Panel 12: Millennium's End (1995.5 to end of the Second Millennium)

In a sense, history is everything that has happened from the Big Bang up to "now," that being the name for the mysterious and fleeting instant between past and future.[1] It has been convenient however, in ChronoZoom, to cut off the time line at midnight between December 31, 1999 and January 1, 2000 — at the exact end of the Second Millennium. This has two advantages: it avoids the problem that "now" is constantly advancing, which would require continual updating of the time line, and it avoids the last few years, which historians think of as current events, not yet offering the advantage of hindsight and perspective. As is the case for Panel 11, this panel was added to bring the resolution down to one day, and a few events are shown for this half year, but not described. Instead this space is used to give some consideration to the character of history.[2]

The Character of History

After Isaac Newton and the physicists who followed him showed that the behavior of the world is governed by unbreakable mathematical laws, an obvious corollary was that history also unfolds according to natural laws, and historians sought to uncover those laws. The effort was notably unsuccessful,[3] and the reasons for that lack of success are beginning to be clear. The laws of physics specify what *can* happen and what cannot (like rocks suddenly rising into the air, or ashes in a cold fireplace bursting into flame), and so physics may be thought of as a *process* science. But there are limits to the ability of physics to predict outcomes — in the case, for example, of sensitive dependence on initial conditions,[4] or when a human being thinks about desired outcomes and makes choices. Finding out what exactly *did* happen is the realm of the *historical* sciences like geology. The complexity of history portrayed by the ChronoZoom panels makes it hard to suppose that the natural situation could have been predicted millions of years in advance, or that its human aspects were inevitable even a few years ago. Rather than search for *laws* of history, it therefore makes more sense to ask what is the *character* of history.

A traditional way to think about the character of history is to ask whether it has unfolded as a very long series of cycles, as in Hindu philosophy, or with linear trends, as in the brief Christian trajectory from Creation to the Day of Judgment. This dichotomy was also prominent in the thinking of the early geologists.[5] It is easy to talk about arrows like "the decline of the West," or cycles like "the rise and fall of empires," but these easy descriptions are difficult to justify in the light of the abundant quantitative data that is more and more available in the historical sciences, especially geology. An excellent example comes from the temperature records in ChronoZoom. Panel 3 shows a long temperature history for the Phanerozoic which is clearly cyclical, but whether the period of the cyclicity is about 40 million years or about 100 million years depends on how the curve is fitted. Panel 4 shows a long cooling trend, but there are long cyclical fluctuations superimposed upon it. Panel 5 shows fluctuations which look random until about 3 Ma, then are high-frequency, symmetrical cycles until about 1 Ma, and finally, as enlarged in Panel 6, low-frequency, asymmetrical cycles continuing until the present time. Finally Panel 7 shows that the temperature for the last 10 kyr has been quite constant. When faced with quantitative historical data sets, neither time's arrow nor time's cycle seems like a useful description of the character of history.

A better approach may be to think in terms of continuities vs. contingencies. Continuities are time sequences like those just considered, with some degree of order and at least short-term predictability, whether more arrow-like or more cycle-like. Contingencies punctuate the continuities of history, and are relatively brief compared to the intervals of continuity that flank them. Natural examples include the assembly of Earth (Panel 2), the Great Ordovician Biodiversification Event and the KT impact and extinction (Panel 3), and the desiccation and refilling of the Mediterranean (Panel 4). It is not at all clear how to define contingency with rigor. Perhaps a contingency needs to be rare, unpredictable, and significant, but there are problems in quantifying each of these. Rarity is scale dependent — for example, only one impact of an Everest-size object is known from the entire Phanerozoic, but sand-size micrometeorites, making meteor streaks, happen many times each night. Unpredictability is ambiguous — orbital movements of potential impactors are predictable with exquisite precision over time scales of years or centuries, but unpredictable over Solar-system history because of sensitive dependence on initial conditions. Significance depends on context — the deaths of most individuals are significant only for their families, while the death of Julius Caesar profoundly affected history.

The unpredictability introduced in natural systems by considerations like sensitive dependence on initial conditions is dwarfed by the unpredictability of sexual reproduction in multicellular organisms and by the human brain. Each human being has two parents, 4 grandparents, etc., with ~1,000 family-tree boxes 10 generation back, ~10^6 boxes 20 generations back, ~10^9 boxes 30 generations back, etc. The sex of each ancestor was determined essentially randomly at conception, and if even one of those myriad ancestors had been of the opposite sex, that person could not be in that box of the family tree, and none of the descendants of that ancestor would exist. The ability of human beings to do thought experiments and make decisions introduces even more unpredictability to history, which might be thought of a system for ensuring unforeseeable outcomes.