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Big History: The longest '*durée*'

Abstract: Big history surveys the past on all scales up to those of cosmology. It answers questions explored in traditional creation stories and universal histories, but it does so with the methods and the evidence of modern scientific scholarship. Though still marginal within historical scholarship, big history is attracting increasing interest and holds out the promise of a fruitful unification of different disciplines that study the past at many different scales. This paper discusses the emergence of big history and its current status and role within historical scholarship.

Key Words: World History, Universal History, creation story, chronometric revolution

Introduction

"Big History" explores the past at very large temporal and spatial scales. It takes familiar arguments for the importance of the *longue durée* and pushes them to their limits by surveying the past as a whole. Fernand Braudel, like most historians interested in the *longue durée*, argued that history is best studied at multiple scales because each scale can add new dimensions to our understanding of the past. As Braudel put it:

> "[…] the way to study history is to view it as a long duration, as what I have called the *longue durée*. It is not the only way, but it is one which by itself can pose all the great problems of social structures, past and present. It is the only language binding history to the present, creating one indivisible whole."[1]

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The same intuition drives much contemporary scholarship in world or global history. Big history simply takes these intuitions to their extreme. But that is quite a radical step, for it means moving well beyond the conventional borders of the history discipline. Big history assumes that historians can find interesting objects, phenomena and questions at all scales, even at scales more familiar to geologists or cosmologists than to historians.

The impulse to explore the past at all possible scales is surely as old as human culture. In all societies we know of, there seem to have been attempts to understand the past as a whole. Such projects were undertaken with the utmost seriousness and according to the highest available standards of truth and rigour because they provided fundamental frames of reference for all members of society. Modern attempts to construct complete maps of the past have been influenced increasingly by the methods and insights of modern science. But not until the middle of the twentieth century did it really become possible to study the whole of the past with scientific rigour. Crucial to this transformation in modern understanding of the past was the elaboration of new dating methods that made it possible to assign reliable absolute dates to events before the existence of written documents. So, though big history asks ancient questions, it could become a serious branch of modern scientific scholarship only from the middle of the twentieth century.

The current status of big history remains unclear. Though it has begun to attract considerable interest, particularly from world or global historians, as well as from scholars in other disciplines, including geology and astronomy, the number of scholars seriously committed to the field at the end of the first decade of the twenty-first century can probably be listed on the fingers of two hands. Finding a well-defined niche for big history within modern educational institutions will not be easy, because the field is by its very nature inter-disciplinary; it can find nourishment as easily in cosmology or palaeontology as within the traditional history discipline. For this reason, if big history ever *does* become a recognized field of scholarship it will surely have a profound impact on both scholarship and teaching, because it will link many different historically-oriented disciplines that are currently quite isolated from each other.

This paper will discuss what big history is and what it tries to do. It will also survey the current state of what remains an embryonic field of scholarship. And it will take up some of the questions historians are bound to ask about such a project: Are there valuable insights for historians at the scales of geology or cosmology? Are they significant enough to justify the intellectual, organizational and even political difficulties of crossing so many discipline boundaries? Can serious research really be conducted at such large scales and across so many disciplines? In short, has "big history" anything to offer professional historians?

The Historiographical Background

In modern Universities and research institutes, with their fractal organization of knowledge into many different disciplines and sub-disciplines, the idea of big history is bound to seem odd. Certainly it must appear over-ambitious because it embraces more scholarly disciplines than any one individual can possibly master. So it is important to remember that the ambition of trying to understand the past *as a whole* is not new; it is in fact extremely ancient. In most cultural traditions, it has been taken for granted that historical understanding should at least try to embrace all of the past. "Universal history" of some kind appears in the historical thinking of all societies we know of. In non-literate societies it takes the form of what we patronisingly call "creation myths": attempts to use the best available knowledge to place society within a larger, often cosmological, context. Creation myths were foundational to most cultures because they provided each individual with a basic sense of orientation in time and place. In some form, universal history has also flourished in all major cultural traditions. It can be found in the Muslim world (in the work of Tabari, Rashid al-Din and Ibn Khaldun), or in the encyclopaedic tradition of Chinese official historiography, or in the chronicles of Mesoamerica.[2] For the Mediterranean world, from which modern historiographical traditions would later emerge, Raoul Mortley has traced the emergence of a self-conscious tradition of universal history soon after the conquests of Alexander the Great.[3] This tradition re-emerged in the universalistic traditions of Christian historiography, which would shape western historical thought for almost 1500 years. As Collingwood puts it:

