the Paleozoic these classes existed together with twelve other echinoderm classes. Of those, only two, the crinoids and the strange looking blastoids, were of high diversity. After the Paleozoic, the crinoids continued as a minor fauna. The blastoids went abruptly extinct at the end of the Paleozoic. The species in the Paleozoic classes that became extinct have (for that reason) a particular strangeness to our eyes.[8]

What is most noticeable about life since the Paleozoic is its mobility compared to before when related life was mostly sessile. Possibly the change to a ranging life style has kept genes better stirred, and this lessened the evolutionary experimentations that produce new classes. Also, extinction, as ecoactivists stridently remind, is forever. Once nature loses a complex experiment in form, it will not arise again as the mathematical odds are too strongly against a repetition of numerous complex steps (which is Dollo's principle of "the irreversibility of evolution"). Thus, as nature loses most of the early experiments to extinctions and nature's gerrymandering, our world becomes populated with fewer surviving major groups. And some forms are no longer possibilities in the stream. Lewis Wolpert's example is: one cannot evolve angels with wings from humans, because of the past evolution of the relevant developmental mechanisms—and for their moral character, Haldane had mused in 1932, "one would have to await or produce suitable mutations." [9]

Brachiopod diversity, modest since end-Permian extinctions, was great during the Paleozoic.[10]

In 1995, Gregory J. Retallack found that 97 % of Permian leaf species did not continue after the end of the period.[11] More recently, Henk Visscher, found a proliferation of wood fungus preserved in sediments of end-Permian age in the Alps, Israel, Siberia, Australia, India, Asia, and North and East Africa. Plant pollen and spores normally outnumber wood-decomposing fungal cells with remnants in sediments. A global forest die off is implied. The brief fungal "spike" [12] eliminates from consideration a simple explanation, such as a drop in sea level, which could explain marine extinctions, but not the die-off of land plant biota.[13]

For what length of time did the devastating extinctions continue into the Triassic across the T-P boundary from their start in the Permian? The answer, benefits from metric radiometric dating of zircon (accurate to within 300,000 years) from volcanic ash layers above and below this extinction event from three sites in southern China and a location in Texas. Extinctions continued for 200,000 years after the Triassic System base ("golden spiked" in the Meishan (Mei Mountain) section, south China at the First Appearance Datum of the conodont *Hindeodus parvus*) after the big initial crunch.[14] The speed of the extinctions and abrupt elimination many marine habitats is in keeping with low sealevel. Explanations for the latter (relatively slow plate tectonic mechanisms, discounted) should also be for Samuel A. Bowring's finding in 1989 of a huge decrease of heavy-carbon to light-carbon ratio in the oceans in the space of 165,000 years, and perhaps in as little as 8,000 years, across the boundary![15] In 2003, Michael Benton, in *When Life Nearly Died*, implicates massive volcanism that also triggered the release of methane from deepsea hydrates.[16] Kliti Grice in 2005 reports that Tethys Ocean was periodically euxinic in the photic zone after and during the extinction event.[17]

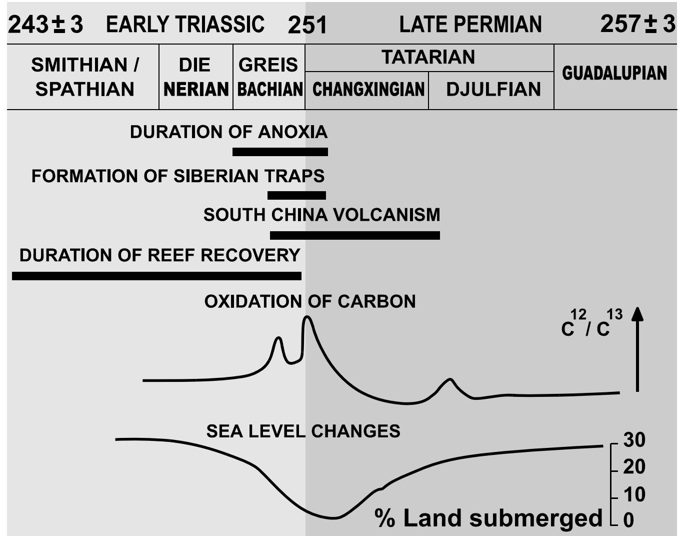
An end-Permian bolide event (an impacting 30-60 km wide asteroid, or a higher velocity impacting 15-30 km wide comet or "dirty snowball" as Fred Lawrence Whipple starting in the 1950s characterized such) is evidenced by a concentration of shock-metamorphosed quartz grains in kaolinite in samples taken in 1996, and again in 1998, at Meishan.[18] In these, against background, Kunio Kaiho found a marked sulfur and strontium isotope excursion that records their release from mantle to ocean-atmosphere, a sharp drop (up to 40%) in atmospheric oxygen (***Figure i23.2***), and a decrease in manganese, phosphorous, calcium, and microfossils (foraminifera).[19]

