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From the Editor

This year marks the tenth anniversary of the International Big History Association, and it has been more than thirty years now since the first big history courses were offered by John Mears at Southern Methodist University in Dallas and David Christian at Macquarie University in Sydney. By now the justifications for doing scientific and humanistic analyses at large time scales have been well established. If anything, they are even *more* relevant today than they were thirty years ago. This comes through clearly in the contributions to this edition.

At the scale of 4 billion years, the scale of life on Earth, Tyler Volk, Professor of Biology and Environmental Studies, New York University, looks for new models and draws links across various disciplines. Author of *Quarks to Culture: How We Came to Be* (2017) and *Metapatterns: Across, Space, Time, and Mind* (1995), here Volk, a self-described "patternologist," compares his tripartite system of dynamic realms with the working conceptual structures currently deployed in the field of big history. While noting the commonalities, especially the metapattern of generalized evolutionary dynamics, between his work and big history, he argues that another metapattern for evolution, PVS (propagation, variation, and selection), could be used profitably in big history both in terms of biological, and especially cultural evolution, suggesting that PVS dynamics could be used in big history to establish a better model of collective learning.

Moving back and forth between the scale of the Anthropocene and the present, Tatiana de Freitas Massuno, Pontifical Catholic University of Rio de Janeiro, and Daniel Barreiros, Federal University of Rio de Janeiro, explore the ways in which big history can respond to what David Christian calls the "intellectual apartheid between the 'two cultures' of science and the humanities." Using the lens of literary theory, they examine Ian McEwan's *Solar* (2010), wherein the main character, one Michael Beard, Nobel laureate for research on clean energy, is so caught up in his own personal problems that he utterly fails to recognize the global implications of his own work. It is a fascinating character study and entirely à propos to our current circumstances. "Beard's epistemological disjunction," the authors warn us, "is a collective, societal, civilizational matter. If it were a disease, it would be a widespread endemic one."

Another benefit of doing analyses at large time scales is that it allows scholars to do some thinking about the future, an exercise that becomes all the more critical as our population and our technological capabilities continue to grow at exponential rates. In "Crossing the Threshold of Cyborgization," Anton Grinin, Moscow State University, and Leonid Grinin, The Institute of Oriental Studies of the Russian Academy of Sciences, Moscow, examine technological evolution. Looking at trends in cyborgization, the process of replacing parts of the human body with cybernetic implants, the authors review its origins in collective learning and ask questions about problems and risks associated with future scientific and technological progress.

At the scale of 500 years, that is, in the context of the emergence of modernity, Kevin Fernlund, University of Missouri, St. Louis, explores debates surrounding the idea of the universal evolutionism of the Enlightenment. Addressing cultural critics who see modernity as yet another form of western cultural imperialism, Fernlund makes the case that this is in fact a global change. Central to the question—and integral to investigations of the past at large time scales—is the notion of progress. Along the way, Fernlund opens a new trail of big history scholarship that extends back to the mid-eighteenth century, arguably even to the sixteenth century, thereby adding significantly to the big history genealogy.

Finally, in keeping with the journal's commitment to pedagogy and at the core of our investigations since the first big history courses were offered in the 1980s, historical analyses at large time scales provide a vital vantage point for purposes of education. All else flows from this: questions of progress and meaning, interdisciplinarity, overcoming the two cultures divide, concerns for the future, stewardship of the Earth, global citizenship. Paolo Vismara, Scuola Secondaria di Primo Grado "Segantini," Nova Milanese, Italy, elicits all these ideas in a creative exposition of his forays into teaching big history in Italian middle schools. Vismara has recently published a big history novel entitled *Storia interiore dell'Universo*. Here in this essay, steeped in the Montessori tradition, he seeks to overcome the fragmentation of knowledge, and to create new experiences for teachers and students alike, that will allow them to enter the "pools of mystery" of each big history threshold so as to approach "common themes studied from the different points of view offered by the various disciplines."

David R. Blanks, Editor

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Articles

Book Reviews

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The Great Battle of the Books between the Cultural Evolutionists and the Cultural Relativists: From the Beginning of Infinity to the End of History

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ABSTRACT

The idea that societies or cultures can evolve and, therefore, can be compared and graded has been central to modern history, in general, and to big history, in particular, which seeks to unite natural and human history; biology and culture. However, while extremely useful, this notion is not without significant moral and ethical challenges, which has been noted by scholars. This article is a short intellectual history of the idea of cultural evolution and its critics, the cultural relativists, from the Age of the Enlightenment, what David Deutsch called the "beginning of infinity," to the neo-Hegelianism of Francis Fukuyama. The emphasis here is on Europe and the Americas and the argument is that the universal evolutionism of the Enlightenment ultimately prevailed over historical particularism, as global disparities in social development, which were once profound, narrowed or even disappeared altogether.

> *I must study Politicks and War that my sons may have liberty to study Painting and Poetry Mathematicks and Philosophy. My sons ought to study Mathematicks and Philosophy, Geography, natural History, Naval Architecture, navigation, Commerce and Agriculture, in order to give their Children a right to study Painting, Poetry, Musick, Architecture, Statuary, Tapestry and Porcelaine.*[1]
>
> John Adams to Abigail Adams, 1780

The idea that societies or cultures can evolve and therefore can be compared and graded has been central to modern history, in general, and to big history, in particular, which seeks to unite natural and human history: biology and culture. However, while extremely useful, this notion is not without significant moral and ethical challenges, which has been noted by scholars. This article is a short intellectual history of the idea of cultural evolution, and its critics, the cultural relativists, from the Age of the Enlightenment, what David Deutsch called the "beginning of infinity," to the neo-Hegelianism of Francis Fukuyama. The emphasis here is on Europe and the Americas and the argument is that the universal evolutionism of the Enlightenment ultimately prevailed over historical particularism, as global disparities in social development, which were once profound, narrowed or even disappeared altogether.

Cultural versus Organic Evolution

The French naturalist Jean-Baptiste Lamarck (1744-1829) was wrong about biology. Organisms do not pass on characteristics acquired in their own lifetimes to their offspring. A giraffe, for example, that learns to stretch its neck to reach leaves higher up a tree, cannot then pass on a

longer neck to the next generation. Biological evolution or nature does not work that way. But Lamarck was right about human history. Humans individually or collectively learn new things all the time, and they may pass on this newly acquired knowledge to the next generation through formal or informal means. This is precisely how cultural evolution, or what one might call Lamarckian evolution, works. The idea was discovered and given full expression by the Enlightenment.[2]

The modern idea that cultures have evolved and that they have the capability to progress, however, did not originate with the advent of critical history during the Enlightenment, marked by the eighteenth-century histories of David Hume, William Robertson, and Edward Gibbon.[3] Rather, the idea formed earlier in the sixteenth and seventeenth-centuries, when English philosopher Francis Bacon looked back to Antiquity and opined that modern inventions have set the modern world apart from the ancient world. Bacon observes:

> We should notice the force, effect, and consequences of inventions, which are nowhere more conspicuous than in those three which were unknown to the ancients; namely, printing, gunpowder, and the compass. For these three have changed the appearance and state of the whole world: first in literature, then in warfare, and lastly in navigation; and innumerable changes have been thence derived, so that no empire, sect, or star, appears to have exercised a greater power and influence on human affairs than these mechanical discoveries.[4]

Bacon was making the case for the Moderns in the Ancients versus the Moderns debate, which grew out of the Renaissance, with the rediscovery of classical learning, and intensified during the Scientific Revolution. Modern Europeans, Bacon argued, could see farther and better than their ancestors because they had powerful new optical instruments, such as the telescope and the microscope. Crucially, because of the scientific method (the testing of hypotheses), the Moderns had the tools and means to think better than the Ancients.

Not to be outdone by the scientists, scholars also developed the humanistic method to think better, which perhaps no one expressed better than did the Victorian educator Matthew Arnold. In an essay entitled "Culture and Anarchy" (1869), he wrote that culture ought to be the

> pursuit of our total perfection by means of getting to know, on all the matters which most concern us, the best which has been thought and said in the world; and through this knowledge, turning a stream of fresh and free thought upon our stock notions and habits.[5]

Implicit in Bacon's argument for the superiority of the present over the past is the notion of progress, that knowledge could be increased, and that society, therefore, could be improved upon over what it had been before.

Dynamic versus Static Societies

The New World of Bacon was not just geographical; it was also psychological—a new state of mind. In short, as reflected in the methods of Bacon and René Descartes—and later with the work and achievements of Isaac Newton and John Locke—Western society had become "dynamic," to use the term of David Deutsch, a British physicist and philosopher of science. To Deutsch, a "static society involves," in contrast to a dynamic one, a "relentless struggle to prevent knowledge from growing."[6] This conservatism was not irrational since, without science, there was no way to test whether a new idea was true or useful. Thus, in static societies, authorities sensibly viewed all ideas or innovations with caution, if not outright suspicion. Cultures that reproduce themselves by avoiding innovation and adhering to tradition—where sons and daughters learn to copy their fathers' and mothers' ways of doing things—may have been static but they were also stable, which was a crucial achievement in what was otherwise a dangerous and an unpredictable world.

Dynamic, as opposed to static, societies, on the other hand, were exceedingly rare. To quote Deutsch again, modern Western civilization is "the only known instance of a long-lived dynamic (rapidly changing) society."[7] Unlike those in static or traditional societies, participants in Western

civilization were aware, sometimes keenly so, that change had occurred or was occurring during their own lifetimes, and they believed that change would go on to remake their children's world as well. In 1776 and 1789 Americans as well as the French, respectively, both embraced revolutionary change. As these two revolutions demonstrated, change was not a random occurrence but could be intentional and directed. Change also brought unintended consequences.

With the rise of freer markets, freer and regular elections, amendable constitutions, scholarly criticism, peer review, due process, freedom of the press, patents, double-entry bookkeeping, and many other processes and mechanisms of self-correction and transparency, including the very study of history itself, change became self-perpetuating and its pursuit institutionalized within new, fiercely competitive and increasingly powerful nation-states as well as within other forms of intrastate organizations, such as the joint stock company and later the business corporation. Even the simplest associations came to keep minutes and to divide the business into old and new.