> "The conception of history as in principle the history of the world […] became a commonplace. The symbol of this universalism is the adoption of a single universal chronological framework for all historical events. The single universal chronology, invented by Isidore of Seville in the seventh century and popularized by the Venerable Bede in the eighth, dating everything forward and backward from the birth of Christ, still shows where the idea came from."[4]

Bishop Bossuet's *Discourse on Universal History*, published in 1681, represents, in the view of Bruce Mazlish, the "last gasp" of a Christian tradition of universal history which dated from the time of St. Augustine.[5] But more secular forms of universal history would flourish for another two centuries during the Enlightenment and in the hands of the great nineteenth century system builders from Hegel to Marx and Spenser. As Fred Spier has noted, Alexander von Humboldt began, but did not finish, a series of volumes on "a cosmical history of the universe." In the introduction to the first volume, published in 1845, he summarized his aims:

> "Beginning with the depths of the space and the regions of remotest nebulae, we will gradually descend through the starry zone to which our solar system belongs, to our own terrestrial spheroid, circled by air and ocean, there to direct our attention to its form, temperature, and magnetic tension, and to consider the fullness of organic life unfolding itself upon its surface beneath the vivifying influence of light."[6]

The language captures well the aspirations of all universal histories.

Then, sometime in the late 19th century, universal history vanished as a serious scholarly pursuit. As the prestige of the natural sciences rose, history, like many other fields of scholarship, began to set higher and more "scientific" standards of rigour, accuracy and evidence. This meant concentrating on the written sources that provided the most reliable evidentiary foundation for dating and understanding the past. An inevitable consequence of the increasing use of written sources was a drastic narrowing of the scope of historical scholarship. Fields such as prehistory or popular history, or the history of the natural world, for which little documentary evidence was available and even fewer dates, were cut ruthlessly from the discipline. Such brutal amputations made sense as attempts to guarantee the scientific rigour of historical scholarship. As Leopold von Ranke put it in the introduction to the universal history that he began at the end of his life:

> "History cannot discuss the origin of society, for the art of writing, which is the basis of historical knowledge, is a comparatively late invention. […] The province of History is limited by the means at her command, and the historian would be over-bold who should venture to unveil the mystery of the primeval world, the relation of mankind to God and nature."[7]

In 1898, in one of the more widely used texts published at the end of the nineteenth century, Langlois and Seignobos wrote: "[t]he historian works with documents. […] For want of documents the history of immense periods in the past of humanity is destined to remain for ever unknown. For there is no substitute for documents: no documents, no history."[8]

The history profession paid a significant price for these gains in scholarly rigour. Above all, historians had to give up any hope of understanding history *as a whole*. Universal history was cut from the discipline along with prehistory. Historians settled instead for the more modest ambition of documenting some of the past, and history, like many other fields of scholarship, began to resemble a vast archipelago of knowledge islands between most of which there was little or no commerce. Ranke understood as well as anyone what had been lost:

> "The study of particulars, even of a single detail, has its value, if it is done well. […] But this specialized study, too, will always be related to a larger context; even local history will be related to the history of the whole country, a biography to the history of a major event in church and state, to an epoch of national or universal history. But all of these epochs themselves, as we have noted, belong in turn to the entire whole which we call universal history. The study of these epochs in a wider context is of a correspondingly greater value. The final goal – not yet attained – always remains the conception and composition of a history of mankind."[9]

Eventually, like an amputee whose phantom pains slowly subside, most historians began to forget about universal history, and concentrated their energies on the more practical and rewarding challenge of studying those parts of the past for which there existed rich archival sources. As Robert Novick has argued, particularly in the English speaking world these shifts encouraged a general suspicion of large hypotheses and a return to the more modest task of clarifying "the facts".[10] Historians abandoned universal history all the more willingly given the evident dangers of constructing grand narratives where there was little hard evidence. Ranke's own unfortunate attempt at universal history showed the dangers: it ended up as a story about Aryans. Meanwhile, the idea of the nation state provided the history discipline with a serviceable alternative to real coherence. If history could no longer study the past as a whole, it could at least recount the whole history of particular nations. And of course, national governments willingly supported this view of the role and function of history, and equally willingly ignored the fact that the grand narratives of national history could be quite as toxic as those of universal history.