T-P boundary sedimentary rocks from Japan, Turkey and China, analyzed by Luann Becker in 2001, are found to contain high concentrations of fullerenes or "buckyballs" (carbon-60 soccerball-shaped molecules).[20] These hold gas in which isotope ratios of helium (extraterrestrial is mostly helium-3 whereas terrestrial is mostly helium-4) and argon are as those found in meteorites and, similarly, in rocks at the E-K (Paleogene-Cretaceous) boundary. These isotope ratios are unambiguously not trapped Earth-atmosphere argon accumulations leaked from the Earth's crust, and are mostly the product of radioactive decay of potassium-40. (Fire and lightning make fullerenes. These trap gases with Earth's atmosphere ratios.) Sid Perkins posits: "The presence of fullerenes could become the new hallmark for layers marking extraterrestrial impacts."[21] In 2003, Asish R. Basu reported on chondritic meteorite fragments in an end-Permian bed at Graphite Peak, Antarctica.[22]

But where is the T-P impact site, and why the found relative lack of iridium and absence of shocked quartz? A glib answer is that the bolide exploded only basaltic ocean crust. So shocked quartz and an impact site should not be expected. "If it," Richard K. Bambach reiterates, "didn't hit a block of continental crust, then you cannot and will not find an impact site," for all seafloor, then existing, has subducted. Norman MacLeod has the last word: "There is no statistically significant association between the stage-level impact occurrence pattern (summarized by crater size or number of impacts) and the extinction-intensity record. This contrasts with the major flood-basalt and sea-level records, both of which show compelling correspondences with the extinction record."[23] ❑

Figure i23.1

The end-Permian extinctions occurred when the environment had become degraded by several factors: rotting outpaced photosynthesis (***Scholium i23.1***), sealevel was dropping and some layers in the oceans may have become anoxic.

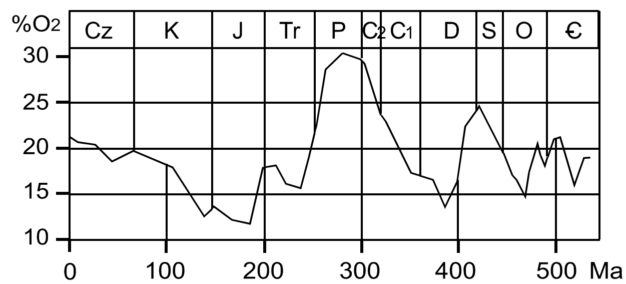


Sadly, in the postextinction interval, survivors of mass extinctions suffer elevated extinction rates. This is best documented for marine genera. These suffered 10-20% attrition in the geologic stage immediately following the extinction event in four of the Big Five mass extinctions of the Phanerozoic. These losses are significantly greater than those found in preextinction stages.

David Jablonski writes: “Because many survivors of mass extinctions do not participate in postrecovery diversifications, and therefore fall into a pattern that can be termed ‘Dead Clade Walking’ (DCW), the effects of mass extinctions extend beyond the losses observed during the event itself.” The ‘survival’ or ‘recovery’ interval contains impoverished (and so often undersampled) biotas. The fates of these Jablonski suggests “may well prove to be nearly as important in shaping the postextinction biota as the bottleneck imposed by the extinction event itself.”[24]

Figure i23.2

The atmospheric concentration of oxygen.[25]



Scholium i23.1 Photosynthesis

Ordinary air sealed in a jar along with a breathing mouse is soon replaced by “noxious” air that suffocates. In 1771, **Joseph Priestley** (1733-1804)[26] impressed his guest Benjamin Franklin no end by showing him a mouse so sealed in a jar along with growing mint which, after a week, survived and flourished respectively. To the sanguine satisfaction of Unitarian minister P and peripatetic statesman F, the mouse died almost instantly when transferred to a jar without mint in which mice had earlier breathed to death.

By the end of the 1770s, Jan Ingenhousz had proved by exhaustive tests 1) that oxygenic photosynthesis “is not performed by the whole plant, but only by the leaves and green stalks,” and 2) that the process is reversible for “all plants contaminated the surrounding air by night” (and so the nurse’s ridiculous ritual of removing flowers from a patient’s room at sunset).

In 1845, Julius Robert Mayer (1814-1878) (who in 1842 had formulated the Law of Conservation of Energy) intoned: “Die Pflanzen nehmen eine Kraft, das Licht, auf, und bringen eine Kraft hervor: die chemische Differenz.” (Plants take in light energy and make it available as a chemical difference.)[27] Early in the 1940s, biochemist Samuel Ruben proved by tracing the flow of elements involved in oxygenic photosynthesis, that breathable O_2 comes from the capture of enough energy from sunlight to split H_2O (and not CO_2).[28] *Note*: Whereas plants’ photosynthesis, at best, can turn about 1%, present commercial solar photovoltaic panels can convert 12-20% of solar radiation into energy that anyone else can use.[29]