These new freedoms certainly did not emerge all at once or occur everywhere. The development of a liberal or free culture, after all, was complex and multifarious, but the liberal ideal was grasped early, and by the end of the eighteenth century, progress toward its full realization had been made on a number of fronts—from Paris to Philadelphia. At the same time, the belief took hold that the future would or should be better than the past; that the next generation could expect to live better than the last.[8]

Thus, the great significance of the Scientific Revolution had far less to do with the science that the Bacons, Newtons, and Lockes produced during the seventeenth century than it did with the new and improved way of thinking that marked this change in intellectual history and which made possible the Enlightenment that followed in the next century. Reason, to say nothing of faith, was no longer enough. To quote Deutsch again, Europe's thinkers began to seek "good," that is, "testable" explanations. On the significance of this important break with the past, Deutsch declared:

> the sea change in the values and patterns of the whole community of thinkers, which brought about a sustained and accelerating creation of knowledge, happened only once in history, with the Enlightenment and its scientific revolution. An entire political, moral, economic and intellectual culture—roughly what is now called the 'West'—grew around the values entailed by the quest for good explanations, such as tolerance of dissent, openness to change, distrust of dogmatism and authority, and the aspiration to progress by individuals and for the culture as a whole. And the progress made by that multifaceted culture, in turn, promoted those values.[9]

In short, the West—Western Europe and by extension North America, i.e., the North Atlantic world—hit upon a variety of methods to test and, crucially, to self-correct for error. These methods would eventually, if selectively, be adopted by other parts of the world.

Europe and America

Modern Europeans not only began to compare themselves with, and distance themselves from, their Ancient but civilized ancestors from Greece and Rome, but they also began to compare their cultures (or their common European civilization) with, and distance it from, the Native cultures of the New World—peoples and lands unknown to the cosmographer Claudius Ptolemy and the other Ancients. To Europeans, the American aborigines seemed primitive because they lived closer to nature, if not actually, they thought, in a state of nature. This idea served as the philosophical jumping off point for the seventeenth-century social contract theorists like Thomas Hobbes, Bacon's contemporary, and John Locke. By the eighteenth century, an entire line of thought had emerged from the evolutionary notion that as primitive America now is, civilized Europe once was. Going to America, or the Pacific Islands, meant one traveled horizontally through space and went vertically backward through time. Thus, with the Renaissance, Europeans discovered the Ancients, their learned forebears, in their newly

stocked libraries of translated texts; in the Age of Discovery, and well after, they encountered in real time and throughout the Americas representatives of what they took as their more primitive or savage progenitors. America was regarded, in short, as Europe's distant mirror.

The West's Clenched Fist and Invisible Hand

The Ancients versus Moderns debate, sometimes framed as the fight between authority and progress, or what Jonathan Swift satirized in 1697 as the "battle of the books," exhausted itself by the end of the seventeenth century.[10] The idea of progress, however, not only survived into the next century, it expanded and thrived, and, later, in the writings of the Scottish Enlightenment philosophers, became richly adorned in theory but firmly based in common sense and in Scotland's own sense of recent history—the divide between Highlands and the clannish old ways, on the one hand, and Lowlands and the newer law-based, market-driven society, on the other. The theory of progress replaced the old declension narrative of sacred history, which traced the fall of man from Adam and Eve, to Noah and Moses, then to Christ, the Redeemer, and, finally, to the expectation and eschatology of the Second Coming and Resurrection.[11] In contrast, the new secular version of history, as traced by the Scottish thinker Adam Ferguson in 1767 in his "An Essay on the History of Civil Society," was one of ascension, as "rude" states evolved into "polished" ones. Mankind was pointed toward ever greater refinement rather than salvation.[12]

In the Enlightenment's shift from a God-centered to a human-centered history—and from a Jerusalem-centered map to a Eurocentric world geography—man arose out of nature rather than in the Garden of Eden. Humans then started their long career hunting and gathering. Hobbes had imagined that this primitive and savage state of affairs was a time when

> every man is Enemy to every man; the same is consequent to the time, wherein men live without other security, than what their own strength, and their own invention shall furnish them withall. In such condition, there is no place for Industry; because the fruit thereof is uncertain; and consequently no Culture of the Earth; no Navigation, nor use of the commodities that may be imported by Sea; no commodious Building; no Instruments of moving, and removing such things as require much force; no Knowledge of the face of the Earth; no account of Time; no Arts; no Letters; no Society; and which is worst of all, continuall feare, and danger of violent death; And the life of man, solitary, poore, nasty, brutish, and short.[13]

Eventually, however, animals were domesticated, easing the struggle for existence. In this Pastoral or Arcadian stage, barbarians—a social grade higher than savages—came into being. They also invented and cultivated the simpler arts. As more time passed, plants were domesticated, giving rise to a higher level of culture—to an agriculture. In this stage, civilization replaced barbarism and the rude arts became ever more polished and refined. One of the key mechanisms, if not the most important mechanism, that propelled humanity forward, from a life that was "solitary, poore, nasty, brutish, and short," was war. For war made the state, Hobbes's "Leviathan," and the state, in turn, made peace.[14] Ferguson agreed, adding

> The strength of nations consists in the wealth, the numbers, and the character, of their people. The history of their progress from a state of rudeness, [was], for the most part, a detail of the struggles they have maintained, and of the arts they have practiced, to strengthen, or to secure themselves. Their conquests, their population, and their commerce, their civil and military arrangements, their skill in the construction of weapons, and in the methods of attack and defence; the very distribution of tasks, whether in private business or in public affairs, either tend to bestow, or promise to employ with advantage, the constituents of a national force, and the resources of war.[15]

Since this was the eighteenth century, when the Industrial Revolution (what the British mathematician and historian Jacob Bronowski called the "English Revolution" because it originated in England) was still inchoate, the highest stage of development seemed to contemporary observers

to be a society based on commerce, trade, and some manufacturing, including incredibly productive pin factories.[16] Indeed, Adam Smith, one of Ferguson's contemporaries and fellow countrymen, boldly argued in 1776 that these market activities alone, if allowed to proceed unhindered by undue government regulation, would eventually make the whole world rich. Thus, between Ferguson's clenched fist of the battlefield and Smith's "invisible hand" of the marketplace, the Enlightenment had not only described mankind's ascent but was prescribing new ways for mankind to ascend. In other words, they discovered by means of wars and markets that humans could break the "cake of custom," as the Victorians would later call it, and take charge of their own future.[17]

The Rise and Fall of Empires

The Enlightenment worked out schemes for how societies evolved or, as the case may be, devolved. Edward Gibbon famously advanced (the first of his six-volume history of Rome appeared in 1776) a two-part explanation for the decline and fall of the Roman Empire. The Latin West succumbed, he contended, to the spread from within of an increasingly intolerant monotheism, namely Christianity, and it failed, in the end, to repulse the barbarian invasions of the Goths, Vandals, and Huns. The Greco East, on the other hand, was assailed from without by barbarian Arabs and later, from without by the barbarian Turks who had converted to another monotheism, Islam. Thus, both halves of the Roman Empire were destroyed by barbarism and monotheism. Barbarians were, by definition, less civilized than the Romans. monotheists were, by definition, intolerant of other faiths. In this respect, differences in culture and cultural or social development were crucial to Gibbon's narrative.

These differences were in no way baked into anyone's DNA or racially determined. Enlightenment evolutionism was universal and self-evident—it applied to all peoples, in the past and in the present. Indeed, Gibbon pointed out that the very barbarian territories that had been carved out of the Roman Empire would one day evolve into the civilized states of Europe, such as Gibbon's own England. In time, these new states not only caught up with Rome but improved upon and eventually surpassed Roman civilization in terms of social development. As Gibbon saw it, the period of the "Renaissance," a term coined by the nineteenth-century historian Jules Michelet, marked the rebirth of Rome, which had been destroyed centuries before by barbarism and superstition. With the Scientific Revolution and the transatlantic Enlightenment—Benjamin Franklin was as much a product of this era as was Voltaire—these Moderns were convinced that they would soar past the Ancients. The situation across the Atlantic was different. In the New World, members of Europe's transplanted civilization believed they were surrounded on every side by "savages" or "barbarians." Later, nineteenth-century historians, e.g., Francis Parkman and William H. Prescott, who continued to look at history through a Gibbonian lens, saw the rise of an independent Latin South and Anglo North as triumphs of Western civilization over American savagery and barbarism.[18] A fear that these victories would be reversed haunted the Romantic imagination of the nineteenth century.[19]

The End of American History—and Beyond

There were many agricultural revolutions, but there was only one Industrial Revolution. The latter-day revolution started in the English Midlands and spread from there to the rest of the world. One of the intellectual consequences of this transformation was that the evolutionism or stage-theory of culture of the Enlightenment was all but eclipsed by the evolutionism of the nineteenth-century, which gave rise to two important variations on the older theme: Marxism, which explained social development in terms of class struggle, and Social Darwinism, which emphasized the survival of the fittest within different races as well as between them. Other writers, especially from the Americas, were drawn less to how cultures evolved or progressed and more to the conflicts that were produced when two cultures at different stages of development come into conflict, such as occurred when the peoples of Europe collided with the peoples of the Americas.

One of the most influential books in Latin

American literature and history was Domingo Faustino Sarmiento's *Civilization and Barbarism: The Life of Juan Facundo Quiroga, and the Physical Aspect, Customs, and Practices of the Argentine Republic,* which was published in 1845. The 1840s was a decade when the future of Sarmiento's Argentina, and much of the rest of Latin America, including Mexico, appeared very much in doubt. According to Sarmiento, Latin America was locked in a "struggle" between the opposing forces of European civilization, that is, "intelligence," which was focused in the port city of Bueno Aires, and "indigenous barbarism," which he equated with "matter" and the wild Pampas. Sarmiento believed that in the Argentine Republic the "nineteenth and the twelfth centuries live[d] together: one inside the cities, the other in the country." For Sarmiento, the New World was where European civilization was engaged in an ongoing clash with American barbarism, represented by its caudillos, military strongmen, and dictators, from Argentina's Juan Manuel de Rosas to Mexico's Antonio López de *Santa Anna*—the villain, from the Texas perspective, of the Battle of the Alamo in 1836.[20]

In 1893, not quite fifty years after the appearance of Sarmiento's *Civilization and Barbarism*, and a little over four hundred years after Christopher Columbus discovered San Salvador, an island in the Bahamas, thereby changing the course of world history, Frederick Jackson Turner delivered a paper, "The Significance of the Frontier in American History." He did so at the meeting of the American Historical Association (AHA), which met in Chicago, where the World's Columbian Exposition was being held to celebrate Columbus's four hundred-year-old achievement. Turner's paper would prove as influential in Anglophone America as Sarmiento's book did in Latin America. In fact, Turner *invented* American history.[21]

Like Sarmiento, Turner saw American history as a struggle between indigenous barbarism, or what he called savagery, on the one hand, and civilization, on the other. The dividing line between these two stages of cultural or social development was the American frontier, a line that moved west from the founding of Virginia in 1607 to 1890, when the nation had supposedly exhausted its free land and subjected its indigenous peoples who were then slated, like it or not, to be assimilated, i.e., turned into God-fearing, property-loving farmers, even as America's farmers of European and African descent were leaving their farms in droves to work and live in the country's booming cities. For Turner, the struggle between civilization and savagery was central to American history because settling the frontier turned Europeans into Americans and it produced a new, rapidly evolving, democratic civilization, one thoroughly independent—politically as well as culturally—he believed, of Europe's. This was the significance of the frontier. However, now that the frontier was closed, as was declared by Robert P. Porter, the Superintendent of the 1890 Census, a chapter of American history was at an end. Turner expected subsequent American development to follow in Europe's footsteps.[22]