All in all, there were many good reasons for abandoning big picture history. H.G. Wells' universal history, *An Outline of History*, was written in the immediate aftermath of the First World War and in the hope of creating a common history of humanity.[11] But despite its commercial success, it had a limited impact on historical scholarship. And one reason was surely the largely speculative nature of the early parts of the book. Trevor-Roper's cruel quip that Arnold Toynbee's *Study of History* ranked "second only to whiskey" as a dollar-earner captures the scorn professional historians came to feel for any attempt at universal history.[12] Memories of a larger, more unified understanding of the past never vanished entirely, but they were banished to the profession's untamed frontier regions. Toynbee himself remained confident that fashions would change, but when he was interviewed by Ved Mehta in the early 1960s his hopes must have seemed utopian:

> "[Toynbee] comforted himself with the thought that the days of the microscope historians were probably numbered. They, whether they admitted it

or not, had sacrificed all generalizations for patchwork, relative knowledge, and they thought of human experience as incomprehensible chaos. But in the perspective of historiography, they were in the minority, and Toynbee, in company with St. Augustine – he felt most akin to him – Polybius, Roger Bacon, and Ibn Khaldun, was in the majority."[13]

Origins of Big History

Early in the twenty-first century, hyper-specialization still rules historical scholarship, and the fear that grand narratives are bound to be both poisonous and unscientific reinforces resistance to big picture scholarship. Yet the recent rise of more expansive views of the past suggests that Toynbee may have been right after all. Since the 1980s, accelerating globalization and the emergence of environmental issues affecting the entire world have revived interest in processes of global change and long-term historical processes.

The same currents have undoubtedly driven interest in big history. But equally important have been other changes that historians largely ignored. These changes have made it possible for the first time to study the remote past with the same degree of rigour expected in conventional historical scholarship.

Perhaps the most important of these changes concern chronology.[14] Though historians often take chronology for granted, it is fundamental to any serious historical scholarship. After all, if events cannot be precisely ordered in time, rigorous discussion of causation is impossible. "Dates and a coherent dating scheme," noted M. I. Finley, "are as essential to history as exact measurement is to physics."[15] Before the middle of the twentieth century, absolute dates could be assigned to past events only where reliable written documents existed. Dates could be assigned with reasonable plausibility to Chinese ruling dynasties for some three thousand years, while Egyptian political dates were reasonably trustworthy for almost four thousand years. But beyond these dates chronology simply collapsed. Nineteenth century archaeologists and geologists learned to assign *relative* dates to events in the remote past, but not until the middle of the twentieth century was it possible to construct reliable *absolute* timelines reaching back further than the 4,000 or so years of recorded history.

The "chronometric revolution" of the mid twentieth century began with the development of radiocarbon dating techniques by Willard Libby in the late 1940s and early 1950s. The basic principle of radiocarbon principle had been understood since the discovery of radioactivity early in the century. It was that radioactive materials, such as the isotope of carbon known as Carbon 14, break down at a predictable pace, so that, by measuring the extent of radioactive breakdown it should

be possible to determine when a lump of material was first formed. Libby was the first to develop sufficiently precise and practicable techniques for making these delicate measurements. Since then, numerous other radiometric techniques have been developed, using different radioactive materials with different "half-lives", so that different techniques can be used to measure different time scales. Carbon 14, for example, with a half-life of about 5,730 years, can be used to determine dates up to about 50,000 years ago, while other elements, such as Uranium, with much longer half-lives, can be used to date events many billions of years ago. Indeed, the power of radiometric dating was demonstrated spectacularly in 1953 when Clair Patterson of the *California Institute of Technology*, used material in meteorites to determine for the first time that the earth was formed about 4.5 billion years ago. Many non-radiometric dating techniques have also been developed and these different techniques can be used to check each other. For example dendrochronology, or the counting of tree rings, was used to re-calibrate Carbon 14 dates once it was realized that levels of C 14 in the atmosphere have varied sufficiently over time to significantly affect the accuracy of carbon dating techniques.

As a general rule, historians have not adequately appreciated the significance of these developments for our understanding of the past. The simplest way of putting it is to say that just 60 years ago reliable timelines could extend only three or four thousand years back in time, which severely limited the scope of historical research. Now, we can construct reliable and increasingly detailed timelines reaching back 13 billion years, to the very origins of the Universe. The chronometric revolution means that history at the largest possible scales can now meet the standards of chronometric rigour taken for granted in traditional historical scholarship.