Andrew Jackson, after whom Turner's father gave Turner his middle name, bore a strong resemblance to Sarmiento's caudillos, especially his contemporary Juan Manuel de Rosas. Both men were noted Indian fighters and both cleared lands for European settlement. Whereas Rosas established a dictatorship in Argentina, Jackson turned the American Republic into a popular democracy with the spread of universal manhood suffrage.[23] Sarmiento expressed his ideas in *Facundo* to protest Rosas's tyranny, while Turner wrote "The Significance of the Frontier" to analyze and celebrate the sources of American liberty and individualism. While Sarmiento called for the influence of more European culture on the manners of his country, Turner celebrated the distinctiveness of America's way of doing things. These two men offered powerful explanations—in prose bordering on poetry—for the history and culture of their respective countries, and, more generally, for Latin America and Anglophone America—the former typified by *gauchos*, the latter by the not-so-different *cowboys*. In return, Sarmiento and Turner were each offered power themselves. Sarmiento would go on to serve as the president of Argentina and Turner, who had befriended Woodrow Wilson as a graduate student at Johns Hopkins University in Baltimore, Maryland,

would later serve as one of President Wilson's postwar planners.[24]

Darwin and Marx

At the end of the nineteenth century, the president of the American Historical Association, James Ford Rhodes, observed that the publication of Darwin's *On the Origin of Species* in 1859 had marked the dividing line between two intellectual worlds.

> Evolution, heredity, environment, have become household words, and their application to history has influenced everyone who has had to trace the development of a people, the growth of an institution, or the establishment of a cause. Other scientific theories and methods have affected physical science as potently, but no one has entered so vitally into the study of man.[25]

To be more accurate, Darwin put biology into *evolution* (a word he initially did not use), although Jean-Baptiste Lamarck and others, including Darwin's own grandfather, Erasmus Darwin, had tried to do just that but not convincingly. The theory of natural selection, the discovery of which Charles Darwin shared with Alfred Wallace, made *organic* evolution finally acceptable to science. Darwin and Wallace were both inspired by Thomas R. Malthus's *Essay on Population as It Affects the Future Improvement of Society* (1798). Malthus postulated that human populations would, in time, always outstrip their environment, forcing the survivors into a grim competition for resources. Malthus's fatalism stood in sharp contrast to the optimism of Robertson and other Enlightenment thinkers.

In the wake of Darwin, the non-organic theory of evolution of the Enlightenment had all but been forgotten. Obviously, there was a great deal of continuity between eighteenth-century and nineteenth-century non-organic evolutionism, as indicated by the evolutionary stages of Ferguson on the one hand and Sarmiento and Turner on the other. The anthropology of Sir Edward B. Tylor and the New York railroad lawyer Lewis Henry Morgan were other cases in point.

In *Primitive Culture,* published in 1871, two years after the publication of Mathew Arnold's essay, *Culture and Anarchy*, Tylor produced the classic, non-organic, definition of culture. It was that "complex whole which includes knowledge, beliefs, arts, morals, law, customs, and any other capabilities and habits acquired by a man as member of society."[26] In 1877 in *Ancient Society*, Morgan, who had conducted extensive field work among the Iroquois (as he was adopted by the Seneca), fleshed out the now very familiar, non-organic, tripartite scheme of cultural evolution: 1) savagery; 2) barbarism; and 3) civilization. While for Adam Ferguson the drive for security was one of main drivers of cultural evolution, for Morgan it was the development of better food production technologies. As Morgan put it, "The great epochs of human progress have been identified, more or less directly, with the enlargement of the sources of subsistence."[27]

Morgan's thinking was, however, somewhat ambivalent on this point, probably because he was not an armchair theorist but had extensive experience in the field, meeting in person, for example, with members of the Iroquois nation. On the one hand, Morgan believed that a "common principle of intelligence meets us in the savage, in the barbarian, and in civilized man." This was quite literally an enlightened point of view. Ferguson similarly observed in 1767 that "[w]e are generally at a loss to conceive how mankind can subsist under custom and manners extremely different from our own; and we are apt to exaggerate the misery of barbarous times, by an imagination of what we ourselves should suffer in a situation to which we are not accustomed. But every age hath its consolations, as well as its sufferings. In the interval of occasional outrages, the friendly intercourses of men, even in their rudest condition, is affectionate and friendly." In other words, ages and stages may come and go but there is a durability to mankind's intelligence and humanity.[28]

On the other hand, Morgan acknowledged what would have seemed obvious to his European and European American contemporaries, which was that the "Aryan family" had become "the central stream of human progress, because it produced the highest type of mankind, and because

it has proved its intrinsic superiority by gradually assuming the control of the earth." Here we see the unfortunate blurring of the Aryan family of race with evolution's highest type and with it, notions of racial superiority: that all men are not created equal, after all. This view marked an abandonment of one of the Enlightenment's most important self-evident truths. In the second-half of the nineteenth century, we see the comingling of biology and culture; of the organic and the non-organic. Even so, the *Aryan* Morgan nevertheless believed that the actual timing of the West's attainment of modern civilization was largely a matter of luck; it "must be regarded as an accident of circumstances."[29] This was more the language of a cultural evolutionist, one with an appreciation of the role of contingency in history, than a racial determinist.

The bearded duo Karl Marx and Friedrich Engels considered Morgan's cultural evolution to be essential to understanding their own parallel theory of developmental stages, namely, 1) slavery; 2) feudalism; and 3) capitalism. Indeed, according to Engels, "in America, Morgan had, in a manner, discovered anew the materialistic conception of history, originated by Marx forty years ago."[30] Despite Morgan's emphasis on technology rather than race, the anthropologist Marvin Harris notes that a "generation of anthropologists" was "brought up to believe" that Morgan was a racial determinist, which discredited him and other nineteenth-century evolutionists, and, ignorant of Morgan's eighteenth-century antecedents, believed "that the division of cultural history into the universal stages of savagery, barbarism, and civilization" was Morgan's "ill-advised late-nineteenth-century accomplishment." With Morgan, cultural evolution was conflated with organic evolution, actually with Social Darwinism, after Herbert Spencer.[31]

The high point of nineteenth-century evolutionism came in 1896, with the completion of Herbert Spencer's multivolume work, *The Synthetic Philosophy*. Volume One, *First Principles*, the first of ten volumes, appeared in 1862, followed by *Principles of Biology* (two volumes), *Principles of Psychology* (two volumes), *Principles of Sociology* (three volumes), and *Principles of Ethics* (two volumes). A school teacher and a railway civil engineer, Spencer sought to apply the principles of evolution, including Darwin's theory of natural selection, to biology and to culture alike. Spencer was not content to describe. He prescribed that governments restrain themselves in order to allow for maximum competition in the market place and elsewhere, for that was, he argued, the key to progress in every sphere of human activity. Spencer, it should be noted here, was influenced by Auguste Comte, the French philosopher and founder of sociology. Comte, who believed there was an order and logic to the development of knowledge, divided the course of human history into three clear stages of development: 1) the theological; 2) the metaphysical; and 3) the positive or scientific. (There are almost as many developmental schemes as there are evolutionists!)[32]

While Spencer adopted a *laissez-faire* philosophy in regard to government's role in the economy and in society, which was influential primarily in the English-speaking world, the followers of Comte, especially in Latin America, including Mexico, arrived at the opposite conclusion. In the second half of the nineteenth century, the positivists in Mexico—the *científicos*, as they were called—urged the government of Porfirio Díaz to engage in social engineering in order to fast-forward, leap-frog, or accelerate the country's evolution and thereby catchup with the more advanced societies in Western Europe and North America.[33] Later, Marxist-Leninists in Russia and China who also believed that what is past is prologue would likewise promise shortcuts to modernization by means of "five-year plans" and "great leaps forward." On the right, Corrado Gini, an Italian statistician who was interested in the demographic evolution of nations—he favored a cyclical theory of population over Thomas Malthus's theory of constant geometric increase—developed the "Gini coefficient," on the eve of the First World War. This index, which measured the dispersion of wealth in a society, could test the ideas of a Marx or of a Turner, to determine whether a society was advancing toward greater inequality or toward greater equality. It could also be used to evaluate the efficacy of national

policies and programs—the importance of which cannot be overstated. In Gini's case, it was used to inform the fascist, racist, and expansionist policies of Benito Mussolini.[34]

Boas and White

The rejection of Social Darwinism, which started at the end of the nineteenth century, was complicated. In the new historical discipline (for which the American Historical Association was founded in 1884), Turner's frontier theory was free of the class reductionism of the Marxists and of the racial determinism of the Social Darwinists. In many respects, his history was a refreshing throw-back to eighteenth-century evolutionism, directionality, and progress. Indeed, it was an explicit and forceful rejection of the Anglo-Saxon and Eurocentric race-based germ theory that prevailed in American historiography during the 1880s and 1890s.[35]

Like Marx, Turner was interested in social change. Whereas, Marx emphasized class conflict within a society, Turner was more interested in the conflict between societies at different stages of development, namely in the violent collision that occurred between *civilization* and *savagery* on the American frontier. Also, whereas, Marx wrote of individuals in terms of their class interests, Turner was interested in individuals principally as representatives of different stages of social development. For instance, Turner's writing is peppered with references to individuals as hunters, herders, farmers, town-builders, and, later, of regional or sectional types.[36] Turner was certainly guilty of harboring a narrow nationalism, and his ideas lost much of their relevance in the broader campaigns to save Western civilization during the world wars and ideological struggles of the twentieth century.[37] His evolutionary, exceptionalist, and narrative ideas nevertheless had a lasting impact on American historiography.

The situation in anthropology was quite different. Turner's contemporary, Franz Boas, the "father of American anthropology," and his numerous students would reject organic evolution and call non-organic evolution into question as well. As early as 1894, Boas, a German-born immigrant, began to lay out his line of attack. He opposed the notion that the biological evolution of humans could have taken place in the recent prehistoric and historic eras. Evolution takes time, lots of it. Five thousand years, the time of recorded history, was simply not a sufficient amount of time, Boas thought, for the occurrence of any significant divergent physiological transformations. Boas did think, however, that cultures evolved over time but not necessarily in a sequential or linear order. Boas did not think that Western culture was necessarily superior to, or more advanced than, other cultures, a view that put him at odds with the racial determinists of the day. "Why, then," he asked, "did the white race alone develop a civilization which is sweeping the whole world, and compared to which all other civilizations appear as feeble beginnings cut short in early childhood, or arrested and petrified in an early stage of development?" Cultures, he said, existed in relation to, and were influenced by, each other. Their differences were the result of historical particularities, if not accident or the "laws of chance" (on the point of contingency as, interestingly, Boas was not that far apart from Morgan). History, in short, was an amoral game of thrones and Western culture was—for the moment—on top.[38]

Boas illustrated the point in this way: It would seem that the civilizations of ancient Peru and of Central America may well be compared with the ancient civilizations of the Old World. In both we find a high stage of political organization, division of labor and an elaborate ecclesiastical hierarchy. Great architectural works were undertaken, requiring the cooperation of many individuals. Plants were cultivated and animals domesticated; the art of writing had been invented. The inventions and knowledge of the peoples of the Old World seem to have been somewhat more numerous and extended than those of the races of the New World, but there can be no doubt that the general status of their civilization measured by their inventions and knowledge was nearly equally high. This will suffice for our consideration. What, then, is the difference between the civilization of the Old World and that of the New World? It is essentially a difference in time. The one reached a certain stage three thousand or four thousand years sooner than the other.

Although much stress has been laid upon the greater rapidity of development of the races of the Old World, it is not by any means conclusive proof of exceptional ability. It may be adequately conceived as due to the laws of chance.[39]

Boas's cultural relativism or historical particularism, was a criticism of anthropological theory—of evolutionism—which was being used to justify, among other things, white supremacy in the American South and Anglo-Saxon Protestant dominance elsewhere in the country as well as to underpin Western imperialism throughout the world.[40] In short, anthropology had been politicized as well as turned into public policy in the late nineteenth and early twentieth centuries by the Social Darwinists and, later, in the 1930s, the same science, Boas observed with growing alarm, was being "subjected" to racial prejudice in "countries controlled by dictators," in a clear reference to Adolph Hitler and Nazi Germany. In the preface to the revised edition of *The Mind of Primitive Man*, which was published in 1911 and reissued in 1938, Boas reasserted the point that there was "no fundamental difference in the ways of thinking of primitive and civilized man," again, knowingly or not, echoing Morgan; furthermore, there has "never been established" a "close connection between race and personality;" and finally, the very "concept of racial type as commonly used even in scientific literature is misleading and requires a logical as well as a biological redefinition."[41]

To fight against this popular and ignorant prejudice, Boas sought, in effect, to re-politicize the discipline, to divorce cultural from physical anthropology, which he accomplished with the help of his students. In *Man's Most Dangerous Myth: The Fallacy of Race*, which was written under Boas's direction and published in 1942 during the war against the Third Reich, Ashley Montagu stated categorically that there was "absolutely no genetic linkage for genes with physical traits, mental capacities, or civilization-building abilities." In 1943, the following year, Margaret Mead, another Boas student, who had written the classic study *Coming of Age in Samoa* (1928), fleshed out the Boasian creed in "The Role of Small South Sea Cultures in the Post War World," an article that appeared in the *American Anthropologist*. "As anthropologists," she wrote, "our contribution has been a recognition of the co-equal value of human cultures seen as wholes.... We have stood out against any grading of cultures in hierarchical systems which would place our own culture at the top and placed the other cultures of the world in a descending scale according to the extent that they differ from ours. Refusing to admit that one culture could be said to be better than another... [,] we have stood out for a sort of democracy of cultures, a concept which would naturally take its place beside the other great democratic beliefs in the equal potentiality of all races of men, and in the inherent dignity and right to opportunity of each human being." In 1946, in her study of Japan, Ruth Benedict, yet another Boas student, declared that the goal of anthropology was "to make the world safe for human differences." In 1952, the Boas student Alfred L. Kroeber and Clyde Kluckhohn (who was not a Boas student) further disentangled the concept of culture and its study from race by clearly and very usefully delineating culture as a "set of attributes and products of society, and therewith of mankind, which are extrasomatic and transmissible by mechanisms other than biological heredity."[42]

The program of the cultural relativists, or the anti-theory particularists, lined up perfectly, as Marvin Harris observed, with the "fundamental ideological outlook associated with left-of-center political liberalism."[43] The Boasians had successfully put the Social Darwinists and other racial determinists, to their right, on the defensive. In the process, and dare one say in theory, they threw the Marxists, to their left, out with the bath water. Marxists graded cultures and placed the West—with the rise of industrial capitalism in Europe, the United States, and Canada—at the top.[44] Marxism may have been ethnocentric, but it was not necessarily racist. Indeed, for students of *Das Kapital* class struggle, not racial determinism, was what drove change. Thus, Marxists had to contend not only with the progressive antiracism and cultural relativism of the Boasians from within anthropology, but also, from 1945 on, with the advent of the Cold War, a growing atmosphere of anti-Communism and

reactionary politics outside anthropology.

While Social Darwinism was being eclipsed by cultural relativism, at least in the United States, Darwinian natural selection was being complemented, indeed empirically confirmed, by Mendelian heredity. In 1942, Julian Huxley, the grandson of T. H. Huxley, who was known as Darwin's bulldog for his fierce advocacy of life's mutability and Darwin's theory for explaining that mutability, called this crucial modification to the theory of evolution the "modern synthesis" or fusion of natural selection (and its later revisions, e.g., group selection, genetic drift, and punctuated equilibrium or "punk eek") and the laws of inheritance.[45]

Given the vindication of biological evolution by genetics, it was only a matter of time before there would be a revival of cultural evolution in some form, and with it the notion of directionality or progress. Writing in London during some of the darkest days of the Second World War, Julian Huxley—seemingly unfazed by the German blitz—observed calmly that "[a]fter the disillusionment of the early twentieth century it has become as fashionable to deny the existence of progress and to brand the idea of it as human illusion, as it was fashionable in the optimism of the nineteenth century to proclaim not only its existence but its inevitability. The truth is between the two extremes."[46] However, when the revival came, one year later, cultural evolution's source of inspiration was not the modern synthesis of the life sciences but modern physics—for this was, after all, also the Heroic Age of Relativity and Quantum Mechanics.[47]

In 1943, the anthropologist Leslie White published "Energy and the Evolution of Culture." This remarkable article appeared in the pages of the *American Anthropologist* in the issue that immediately followed the one containing the Margaret Mead piece on planning Oceania's future. This was the article in which she articulated the Boasian creed of cultural relativism, thereby putting belief or political commitment ahead of science; there is a fine line between creed and dogma. White taught at the University of Michigan and was an unreconstructed nineteenth-century evolutionist who saw his work picking up right where his predecessors Lewis Henry Morgan, Herbert Spencer, Edward Tylor, and Karl Marx left off, *sans* the racial determinism.[48] On this important point, White was emphatic: "Although peoples obviously differ from each other physically, we are not able to attribute differences in culture to differences in physique (or "mentality"). In our study of culture, therefore, we may regard the human race as of uniform quality, i.e., as a constant, and, hence, we may eliminate it from our study." White removed race from the table and focused instead on the purity of energy; by energy he meant the "capacity for performing work." White declared, "Everything in the universe may be described in terms of energy. Galaxies, stars, molecules, and atoms may be regarded as organizations of energy. Living organisms may be looked upon as engines that operate by means of energy derived directly or indirectly from the sun. The civilizations, or cultures of mankind, also, may be regarded as a form or organization of energy." In 1959, he would call civilizations or cultures "thermodynamic systems."[49]

White eliminated *race* and he eliminated *place* from his study as well. Just as he considered the former a constant, he considered habitat, even though "no two habitats are alike," to be also a constant. He did so by reducing the "need-serving, welfare-promoting resources of all particular habitats to an average." Having dispensed with the constants of race and place (but not class as he was a clandestine Socialist), White then turned to the three variables of energy, technology, and product. That is, 1) "the amount of energy per capita per unit of time harnessed and put to work within the culture;" 2) the "technological means with which this energy is expended," and 3) the "human need-serving product that accrues from the expenditure of energy." White expressed the relationship of these variables in a formula: **E x T = P** (**Energy** expended per capita per unit of time) x (the **Technological** means of its expenditure) = (the magnitude of the **Product** per unit of time). To illustrate, he wrote that "[o]ther things being equal, the amount of wood" a workman cuts "varies with the quality of the axe: the better the axe the more wood cut." It follows, White argues, that a workman can "cut

more wood with iron" than "with a stone axe." Iron Age cultures, to generalize, were able to capture and use more energy than Stone Age cultures. White had thus produced an energy index that he used to compare, evaluate, and grade the cultural evolution of different societies.[50]

White was sharply critical of the cultural relativists for their full retreat from evolution. As he put it, "It seems almost incredible that anthropologists of the twentieth century could have repudiated such a simple, sound, and illuminating generalization, one that makes the vast range of tens of thousands of years of culture history intelligible, yet they have done just this. The anti-evolutionists, led in America by Franz Boas [and in Great Britain by Bronislaw Malinowski], have rejected the theory of evolution in cultural anthropology—and have given us instead a philosophy of 'planless hodge-podge-ism.'" To White, the fact-centered descriptions of the cultural relativists or "historical particularists" got thicker and thicker and, as they did so, they signified less and less.[51] White also distinguished evolution from history. Evolution was the story of progress or of retrogression, while "history was the chronological sequence of particular events." He further added that the "historical process [was] particularizing; the evolutionary process [was] generalizing." He insisted that "by and large, in the history of human culture, progress and evolution have gone hand in hand.[52]

In the years leading up to the centennial of Darwin's *On the Origin of Species*, cultural evolution reemerged as a viable theory, as the neo-evolutionists, White foremost among them, swam hard against the Boasian tide. It was in 1959 that White's *The Evolution of Culture: The Development of Civilization to the Fall of Rome* was published. Grand generalization, it seemed, was back.[53] Like the evolution of Marx, Spencer, Tylor, and Morgan, White's evolution was universal and he accepted, unapologetically, that the industrial and capitalist West, propelled by what he called the "Fuels Revolution," was the world's most advanced society. Looking back on the field in 1971, Elman R. Service, a White student, noted that despite the obvious utility of neo-evolutionary ideas, "Leslie A. White, Julian A. Steward, and [in Europe], V. Gordon Childe were virtually alone in opposing the antievolutionary temper of the times. It was not until after midcentury that there was any noticeable shift in opinion toward an evolutionary outlook again, and this took place only in America, only in anthropology, and there only in small part."[54] This small part grew even smaller, with the unrest of the 1960s and early 1970s. In 2000, Marshall Sahlins, another one of White's students, reflected that "sympathy and even admiration for the Vietnamese struggle, coupled to moral and political disaffection with the American war, might undermine an anthropology of economic determinism and evolutionary development."[55] Indeed.