A second, related change, is the increasing historicisation of the natural sciences.[16] In the nineteenth century, geology and biology both became historical disciplines. That is to say, scholars in both fields learned that the present state of affairs was the product not just of general laws, but also of many slow changes over vast periods of time. But this general awareness of geology and biology as historical disciplines could not transform research until radiometric dating techniques made it possible to construct reliable absolute timelines within both these disciplines. More recently, astronomy and cosmology have also become historical disciplines as it has been realized, partially since the 1920s, but more generally since the discovery of the cosmic background radiation in 1964, that the Universe as a whole is also a product of historical changes over large periods of time. Here, too, new dating techniques have made it possible to construct reliable and increasingly precise timelines for the past of the Universe as a whole.

Taken together, these changes mean that we can now tackle many of the questions asked within traditional universal histories with something of the precision

and rigour of modern science. Human history based on written records can now be integrated within a much larger account of the past that includes human prehistory as well as the entire history of the natural world. It is true, of course, that only written records can give us a rich insight into the internal world of historical actors.[17] But it is also true that big history, by placing traditional historical scholarship within a much larger context, raises the historical question of how, why and when human conscious arose, and what is the precise relationship between a world of conscious actors and a world of natural processes. In other words, big history encourages a re-examination of the relationship between history and the natural sciences.

In summary, big history in its modern forms represents more than a naive nostalgia for the grand visions of universal history. It is, rather, a product of the rapid and accelerating development of historical and scientific scholarship in the twentieth century. The questions of universal history were abandoned not because they were bad questions, but because they could not be tackled with adequate rigour. A century later, much has changed and many of those questions now *can* be tackled according to the highest scholarly standards. This is the challenge taken up by big history.

Big History Today

Currently, big history exists as an interesting but still marginal sub-discipline on the borders between history, biology, geology and astronomy. There are several courses in big history being taught at universities in Australia, the USA, the Netherlands and Russia. The astronomer, Eric Chaisson, has taught an astronomer's version of big history in Boston since the 1970s; and currently, the geologist Walter Alvarez is teaching a geologist's version of big history at Berkeley. The first historians to teach such courses were John Mears, at Southern Methodist University in Dallas, Texas, and David Christian, at Macquarie University, in Sydney. Both courses began at the end of the 1980s.

Though I have argued that there are objective reasons for renewed interest in big-picture history, my own path towards big history was extremely serendipitous. It was driven largely by a naïve curiosity about the outer limits of the history discipline. I began my career as a historian of Russia. In the 1970s and 1980s, under the influence of the *Annales* school, and the major British Marxist historians, I studied the material life of the nineteenth century Russian peasantry. Braudel argued persuasively that study of the slowly changing patterns of material life requires the historian to think on large scales and to look for large patterns that are invisible from close up. This is because such subjects are shaped more powerfully by large

and slow-moving structural features of the past than by the more rapidly changing, and less predictable events of traditional political history described within the *Annales* tradition as *l'histoire événementielle*. At the scale of political events, unpredictable quantum processes seem to dominate history, as they dominate physics at the scale of sub-atomic particles. General laws can explain little at this scale, and the researcher must be alert to the contingent, the unpredictable and the unexpected. Yet at the scales of demographic history or the study of material life, which aggregate large amounts of detailed information, larger patterns become more apparent, as they do in the physics of large numbers of quantum processes.

The conviction that large historical patterns, more or less invisible at the scales of traditional historical scholarship, might become apparent at very large scales, may have pushed me in the direction of big history. But my first step in this direction was itself a quantum process. In a departmental discussion about what should be taught in our foundation courses (a discussion so familiar to the many tribes of University historians that it can be counted as one of their distinctive anthropological rites), I remember suggesting, entirely facetiously, that we should teach "the whole of history". This, I argued, would equip students with a sort of world map of the past which would help them place specific historical subjects within a larger global context. My colleagues ignored my comment, and they were right to do so. However, my suggestion nagged away at my mind and over the next few weeks I began to wonder if it might really be possible to teach a history course covering "the whole of history". The first question that worried me was: when did history begin? None of my colleagues could offer serious answers to what struck me as an important question, and yet I began to feel that it was embarrassing for a professional historian not to be able to identify the outer limits of the history discipline. Pursuing the question of beginnings on my own, I realized it might make sense to start with the appearance of our own species, *Homo sapiens*. But that answer already threatened to take me beyond the conventional borders of the discipline, into prehistory, palaeontology and biology. In any case, the question of human origins seemed lure me into an infinite regress, as different aspects of humanity led me further and further back in time, to the origins of bipedalism, of mammals, of intelligence, and even of life itself. Eventually, though, I discovered to my surprise that if I pursued these questions far enough (How did life originate? How did the earth originate? How did the Universe begin?) there was an end to the regress. This is because, at present we have no idea how to say anything scientific and we have no empirical evidence about anything that happened before a tiny fraction of a second after the big bang. Here, in practice, was an objective starting point for a complete history of the past.