The Two Cultures: Ruskin and Snow

The same year (1959) that White published *The Evolution of Culture*, the English novelist and chemist Charles Percy Snow warned that Western civilization was splitting into two cultures—a culture of the math and sciences, on the one hand, and a culture of the arts and humanities, on the other. Snow believed that for the developed West to render effective aid to the underdeveloped world, it was crucial to repair the growing breach between these two cultures. The year 1959 was, after all, the height of the Cold War and he was very clear about which side he wanted to win—the West. Snow was critical of both cultures for their basic ignorance of each other, but his real target was, in his view, the backward-looking humanities; to the "intellectuals as natural Luddites."[56]

First, more background information and context—in the nineteenth century, the Victorian art critic John Ruskin had believed Western civilization went off the rails, although he would not have appreciated the metaphor, with the rebirth of classical learning and the influence of Greek and Roman models on European literature, art, and politics. This change was represented by replacement of organic and communal Gothic art of the Middle Ages in favor of the "rigid, cold, and inhuman" geometry of the Renaissance and emphasis on individual genius and ego rather than the anonymity and raw energy of the medieval workman.[57] In *The Stones of Venice* (1851-1853),

Ruskin charted the rise and fall of *La Serenissima* through its architecture, marking its height with the triumph of Gothic and, in the third of three volumes, its "fall," with the advent of the "Roman Renaissance." This latter movement was characterized by the "pride of science," the "pride of state," and the "pride of system" in which knowledge was arrogantly reduced or "caged" and manacled" to philosophy. In other words, an earlier Christian calmness was replaced by the discordant individualism of the Pagan world. To Ruskin, the Renaissance "preferred science to emotion, and experience to perception." Ruskin's cultural history is a perfect inversion of Enlightenment historiography—that the Renaissance, after a thousand-year hiatus of backwardness, fear, and superstition—more or less— restored high civilization to Europe. For Gibbon, as we have seen, the Renaissance marked the rebirth of Rome, while for Ruskin it was the cultural movement that murdered the Middle Ages.[58]

In reaction to what was, in Ruskin's view, Victorian England's money-grubbing and materialist culture, he championed the Pre-Raphaelite Brotherhood and inspired the Arts and Crafts movement. The Pre-Raphaelites tried to recapture in their representational paintings the magic and romance of an imagined Arthurian or Christian pastoral past. Ruskin's Romantic counterparts in America were the Transcendentalists Henry David Thoreau and Ralph Waldo Emerson and the artists Thomas Cole, Frederic Edwin Church, and Albert Bierstadt of the Hudson River and Rocky Mountain Schools. In North America—whether in the eastern woodlands and river valleys or later in the western mountains, plains, and deserts—artists learned early on to substitute the continent's natural landscapes and geology for Europe's legends and antiquity. Nevertheless, this transatlantic art had one thing in common: it was a form of redemption from either the weary, Ozymandias-cycle of the rise and demise of civilizations, which, after Gibbon's history of Rome, long haunted the Romantic imagination; or, it was an escape to nature from the Dickensian and dispiriting realities of the Industrial Age.

To counter the mind-numbing tasks, the division of labor, manager-worker alienation, the dangers of the factory floor, and the banality of mass-production, the designers, including William Morris, in the Arts and Crafts movement, many of whom were utopians and socialists, tried to revive the high craftsmanship and pride in the workplace they believed had once existed in the Middle Ages.[59] These aesthetic visions were also shared throughout the British Empire and well into the twentieth century. In 1909, Mohandas K. Gandhi applied Ruskin's nostalgic critique to India in his anti-colonial and anti-modern tract *Hind Sawraj* or "Indian Home Rule." On machinery Gandhi wrote that it is "the chief symbol of modern civilization; it represents a great sin. . . [, and] it is machinery that has impoverished India."[60] As for the effects of Westernization on India, he wrote:

> Only the fringe of the ocean has been polluted and it is those who are within the fringe who alone need cleansing. We who come under this category can even cleanse ourselves because my remarks do not apply to the millions. In order to restore India to its pristine condition, we have to return to it. In our own civilization there will naturally be progress, retrogression, reforms, and reactions; but one effort is required, and that is to drive out Western civilization. All else will follow.[61]

Finally, Gandhi, believed that India's future was in its villages, not in its towns or cities.

Snow, however, would have none of what he considered to be elite handwringing, fantasy, or escape; in fact, he pointedly criticized Ruskin, William Morris, Thoreau, Emerson, and D. H. Lawrence for their "screams of horror" at the dehumanizing effects of industrialism and modernity. To Snow, however, the only sure way to improve the lives and health of the ordinary person was through applied science, technology, and industry. He lectured:

> It is all very well for us, sitting pretty, to think that material standards of living don't matter all that much. It is all very well for one, as a personal choice, to reject industrialization—do a modern Walden, if you like, and if you go without much food, see most of your children die in infancy, despise the comforts of literacy, accept twenty years off your own life, then I

> respect you for the strength of your aesthetic revulsion. But I don't respect you in the slightest if, even passively, you try to impose the same choice on others who are not free to choose. In fact, we know what their choice would be. For, with singular unanimity, in any country where they have had the chance, the poor have walked off the land into the factories as fast as the factories could take them.[62]

Still, during the 1960s the divide between Snow's two cultures widened even further—with an important difference. The cultural relativists of the prewar era, the Boasians, had been critical of any theory or system in which cultures or peoples were compared against or contrasted with Western culture or development. By these lights, evolutionists were ethnocentric. Margaret Mead had declared that anthropology's great "contribution" was the "recognition of the co-equal value of human cultures seen as wholes." However, the cultural relativists of the postwar, *countercultural* era—whose research and writing were deeply influenced by the various agendas of anti-colonial, civil rights, environmental, and other reform movements—began to replace Mead's neutrality on the co-equal value of cultures with far more radical, and increasingly, anti-Western positions. To these morally committed scholars and writers, other cultures were no longer *co-equal* with, but were, in fact, morally superior to, the West—a civilization that was more and more regarded as violently at odds with itself, with nature, and with the rest of the world.[63]

It was in this zeitgeist that the zoologist E. O. Wilson dared to resurrect the idea that biology and human culture have gradually co-evolved, producing ever greater complexity over time. He also asserted that some human behavior or traits may have a genetic basis. Wilson advanced these arguments in a book entitled, *Sociobiology: The New Synthesis* (1975), a title that recalls Julian Huxley's 1942 work. Wilson found himself immediately inside an interdisciplinary firestorm of controversy. He was called a fascist and a reductionist and accused by critics, notably fellow biologists and Marxists Stephen Jay Gould and Richard Lewontin, of offering a new defense of Social Darwinism, eugenics, and scientific racism. Curiously, Wilson, who believed in directionality in human evolution, that is, in the idea of progress in history, attacked or demonized Lewontin and Gould for their Marxism. Channeling Boas and Mead and with Wilson in mind, Lewontin charged, "It is not surprising that the model of society" of biological determinists always "turns out to be natural, just and unchangeable" and it "bears a remarkable resemblance to the institutions of modern industrial Western society, since the ideologues who produce these models are themselves privileged members of just such societies." Lewontin really was a committed Marxist, while Gould was more attracted to Marx's dialectical theory of historical change on the one hand and to Kuhn's paradigm-shifting epistemology on the other.[64] If all of this was not enough to ponder, Wilson conceded also that "Marxism is sociobiology without the biology," while Gould viewed evolution as a series of disruptions—a random and pointless process rather than one that was gradual and progressive. Yet, Gould allowed that cultures or societies could progress from one generation to the next because of Lamarckian self-learning, whereas biological mutability was the result of other mechanisms. In what was an instance of true intellectual diversity, all three scientists worked in the same building: Harvard's Museum of Comparative Zoology.[65]

Rostow and Batalla

Many in the *developed* world, beginning with the Missouri-born U. S. President Harry S. Truman, thought it was in the interest of the developed world, or capitalist world, or "First World," that is, the West (which would later include Japan—the modern West was socially vertical not geographically horizontal) to assist the underdeveloped world, or "Third World," to progress, evolve, modernize, or Westernize (modernists used these terms interchangeably). This was the enlightened thinking behind Truman's 1949 Point Four Program. For if the West failed to assist in the economic development of the "Third World," then that would likely result in these underdeveloped countries turning to the socialist states of the "Second World," principally, the Soviet Union and later the Peoples Republic of China, for help

in modernizing their societies. In exchange for this assistance, Third World countries, it was feared, would align themselves with or allow themselves to be used by the Second World against the First World. The Cuban Missile Crisis, which occurred in October 1962, was the perfect realization of this triangle of worries over the asymmetry of global social development.[66]

To guide U. S. policy overseas, the American Walt Whitman Rostow developed a model of economic growth, which was published in 1960 under the title, *The Stages of Economic Growth: A Non-Communist Manifesto*. The subtitle was intended to differentiate his modernization theory from Marxist theory, which had become the ideology of the enemies of the "Free World" (one among many worlds in those days)—led by the United States—during the protracted Cold War. Rostow's five stages of development were these: 1) traditional society; 2) pre-conditions for take-off; 3) take-off; 4) drive to maturity; and 5) age of high mass consumption. Rostow went on to serve as the National Security Advisor to President Lyndon Johnson during the Vietnam War.[67]

Since the Second World War, the United States had helped to create a number of international as well as national programs and agencies to address the problem of human development. The United Nations, the International Monetary Fund, the World Bank, along with the Alliance for Progress and the Peace Corps were some of the most important state-supported examples. Rostow's modernization theory made explicit the philosophy underlying these different bodies. At the close of the Cold War, this national idea went global when in 1990—a year after the fall of the Berlin Wall—the United Nations adopted the Human Development Index (HDI), which had been devised by Mahbub ul Haq of Pakistan (who had been an advisor at the World Bank under Robert McNamara, the former U. S. Secretary of Defense for U. S. Presidents Kennedy and Johnson).

Haq explained his method for constructing the HDI: "Longevity is measured by life expectancy at birth as the sole unadjusted indicator. Knowledge is measured by two education variables: adult literacy and mean years of schooling, with a weight of two-thirds to literacy and one-third to mean years of schooling.... The third variable, income... is merely a proxy for a bundle of goods and services needed for the best use of human capabilities." Haq saw the HDI as a return to classical economics. Haq's three traits closely mirror Benjamin Franklin's "healthy, wealthy, and wise." The "founders of economic thought," he wrote, "never forgot that the real objective of development was to benefit people—creating wealth was a means. That is why, in classical economic literature, the preoccupation is with all of society, not just the economy. After the Second World War...an obsession grew with economic growth models and national income accounts. What was important was what could be measured and priced. People...were forgotten." From this perspective, Haq's HDI was a long overdue corrective.[68]

Thus, the index measured a country's economic development by focusing on the well-being of its people as opposed to the production of goods and services (Gross National Product or GNP) and was used to grade and evaluate every country in the world. Actually, Haq thought HDI should complement GNP because "GNP, by itself, reveals little about how the people in a society live and breathe." The beauty or crudity of the HDI was its sheer simplicity: each country was assigned a single composite number. Not surprisingly, the most economically advanced countries in the West or in the richer northern hemisphere scored much higher (Norway consistently topped the list) than did the less advanced countries in the Third World, primarily those in Sub-Saharan Africa, e.g., Sierra Leone, the South Sudan, and the Central African Republic.[69] Margaret Mead would have rolled over in her grave.

In fact, the reaction of the postmodernists and the anti-globalists to "development-alism" (the idea of development had been reduced to an "ism" or an ideology) closely resembled the earlier critiques of cultural evolutionism by Mead and the cultural relativists. Except that the postmodernists were deeply suspicious of science and capitalism, two of modernism's greatest achievements. In the words of Carolyn Merchant, a radical ecologist (not ecologist who is radical but theorist of *radical ecology*), "Science is not a process of discovering the ultimate truths of nature, as

the Enlightenment thinkers would have argued, but a social construction that changes over time. The assumptions accepted by its practitioners are value-laden and reflect their places in both history and society, as well as the research priorities and funding sources of those in power."[70]

Who was in power? According to the anti-globalists, it was the elites in the Group of 7 or G7 countries—France, Italy, Germany, Japan, the United States, the United Kingdom, and Canada. After having been involved in two world wars, these countries decided to abandon competition, which was costly and destructive, and embrace cooperation, which allowed them to govern the world for their own immense economic and political benefit. The differences, then, between more advanced and less advanced countries, between the rich and the poor countries, between the North and the South hemispheres (divided along the "Brandt Line," a global version of Turner's frontier of social development), were due not to cultural evolution but to global systems of inequality—imperial and neo-imperial systems that had been created by the West to extract wealth from, as well as to lord over, the Rest.[71]

These feelings and views were especially pronounced among intellectuals in Latin America, a region that had experienced the wrenching "lost decade" (*La Década Perdida*) of the 1980s. Barbara Weinstein, a specialist on Brazil who was president of the American Historical Association in 2007, pointed out that with this decade—in which the economies of Latin America, including that of Mexico, fell behind and deep into debt—the Enlightenment notion of progress came under the harshest scrutiny. According to Weinstein, the "crisis of the 1980s catalyzed a more radical, thoroughgoing, root-and-branch offensive against the very idea of development." Postmodernists or post-development thinkers, Weinstein notes, took the position that development was a *discourse* that needed to be deconstructed, choosing to ignore that development was actually a *process*, as the empiricist Haq had shown, which could be objectively measured. These critics also attacked "developmentalists of every stripe for representations of the so-called 'developing world' as landscapes of unrelieved poverty, misery, and backwardness, and for setting up Western standards as the universal benchmarks for economic, political, and cultural success."[72]

Perhaps the strongest rejection of Western development or the Eurocentric notion of progress came from the Mexican anthropologist Guillermo Bonfil Batalla. In 1987 in what amounted to a manifesto, which called to mind Gandhi's anti-colonial views, thundered:

> The recent history of Mexico, that of the last five hundred years, is the story of permanent confrontation between those attempting to direct the country toward the path of Western civilization and those, rooted in Mesoamerican ways of life, who resist. The first plan arrived with the European invaders but was not abandoned with independence. The new groups in power, first the creoles and later the mestizos, never renounced the westernization plan. They still have not renounced it. Their differences and the struggles that divide them express only disagreement over the best way of carrying out the same program. The adoption of that model has meant the creation within Mexican society of a minority country organized according to the norms, aspirations, and goals of Western civilization. They are not shared, or are shared from a different perspective, by the rest of the national population. To the sector that represents and gives impetus to our country's dominant civilizational program, I give the name "the imaginary Mexico".... Imaginary Mexico's westernization plan has been exclusionary and has denied the validity of Mesoamerican civilization.[73]

A bitter Batalla had turned Sarmiento on his head. Nevertheless, the leaders of Mexico rejected these ideas, choosing instead the free market, as the surest way out of the country's economic predicament. Mexico signed the North American Free Trade Agreement in 1992, which was revised in 2020 and renamed "the United States-Mexico-Canada Agreement," and in 1994 joined the Organization for Economic Co-operation and Development.

Another strongly worded rejection of development came in 1995, the same year that the World Trade Organization was founded, from yet another anthropologist: namely, the Columbian anthropologist Arturo Escobar, who wrote *Encountering Development: The Making and Unmaking of the Third World*. Escobar, whom Weinstein calls "highly provocative," condemned efforts to develop the Third World as "ethnocentric and arrogant, at best naïve." Instead of lifting up the peoples of the Third World, he alleged that Western-led efforts brought about "massive underdevelopment and impoverishment, untold exploitation and oppression." He equated "developmentalism," the mindset of the powerful over the powerless, with "orientalism" and "Africanism." Escobar cited the "debt crisis, the Sahelian famine, increasing poverty, malnutrition, and violence" as only the "most pathetic signs of the failure of forty years of development," going back to President Truman's Point Four Program.[74]

The End of World History—and Beyond

With the close of the Cold War, Francis Fukuyama declared in 1989 that history was at an end, not with the victory of world communism, as Marx had predicted, but with the triumph of bourgeois or neoliberal civilizations, which, in turn, were based on the universalist values and institutions of the Enlightenment": namely, free elections, free markets, and free inquiry as well as a very expensive defense. In Fukuyama's words,

> What we may be witnessing is not just the end of the Cold War, or the passing of a particular period of postwar history, but the end of history as such: that is, the end point of mankind's ideological evolution and the universalization of Western liberal democracy as the final form of human government.[75]

He went on to clarify that "the victory of liberalism has occurred primarily in the realm of ideas or consciousness and is as yet incomplete in the real or material world."[76]

In this real world, the United States emerged from the Cold War as the sole superpower, as the Soviet Union, a former superpower, imploded in 1991. In the following year, Europe formed a new United States—the European Union. At the same time, the old United States created a continent-sized free trade zone with its two North American neighbors, Canada and Mexico, and issued a sweeping post-Cold War policy statement, the Defense Planning Guidance of 1992, which basically globalized the Monroe Doctrine. The U. S. declared that it would not brook the emergence of any new rival—*anywhere* in the world. The Monroe Doctrine of 1823, which had applied originally to the Western Hemisphere and was aimed primarily at Europe, specifically at Spain, was now extended to the entire globe and to every power and region. No power has ever before been able to so dominate its own region, in this case North America, so thoroughly and thus been free to try to extend its power elsewhere throughout the world.[77]

Thus, despite the passage of two centuries, world progress was still being driven by wars and markets—Adam Ferguson's *clinched fist* and Adam Smith's *invisible hand*. For the rest of the 1990s, the unipolarity of the United States provided the global security necessary for globalization, a new stage of cultural evolution or social development in which the peoples of the world were becoming increasingly interdependent, as peoples, goods, and ideas flowed freely around the Earth—less and less vexed by national borders. It was a heady time. A wealthy world finally seemed at hand. The Yugoslav Wars tested the *Pax Americana* as did the Global War on Terrorism but it was Vladimir Putin's annexation of the Crimean Peninsula and the breakout of the Russo-Ukrainian War in 2014, exactly one century after the start of the First World War, that history and geography roared back with a vengeance and the ghosts of Halford Mackinder, J. Nicholas Spykman, George Kennan, and Hans J. Morganthau were again seen haunting the world island with a renewed sense of relevance.

Indeed, as much as the United States, an established power, has tried to avoid falling into "Thucydides's Trap" with China, a rising power, it now appears to be in a cool war, as Communist China builds up its military and looks east to dominate first Hong Kong (with the new one country, one system policy) and later Taiwan as

well as the South China Sea and as it looks west to gain influence in Eurasia and Africa by means of the Belt and Road Initiative.[78] Another blow to globalization occurred in 2016 when the United Kingdom voted to leave the European Union (but not Europe) and the United States elected Donald Trump, an economic nationalist, to the presidency. Moreover, the Internet is balkanizing into a "splinternet," while Turkey, Iran, India, and Sunni Islamic radicals all vie to reclaim past imperial glories. As the Cold War came to an end, the political scientist Samuel Huntington foresaw a future "clash of civilizations" rather than an "end of history," as Fukuyama had predicted. Of the two, Huntington seems to be the one who was correct—at least in the short term.[79]

Only Yesterday

The Great COVID Pandemic—which began in Wuhan, China, in late 2019, after a coronavirus was transmitted from animal to a human—has accelerated de-globalization and turned public health into a security problem of the first rank. These troubling trends posed a growing threat to the American-led liberal order as well as to international economic development in general, proving that the rumors of history's demise were greatly exaggerated. Nevertheless, Fukuyama had a point. As of 2018, which seems like only yesterday, the late Swedish statistician Hans Rosling declared,

> Poor developing countries no longer exist as a distinct group. That there is no gap. Today, most people, 75 percent, live in middle-income countries. Not poor, not rich, but somewhere in the middle and starting to live a reasonable life. At one end of the scale there are still countries with a majority living in extreme and unacceptable poverty; at the other is the wealthy world (of North America and Europe and a few others like Japan, South Korea, and Singapore). But the vast majority are already in the middle.

Given the data, Rosling makes the compelling case that the terms "West and the rest," "developed and developing," "rich and poor," are now passé.[80]

In other words, the Brandt Line had dissolved; the world frontier of social development was no longer significant. The massive economic disruption caused by COVID-19 will no doubt temporarily reverse some of this progress and levelling. Nevertheless, the universal evolutionism of the Enlightenment, which originally had existed largely as an optimistic set of ideas, was conceived at a time when there were profound disparities of social development among the world's different societies and cultures. However, by the twenty-first century, with the dramatic narrowing of these disparities or asymmetries, there was an even greater material basis for a hopeful outlook about the future of the Enlightenment project.

Endnotes

[1] Letter from John Adams to Abigail Adams, May 12, 1780, Adams Family Papers, An Electronic Archive, https://www.masshist.org/digitaladams/archive/index, accessed on August 29, 2020.

[2] The literature on cultural evolution as well as cultural relativism is vast—two veritable oceans of immensity. Needless to say, this discussion is perforce very selective. I would like to thank my mentor Richard W. Etulain and my colleagues Deborah Cohen and Kara Moskowitz for their comments on an earlier version of this article.

[3] David Hume produced The *History of England* (1754-1761); William Robertson, *The History of Scotland, 1542-1603* (1759) and *The History of America* (1777-1796), and Edward Gibbon, *The History of the Fall and Decline of the Roman Empire* (1776-1788). Of this once celebrated triumvirate, only Gibbon, sadly, continues to enjoy a wide readership.

[4] Francis Bacon, *The New Organon*, ed. by Lisa Jardine and Michael Silverthorne (1620: Cambridge, U.K.: University of Cambridge Press, 2000), 100.