Was it possible to teach a viable history course that began with the big bang? It was immediately obvious that such a course would consist, like a *matrioshka* doll, of many different stories nested one within the other, and told at different scales. This was good. It meant that the course would raise interesting historical questions about the relationship between different scales and the different phenomena that dominated each scale. What can understanding of the big bang tell us about our earth and solar system? What links stars and living organisms? What is the difference between complex chemicals and living organisms? What distinguishes the history of our own species from the histories of many other species? What, in other words, makes human history different from, say, the history of chimps, or elephants or dolphins or owls? I soon decided that, if nothing else, such questions would provoke interesting discussion about the nature, scope and purpose of history, and my colleagues, with some anxiety (and some averting of the gaze), allowed me to road test such a course for first year students.

I began teaching big history in 1989. To give the lectures, I recruited colleagues from astronomy, geology, biology, anthropology, ancient history and history to lecture in the course. For the readings, I cobbled together a collection of readings that included works by scientists and anthropologists (including Marshall Sahlins' famous essay, *The Original Affluent Society*, and the theoretical introduction to Eric Wolf's *Europe and the Peoples without History*). The first lecture discussed time. The second lecture discussed creation stories, in order to raise the possibility that this course could be thought of as a modern, scientifically based, creation story. Then we began at the beginning with lectures on the key ideas of big bang cosmology and the evidence on which it is based. Created in the big bang, 13.7 billion years ago, were the fundamental constituents of our Universe: matter and energy and (perhaps) time and space as well. There followed lectures on the formation of stars and galaxies. These are some of the largest inhabitants of our Universe, and stars generate the energy flows that drive change on planets such as our own earth. Discussion of the life cycle of stars led naturally to discussion of the creation, within stars and supernovae, of most of the chemical elements of the periodic table. Equipped with a much richer palette of chemical elements, it was now possible to discuss the creation of planets and of living organisms. Lectures described the creation, in orbit around stars, of planets, and of our own solar system, about 4.5 billion years ago. Lectures on the early earth and the evolution of the earth's atmosphere and its surface (a topic that introduced plate tectonics), led naturally to the subject of life itself which, intriguingly, appeared very early in the history of our planet. What is life? How does natural selection work? And how did life arise on earth? There followed lectures on the major stages in the evolution of life over almost 4 billion years, ending with an account of the evolution of our bipedal ancestors, the hominines (from about 6

million years ago), and of our own species, *Homo sapiens*, sometime within the last 200,000 years. The appearance of our own species was associated with the emergence of new, accelerated mechanisms of change, as the social accumulation of information began to transform lifeways faster than the slower mechanisms of genetic change. With human history, culture overtook natural selection as the main driver of historical change. The rest of the course surveyed the consequences of this momentous transition. Lectures covered the Palaeolithic era of human history (embracing well over 90% of the time humans have been on earth), the Agrarian era of the last 10,000 years, and finally the Modern era, covering just the last few centuries. Under pressure from students, shocked that a course dealing with such large patterns and trends might refuse to consider the near future, we soon began giving lectures on prospects for the near future and even for the future of the Universe as a whole.

Our first attempts at teaching big history showed several things. To no one's surprise, they showed that teaching such a course was difficult. We encountered awkward border crossings as we moved from discipline to discipline. At these borders the language changed, as well as the paradigms, the central questions and the notions of what counted (or did not count) as legal scholarly behaviour. Over time, we managed to ease the border crossings for ourselves and for our students by learning how to translate the jargon of one discipline into the jargon of another. Often, this showed that different disciplines were asking similar questions but in different scholarly dialects. The biologist talking of "evolution" or the astronomer talking of "star formation" or the geologist discussing erosion were all referring in different ways to what historians might describe simply as historical change or change through time. Is change fundamentally the same thing in cosmology, biology and history? Whatever the answer, discussing the question was interesting for both teachers and students.

On the other hand, we found it was remarkably easy to construct a coherent story of origins. Each new topic seemed to arise naturally from the previous topic, rather as if the Universe was slowly being filled up with the entities and forces needed to explain the world around us. The big bang provided the energy and raw materials for the manufacture of stars, while stars provided the energy and raw materials for the manufacture of planets. Similarly, the chemical and thermodynamic complexity of planets made possible the even more complex chemistry of living organisms, and understanding of the evolution of the biosphere set the stage naturally for the appearance of our strange species. Finding coherence in this grand story turned out to be surprisingly easy.

Student responses to the course demonstrated that there is a huge thirst for large, coherent and all-embracing accounts of the past. The best students found even the prototype versions of the course extremely satisfying because they raised

large questions that are normally avoided in University courses, and they held out the possibility that there might be interesting answers to them somewhere. How significant are human beings in the history of the planet? Or even the Universe? Is human history a continuation of the history of life on earth? Does it make sense to treat human history in complete isolation from the history of the biosphere? Or does the appearance of human beings count as a new turning point in the history of the planet? The course also raised powerful questions about the near future. Are humans doing serious damage to the biosphere? Are present consumption levels sustainable? Are levels of inequality greater than ever before in human history? Are there solutions available to such problems? All in all, we found that the agenda of big history was exciting for students because of the large, interlinked questions that it raised, whether or not it could promise fully satisfactory answers.

What of scholarship in big history? Fred Spier has shown that a number of works published since the middle of the twentieth century can legitimately be regarded as studies in big history, beginning with Erich Jaensch's *The Self-Organizing Universe*.[18] In 1992, I published an article describing my big history course, and it was in that article that I first used the label, "big history".[19] I used it because I needed a simple and memorable label to describe the course. It is not ideal, of course, but it seems to have stuck. And the article itself attracted significant attention, particularly among world historians in the USA. In 1996, Fred Spier published the first book-length study of big history: *The Structure of Big History*.[20] In it, Spier, argued that the notion of distinct "regimes" might offer a conceptual framework for thinking about big history. In 2001, Eric Chaisson published an astronomer's view of big history in *Cosmic Evolution*, which he followed up five years later with another survey of big history, *The Epic of Evolution*.[21] In 2004, I published *Maps of Time*, an attempt to summarise the story of big history, as I understood it, within a single volume.[22] In 2007, Cynthia Stokes Brown published a second text in big history.[23] In 2009, Fred Spier will publish a major study on big history exploring the central theme of increasing complexity.[24]

Research Agendas

There is, as I have argued, a clear narrative coherence to the agenda of big history. But can it yield a deeper coherence? Can big history yield new scientific research agendas? I believe that, by raising questions across multiple disciplines and combining the insights and methods of different disciplines, it can indeed yield new research agendas. E.O. Wilson has argued forcefully that we are on the verge of a grand unification of scholarly disciplines that will prove even more significant than

the earlier unification of physics and astronomy whose majestic offspring was big bang cosmology.[25]

Eric Chaisson has shown how the coherent narrative of big history might yield deep research agendas in his discussions of complexity in big history. He has shown that there are powerful reasons for thinking that, over 13.7 billion years, the upper level of complexity has slowly increased. And with each new level of complexity, we can identify new emergent properties that define the central problems of different scholarly disciplines. At an intuitive level this claim is surely correct. For the first hundred or two hundred million years of its existence, the Universe was simple. It consisted of huge clouds of dark matter (whose nature remains obscure, though we do know that it has few interactions with forms of energy apart from gravity); huge clouds of visible matter, consisting (after about 380,000 years from the big bang) almost entirely of hydrogen and helium atoms; and four different types of energy. The Universe as a whole was relatively homogenous and most of its properties could be explained within the fundamental laws of physics. With the appearance of the earliest stars and galaxies, large, structured objects, organized mainly by the force of gravity, emerged, and the Universe became less homogenous. Of particular importance for us are differences in density and temperature. Stars, whose hot centres fused hydrogen into helium atoms, represented tiny furnaces in a Universe most of which was close to absolute zero. These energy differentials could drive processes that would eventually generate new levels of complexity in the vicinity of stars. Stars (particularly large stars) also raised the general level of chemical complexity by manufacturing elements up to iron in their cores, and then by manufacturing all other stable elements in the vast explosions of dying large stars known as supernovae. A world of extreme chemical simplicity slowly turned into one in which, in the heart of galaxies there appeared new substances, with entirely new properties. At this point, the laws of chemistry come into play. Only in a Universe seeded with all the elements of the periodic table could planets form. In deep space, but more actively on the surface of planets orbiting stars, complex new substances began to be manufactured by the chemical combination of atoms in environments seeded with many new elements and powered by the energy differentials generated by nearby stars. Some planets were ideally placed to nurture chemical reactions of exceptional complexity, being neither too close to the energy flows generated by their parent stars, nor too far away. On at least one planet in one star system, there emerged large chemicals so intricately organized that we think of them as living organisms. Life represents a new level of chemical complexity, as living organisms can replicate themselves and slowly change and adapt to their environments according to the laws of natural selection. This is the source of their astonishing diversity, and their emergent properties are studied within the life sciences.