[5] Matthew Arnold, *Culture and Anarchy: An Essay in Political and Social Criticism* (London: Smith, Elder, 1869), viii, Internet Archive, https://archive.org/details/dli.granth.72045/page/n3/mode/2up, accessed August 29, 2020.

[6] David Deutsch, *The Beginning of Infinity: Explanations that Transform the World* (New York: Viking, 2011), 385.

[7] Ibid, 387.

[8] See Hans Rosling, Ola Rosling, and Anna Rosling Rönnlund, *Factfulness: Ten Reasons We're Wrong About the World—and Why Things Are Better Than You Think* (New York, N.Y.: Flatiron Books, 2018), 27-28.

[9] Ibid, 23.

[10] Jonathan Swift, *The Battle of the Books and other Short Pieces* (London: Cassell and Company, 1891),13-50. The original title was "A Full and True Account of the Battle Fought Last Friday Between the Ancient and Modern Books in Saint James's Library."

[11] For an insightful discussion of eighteenth-century English historiography, see Roy Porter, "The Uses of History in Georgian England" in Gibbon: *Making History* (New York: St. Martin's Press, 1988), 15-41.

[12] Duncan Forbes points out that Ferguson was born "practically on the line" between the Highlands and the Lowlands and took a "cool look at both sides of the medal of modern civilization," and what Ferguson and his fellow countrymen, including Adam Smith, "saw as the paradox of the progress of commerce and manufactures giving rise on the one hand to personal liberty and security, the blessings of the rule of law, but at the same time and equally inevitably producing a second-rate sort of society full of second-rate citizens pursuing comparatively worthless objects." See Duncan Forbes's introduction to Adam Ferguson, *An Essay on the History of Civil Society* (1767; Edinburgh, U.K.: Edinburgh University Press, 1966), xiii-xiv.

[13] Thomas Hobbes, *Leviathan* (1651; Oxford: At the Clarendon Press, 1909), 96-97.

[14] See Ian Morris, *War! What is it Good For? Conflict and the Progress of Civilization from Primates to Robots* (New York: Farrar, Straus and Giroux, 2014), 18.

[15] Ferguson, *An Essay on the History of Civil Society*, 232.

[16] Bronowski's point was that just as there was a national dimension to the contemporary American and French Revolutions, as their names make clear, so too was there a specific national character to the Industrial Revolution. This crucial change in the modes of production did indeed start in England, actually in the countryside of the Midlands, and was largely driven, at least initially, by common men. Jacob Bronowski, *The Ascent of Man* (Boston: Little, Brown and Company, 1973), 259.

[17] Adam Smith, *An Inquiry Into the Nature and Causes of the Wealth of Nations*, (1776; Oxford: Clarendon Press, 1976), Vol. 1., 2-3; Vol. 2., 29-30. Smith also proposed a four-stage theory of socio-economic development. His stages were hunting, pastoralism, agriculture, and commerce. The "cake of custom" was an expression coined by the Victorian Walter Bagehot, an influential journalist, editor of The Economist, and a keen political observer. He was the author of *Physics and Politics: Or, Thoughts on the Application of the Principles of "Natural Selection" and "Inheritance" to Political Society*, which was published in 1872.

[18] Francis Parkman chose as his topic the rise and fall of New France, while for William H. Prescott it was the rise and fall of New Spain.

[19] Thomas Cole's *The Course of Empire* (1833-1836), a painting in five parts at the New York Historical Society, was an illustration of the rise and fall of empire. The stages were: 1) The Savage State; 2) The Arcadian or Pastoral State; 3) The Consummation of Empire; 4) Destruction; and finally 5) Desolation. The theme of decline was ubiquitous in Romantic art and literature. See the sonnet, "Ozymandias" (1818), by Percy Bysshe Shelley in Rosalind and Helen, *A Modern Eclogue; with Other Poems* (London: C. and J. Ollier, 1819), 72, or the painting, "The Colossal Pair, Thebes" (1856), by Frank Dillon at the St. Louis Museum of Art in Missouri.

[20] Domingo Faustino Sarmiento, Facundo: *Civilization and Barbarism*, trans. by Kathleen Ross (Berkeley: University of California Press, 2003), 59. Rosas, who had already exiled Sarmiento to Chile in 1840, considered Sarmiento's book to be the best written attack on his dictatorship. See Frances G. Crowley, *Domingo Faustino Sarmiento* (New York: Twayne, 1972), 61.

[21] Frederick Jackson Turner, "The Significance of the Frontier in American History," in the

Annual Report of the American Historical Association for 1893 (Washington, D.C.: Government Printing Office, 1894), 199-227.

[22] Kevin Jon Fernlund, "American Exceptionalism or Atlantic Unity? Frederick Jackson Turner and the Enduring Problem of American Historiography," in the *New Mexico Historical Review* 89 (Summer 2014): 359-399.

[23] For more on "Old Hickory in the Americas," see Lester D. Langley, *America and the Americas: The United States in the Western Hemisphere* (Athens: University of Georgia Press, 1989), 54-55. In the United States, the franchise was extended to Black men in 1869 with the passage of the Fifteenth Amendment and to all women in 1919, with the enactment of the Nineteenth Amendment. However, the Black franchise had to be re-secured with the Voting Rights Act in 1965.

[24] For biographies of Sarmiento and Turner, see Frances G. Crowley, *Domingo Faustino Sarmiento* (New York: Twayne Publishers, 1972), Ray Allen Billington, *Frederick Jackson Turner: Historian, Scholar, Teacher* (New York: Oxford University Press, 1973), and Allan G. Bogue, *Frederick Jackson Turner: Strange Roads Going Down* (Norman: University of Oklahoma Press, 1998).

[25] James Ford Rhodes, "History," *Annual Report of the American Historical Association*, (Washington: Government Printing Office, 1899), 49-50.

[26] Edward B. Tylor, *Primitive Culture: Researchers into the Development of Mythology, Philosophy, Religion, Art, and Custom* (1871), 1.

[27] Lewis Henry Morgan, *Ancient Society or Researchers in the Lines of Human Progress from Savagery through Barbarism to Civilization* (New York: Henry Holt and Company, 1877), 19.

[28] Ibid., 553; Ferguson, *An Essay on the History of Civil Society*, 105-105.

[29] Morgan, *Ancient Society*, 553.

[30] See "Author's Preface to the First Edition," in Frederick Engels, *The Origin of the Family, Private Property and the State*, trans. by Ernest Untermann (1884; Chicago: Charles H. Kerr, 1902), 9.

[31] Marvin Harris, *The Rise of Anthropological Theory: A History of Theories of Culture* (1968; Walnut Creek, California: Altamira Press, 2001), 29.

[32] To Comte, evolution was a law for all social phenomena, past and present. "From the earliest beginnings of civilization," he wrote, "to the present state of the most advanced nations, this theory has explained consistently and dispassionately, the character of all the great phases of humanity; the participation of each in the perdurable common development, and their precise filiation; so as to introduce perfect unity and rigorous continuity into this vast spectacle which otherwise appears desultory and confused." See Auguste Comte, *The Positive Philosophy of August Comte*, Vol. 2, translated by Harriet Martineau (New York: D. Appleton, 1853), 465.

[33] In Mexico, the leading positivists were Gabino Barreda (1818-1881) and Justo Sierra (1848-1912).

[34] Like other fascists who grew up among the ruins of the Roman Empire, Carrado Gini was worried about degeneration—that "those people belonging higher up in the social ladder, those forming the upper classes, generally have a much weaker reproduction rate than the lower classes." As the Italian economist Vilfredo Pareto put it, "Whatever the underlying determinants might be, it is undisputable that after a certain period (the aristocracies) disappear. History is a cemetery of aristocracies." The Gini and Pareto quotes are from the article by Piero Manfredi and Giuseppe Annibale Micheli, "Some unnoticed Insights in Gini's Cyclical Theory of Populations" in *Genus*, Vol. 71, No. 2-3, *Thematic issue: The Legacy of Corrado Gini in Population Studies* (May-December 2015), 7-8.

[35] Fernlund, "American Exceptionalism or Atlantic Unity?," 362-367. At Johns Hopkins, Turner's mentor was the historian and germ theorist Herbert Baxter Adams, author of *The Germanic Origin of New England Towns* (Baltimore, MD.: Johns Hopkins University Studies, 1882).

[36] Sarmiento had also been drawn to the idea of types. To Crowley, a Sarmiento biographer, "Herein lies the key to the whole Sarmiento narrative, the very goal and dimension of his writing. People are not primarily characters in their

own right, but rather national prototypes. These are either exemplary personages to be emulated, such as Lincoln, Franklin, and Horace Mann, or they are undesirables." Crowley, *Sarmiento*, 62.

[37] In 1946, Carlton J. H. Hayes, president of the American Historical Association and former U.S. ambassador to Spain, would challenge the ethnocentric history of his colleagues, imploring them to speak to the issues confronting Western civilization—of which the U.S. forms an integral part. See Hayes's presidential address, "The American Frontier—Frontier of What?" in the *American Historical Review* 50 (January 1946): 199-216.

[38] Franz Boas, "Human Faculty as Determined by Race," in the *Proceedings of the American Association for the Advancement of Science for the Forty-Third Meeting Held at Brooklyn, New York, August 1894* (Salem: published by the Permanent Secretary, 1895), 303. Boas found himself at odds with William Henry Holmes, a cultural evolutionist who, at one point, as chief of the Bureau of American Ethnology, was one the country's foremost experts on the aboriginal peoples of the United States. In fact, in 1919 Holmes led the effort by the American Anthropological Association (AAA) to censure Boas for his public criticism of several of his fellow anthropologists. Without naming names, Boas accused them of using their positions in the field to engage in espionage for the United States during the First World War. The AAA voted to rescind the censure in 2004. See Kevin J. Fernlund, *William Henry Holmes and the Rediscovery of the American West* (Albuquerque: University of New Mexico Press, 2000), 225.

[39] Franz Boas, *The Mind of Primitive Man, A Course of Lectures Delivered Before the Lowell Institute, Boston, MA, and the National University of Mexico, 1910-1911* (New York: MacMillan, 1911), 7-8.

[40] The influence of the Boas school extended well beyond anthropology. In his analysis of race and culture, the Harlem Renaissance intellectual Alain Locke drew upon the "extreme cultural relativism" of Robert H. Lowie, one of Bowie's students, as a point of departure. See Alain Locke, "The Concept of Race as Applied to Social Culture," which was published in 1924 in the Howard Review and reprinted in *The Philosophy of Alain Locke: Harlem Renaissance and Beyond*, ed. by Leonard Harris (Philadelphia: Temple University Press, 1989), 190.

[40] Harris, *The Rise of Anthropological Theory*, 298.