Seen within this large framework, human history itself can be seen as the product of a new level of complexity. What distinguishes change in human history from change in the biological realm is that humans can exchange learned information with such speed and precision that learned knowledge begins to accumulate within each human community. As learned knowledge accumulates within each community, humans begin to adapt no longer just through the slow mechanisms of genetic change, but the much faster mechanisms of cultural change. As a result, the diversity of human societies is greater by orders of magnitudes than that of any other living species. Only within our own species can learned information accumulate so effectively that it begins to drive change faster than natural selection. In other words, with the appearance of our own species we discover new emergent properties driven by a new mechanism of change, which we can call by the more familiar label of cultural change.

I hope this discussion suggests how the large framework of big history can suggest new ways of understanding what is distinctive about human history. It also suggests that the dangers faced by our biosphere today arise not simply because of developments in recent centuries, but from the very nature of our species as an information exchanging organism that can accumulate ecologically significant information in ways that no other species can match. All living species can adapt to their environment; that is one of the defining features of life itself. We are simply terrifyingly, even dangerously, good at adapting. We are, in fact, "hyperadaptive".

I hope this brief, and highly simplified survey of how one might think about complexity within the agenda of big history can also suggest how big history can link the many knowledge islands of today's vast archipelago of knowledge by tracing a single, coherent, story of change in time across many different disciplines.

The Future of Big History?

When I began teaching it twenty years ago, the idea of big history seemed little more than an intriguing intellectual experiment, even though I soon realized that I was not the only scholar conducting such an experiment. At the end of the first decade of the twenty-first century, big history is still marginal. But it is no longer invisible. There have been several trans-disciplinary conferences on the subject, two in Russia and one organized by the Santa Fe Institute in Hawaii, in 2008. Big history is now being taught in a number of history departments, and in departments of astronomy and geology in several countries. But the indirect influence of big history is greater than these figures might suggest, for its questions and agendas are beginning to influence some of the agendas of world history.[26] My own impression

is that, in general, the natural sciences offer a more friendly environment for big history than the humanities disciplines. This may be because the natural sciences have already witnessed several powerful intellectual revolutions generated by the coming together of once isolated disciplines. One of the most spectacular recent examples is the emergence of big bang cosmology from the coming together of nuclear physics and astronomy. Indeed, so powerful was that merger that scientists often talk of "grand unifying theories" with an abandon that would shock most historians. Equally spectacular, and much more influential in practice, has been the emergence of modern genetics from the borderlines of biology and biochemistry. The humanities have generally been less optimistic about the value or even the possibility of such large inter-disciplinary mergers, and there remains significant resistance to grand narratives such as those implicit in big history.

However, it is my hope that this resistance will eventually vanish, and that the basic story of big history will become a familiar piece of intellectual furniture in the minds of all historians and perhaps of all scientists, a "grand unified story" to match the "grand unified theories" of modern physics. Indeed, if creation stories are as significant as their apparently universal presence in human societies suggests they are, then big history ought to be part of every high school syllabus. Its presence in high school curricula would ensure that all high school students would acquire a sense of the fundamental unity of modern knowledge, and the way that different forms of knowledge can combine to help explain the world and Universe we inhabit. In an intellectual environment where the basic story of big history was familiar to every educated citizen, we might also expect a sense of global citizenship to seem more natural, and we might also expect interdisciplinary research to seem more natural.

Notes

1 Fernand Braudel, On History, Chicago 1980, viii, from the preface to the 1969 edition.
2 Marnie Hughes-Warrington, Writing World History, in: William McNeill, ed., Berkshire Encyclopedia of World History, vol. 5, Great Barrington, Conn. 2004, 2095–2103. On the historiography of big history see also Marnie Hughes-Warrington, Big History, in: Social Evolution & History, vol. 4, issue 1 (Spring 2005), ed. Graeme Donald Snooks, 7–21 [also available in: Historically Speaking, November, 2002: 16–17, 20]
3 Raoul Mortley, The Idea of Universal History from Hellenistic Philosophy to Early Christian Historiography, Lewiston 1996.
4 R. G. Collingwood, The Idea of History, rev. ed., intro. by Jan van der Dussen, Oxford and New York 1993, 51.
5 Bruce Mazlish, Terms, in: Marnie Hughes-Warrington, ed., Palgrave Advances in World Histories, Basingstoke, 2005, 20–23.
6 Fred Spier, Big History and the Future, manuscript in press with Amsterdam University Press, ch. 1.
7 Cited from Dan Smail, On Deep History and the Brain, Berkeley 2008, p. 45, and In the Grip of Sacred History, in: American Historical Review, 110, No. 5 (Dec 2005), 1337–1361, from 1350.

8 Also cited from Smail, On Deep History, 46.
9 Cited in Fritz Stern, ed., The Varieties of History: From Voltaire to the Present, New York 1956, 61. The conviction that good scholarship must balance a sharp research focus with broad theoretical perspectives was a commonplace of 19th century scientific scholarship. In his autobiography, Darwin writes: "My industry has been nearly as great as it could have been in the observation and collection of facts." But he immediately adds: "From my early youth I have had the strongest desire to understand or explain whatever I observed, that is, to group all facts under some general laws. These causes combined have given me the patience to reflect or ponder for any number of years over any unexplained problem." Paul H. Barrett and R.B. Freeman, eds., The Works of Charles Darwin, 29 vols., London 1986–1989, vol. 29, 159.
10 Peter Novick, That Noble Dream: The "Objectivity Question" and the American Historical Profession, Cambridge 1988, ch. 1.
11 H.G. Wells first published his *Outline of History* in 1920, in the hope that its broad vision of the past would help undercut the nationalist accounts that, in his view, had led to the calamity of World War I. See Outline of History, 3rd ed., London 1921, vi.
12 Cited from Gilbert Allardyce's 1990 article, Towards World History, in: Ross E. Dunn, ed., The New World History: A Teacher's Companion, Boston and New York 2000, 30.
13 Ved Mehta, Fly and the Fly-Bottle: Encounters with British Intellectuals, Boston 1962, 143.
14 David Christian, Historia, complejidad y revolución cronométrica [History, Complexity and the Chronometric Revolution], in: Revista de Occidente, Abril 2008, No 323, 27–57.
15 Cited from Bruce Mazlish, Terms, in: Hughes-Warrington, ed., World Histories, 19.
16 William H. McNeill, History and the Scientific Worldview, in: History and Theory, vol. 37, issue 1 (1998), 1–13.
17 The English historiographer, R. G. Collingwood, followed a line of thinkers reaching back through German historiography to Mill and Vico, in arguing that history was unique in dealing not just with blind "events" but with conscious "acts". See Collingwood, The Idea of History, 210, 115; and see the discussion in Bruce Mazlish, The Uncertain Sciences, New Haven and London 1998, 12 (on the influence of Mill), and 86 (on the distinction, based partly on the writings of Mill, between Geisteswissenschaften and Naturwissenschaften).
18 Erich Jantsch, The Self-Organizing Universe: Scientific and Human Implications of the Emerging Paradigm of Evolution, Oxford 1980.
19 David Christian, The Case for 'Big History", in: The Journal of World History, 2, No. 2 (Fall 1991), 223–38.
20 Fred Spier, The Structure of Big History: From the Big Bang until Today, Amsterdam 1996.
21 Eric Chaisson, Epic of Evolution: Seven Ages of the Cosmos, New York 2006, and Eric Chaisson, Cosmic Evolution: The Rise of Complexity in Nature, Cambridge, Mass. 2001.
22 David Christian, Maps of Time: An Introduction to Big History, Berkeley, CA. 2004.
23 Cynthia Stokes Brown, Big History, New York 2007.
24 Fred Spier, Big History and the Future, manuscript in press with Amsterdam University Press.
25 E. O. Wilson, Consilience: The Unity of Knowledge, London 1998.
26 For example, Pat Manning writes in a survey of the evolution of world history: "[…] several interventions in big history at a broad and synthetic level required attention to knowledge and theories beyond the established topics of history. Most dramatically, the 'big history' initiated by David Christian and pursued by Fred Spier drew on the full range of the natural sciences and the information they provided on the earth's past." Pat Manning, Navigating World History: Historians Create a Global Past, New York 2003, 99.