[41] Boas's "Preface" to the 1938 edition in the rev. ed., *The Mind of Primitive Man* (1938; New York: The Free Press, 1963), 17-18.

[42] M. F. Ashley Montagu, *Man's Most Dangerous Myth: The Fallacy of Race* (New York: Columbia University, 1942), 47; Margaret Mead, "The Role of Small South Sea Cultures in the Post War World," *American Anthropologist N. S.* 45 (April-June 1943): 193-197; Ruth Benedict, *The Chrysanthemum and the Sword: Patterns of Japanese Culture* (Boston: Houghton Mifflin, 1946), 15; A. L. Kroeber and Clyde Kluckhohn, *Culture: A Critical Review of Concepts and Definitions* (Cambridge, MA: Peabody Museum of American Archaeology and Ethnology, 1952), 145.

[43] Harris, *The Rise of Anthropological Theory*, 298.

[44] It was ironic that Marxism's greatest appeal was in the largely agricultural and backward nations of Russia and China, which lay outside the modern and industrialized West.

[45] Gregor Mendel's research on garden peas, from which he derived the laws of heredity, was first published in 1866, seven years after Darwin and Wallace's co-discovery of the theory of natural selection in 1859. Not until 1900, however, was Mendel rediscovered by, as well as made famous by, three European botanists—Carl Erich Correns, Erich Tschermak von Seysenegg, and Hugo Marie de Vries—each one working independently of the other. On the fusion of Mendel and Darwin, see Julian Huxley's popular and scholarly, *Evolution: The Modern Synthesis* (New York: Harper and Brothers, 1942).

[46] Huxley, *The Modern Synthesis*, 578. During the Blitz, Huxley studied the effects of the bombing on animals at the London Zoo.

[47] Herbert Spencer, it should also be noted, had found the origins of evolution, or the increase in levels of complexity and differentiation, not in Darwin's natural selection but in the

First Law of Thermodynamics (also called the Law of Conservation of Energy); Spencer, however, preferred "persistence" to "conservation" and "force" to "energy," hence his phrase the "Persistence of Force." This law stated that energy cannot be created or lost; it was constant, but it could also be transformed or converted into another form. Herbert Spencer, *First Principles* (1862; D. Appleton and Company, 1885), 190. According to Michael W. Taylor, Spencer's evolutionism had clear directionality; it was a "flow in the universe" from "simple to complex, diffuse to integrated, incoherent to coherent, independent to interdependent, undifferentiated to differentiated; from homogeneous and uniform to heterogeneous and multiform." See Taylor, *The Philosophy of Herbert Spencer* (London: Continuum, 2007), 63-64.

[48] Cultural evolution, however, was not entirely dead. Two notable cases in point were the scholarship of V. Gordon Childe, an Australian-born British archaeologist, and Karl A. Wittfogel, a German-born American Sinologist. Both scholars were Marxists and both proved to be very influential. (The Second World War turned Wittfogel into an anti-Communist.) Childe postulated a Neolithic or Agricultural Revolution, thus reconceptualizing the transition from prehistory to history. Karl A. Wittfogel's famous generalization and Marxist analysis, *Oriental Despotism: A Comparative Study of Total Power* (New Haven: Yale University Press), was not published until 1957. However, Wittfogel's ideas on the importance of irrigation in the rise of the bureaucratic state, advanced in a series of articles on early China dating back to 1935, influenced Julian H. Steward and other Americanists. Wittfogel's ideas appeared applicable to Andean South America and Central Mexico, where irrigation was well established, but they appeared less so in the Yucatán, with its cenotes and lagoons. On the peninsula, Mayan farmers used a slash-and-burn, or swidden, system. See Julian H. Steward, "Cultural Causality and Law: A Trial Formulation of the Development of Early Civilizations" in the *American Anthropologist* 51 (January-March 1949): 17. Hydraulics may or may not have played a role in the rise of the Mayan civilization but it appears to have contributed to their decline. See Lisa J. Lucero, "The Collapse of the Classic Maya: A Case for the Role of Water Control," in *American Anthropologist* 104 (September 2002): 814-826.

[49] Leslie A. White, "Energy and the Evolution of Culture," *American Anthropologist N.S.* 45 (July-September 1943): 336; White, *The Evolution of Culture: The Development of Civilization to the Fall of Rome* (1959; Walnut Creek, CA: Left Coast Press, 2007), 38.

[50] White, "Energy," 336.

[51] Bronislaw Malinowski's field work among the Trobriand Islanders during the First World War led him to champion the study of how cultures function rather than how they develop. According to Malinowski (1884-1942), the goal of the ethnographer was to eschew ethnocentrism and to strive "to grasp the *native's point of view* [italics mine], his relation to life, to realise his vision of his world. We have to study man, and we must study what concerns him most intimately, that is, the hold which life has on him. In each culture, the values are slightly different; people aspire after different aims, follow different impulses, yearn after a different form of happiness. In each culture, we find different institutions in which man pursues his life-interest, different customs by which he satisfies his aspirations, different codes of law and morality which reward his virtues or punish his defections. To study the institutions, customs, and codes or to study the behavior and mentality without the subjective desire of feeling by what these people live, of realising the substance of their happiness—is, in my opinion, to miss the greatest reward which we can hope to obtain from the study of man." See Malinowski, *Argonauts of the Western Pacific: An Account of Native Enterprise and Adventure in the Archipelagoes of Melanesian New Guinea* (New York: E. P. Dutton, 1922), 25. Clifford Geertz's influential *The Interpretation of Cultures* (1973) expanded upon these ideas with an ethnography he called "thick description."

[52] See Leslie White's review of Julian H. Steward's *Theory of Cultural Change: The Methodology of Multilinear Evolution* (Urbana: University of Illinois Press, 1955) in *American Anthropologist* 59 (June 1957): 539-542.

[53] In 1958, Gordon R. Willey and Philip Phillips outlined their own five-stage typology of historical-development for the Americas, one that has enjoyed wide acceptance. These stages were the 1) Lithic; 2) Archaic; 3) Formative; 4) Classic; and 5) Post-Classic. The two social scientists noted that "overt developmental classifications [were] comparatively new in American archaeology" and added that this was "possibly because of the strong reaction in this country," the United States, "to what [was] disdainfully referred to as 'nineteenth-century evolutionism.'" Gordon R. Willey and Philip Phillips, *Method and Theory in American Archaeology* (Chicago: University of Chicago, 1958), 64.

[54] Elman R. Service, *Cultural Evolutionism: Theory in Practice* (New York: Holt, Rinehart and Winston, 1971), 9. An Americanist, Service postulated four stages of political evolution: 1) band, 2) tribe, 3) chiefdom, and 4) state, a scheme perhaps as influential as that of Willey and Phillips.

[55] Marshall Sahlins, *Culture in Practice: Selected Essays* (New York: Zone Books, 2000), 22-23. Although a student of White's, Sahlins's stone age affluence thesis was a provocative challenge to neo-evolutionary theory.

[56] C. P. Snow, *The Two Cultures and the Scientific Revolution* (New York: Cambridge University Press, 1961), 23.

[57] The British Houses of Parliament in London and the government edifices on Canada's Parliament Hill in Ottawa were all built in Gothic Revival, which Ruskin's criticism helped to inspire. This was considered a moral architecture, as opposed to the supposedly soul-less Neo-classical style of which the U.S. capitol and Thomas Jefferson's Monticello were good examples.

[58] John Ruskin, *The Stones of Venice*, Vol. 3, 2nd ed. (1851-1853; London: Smith, Elder, and Company, 1867), 35, 60, 95, 170. Ruskin warned his Victorian countrymen that without moral regeneration England was at risk of becoming a fallen empire like the thalassocracies of Tyre and Venice. See Ruskin, *The Stones of Venice*, Vol. 1, 2nd ed. (1851-1853; London: Smith, Elder, and Company, 1858), 15.

[59] Thomas Cole's five-part *The Course of Empire (1833-1836)*, at the New York Historical Society, was an illustration of the rise and fall of empire. The stages were 1) The Savage State; 2) The Arcadian or Pastoral State; 3) The Consummation of Empire; 4) Destruction; and finally 5) Desolation. The theme of decline was ubiquitous in Romantic art and literature. See the sonnet, "Ozymandias" (1818), by Percy Bysshe Shelley in Rosalind and Helen, *A Modern Eclogue; with Other Poems* (London: C. and J. Ollier, 1819), 72, or the painting, "The Colossal Pair, Thebes" (1856), by Frank Dillon at the St. Louis Museum of Art.

[60] See "Machinery" in Mohandas K. Gandhi, *Hind Swaraj or Indian Home Rule* (1909), https://www.gandhiashramsevagram.org/hind-swaraj/chapter-19-machinery.php, accessed August 29, 2020.

[61] See "Education" in Mohandas K. Gandhi, *Hind Swaraj or Indian Home Rule* (1909), https://www.gandhiashramsevagram.org/hind-swaraj/chapter-18-education.php, accessed August 29, 2020.

[62] Snow, *The Two Cultures*, 26-27.

[63] The influence of Margaret Mead's anti-evolutionism on the social sciences and the humanities was legendary. However, Mead's fieldwork in, and her published conclusions on the sexual mores of, Samoa has come under withering criticism by a fellow anthropologist. See Derek Freeman, *The Fateful Hoaxing of Margaret Mead: A Historical Analysis of Her Samoan Research* (Boulder, CO: Westview Press, 1999).

[64] Carolyn Merchant, *Radical Ecology* (New York: Routledge, 1992), 236.

[65] Colin Campbell, "Anatomy of a Fierce Academic Feud," *New York Times*, November 9, 1986, https://www.nytimes.com/1986/11/09/education/anatomy-of-a-fierce-academic-feud.html, accessed August 29, 2020; Michael Yudell and Rob DeSalle, "Essay Review: Sociobiology: Twenty-Five Years Later," in the *Journal of the History of Biology* 33 (2000): 577–584, https://link.springer.com/content/pdf/10.1023%2FA%3A1004845822189.pdf, accessed August 29, 2020; John Horgan, "Stephen Jay Gould on Marx, Kuhn and Punk Meek: Paleontologist Stephen Jay Gould Was Influenced by Marx and Kuhn as well as by Darwin," in *Scientific American* November 2, 2015, https://blogs.scientificamerican.com/

cross-check/stephen-jay-gould-on-marx-kuhn-and-punk-meek/, accessed August 29, 2020.

[66] To avoid this great power rivalry and danger, India, Egypt, Ghana, and many other underdeveloped countries formed the Non-Aligned Movement (NAM), which emerged from the 1955 Asian -African Conference, a gathering of post-colonial states, in Bandung, Indonesia. Cuba joined NAM in 1961, when the group was formed in Belgrade, and Mexico, the next-door neighbor of the United States, has observer status, enjoying, in effect, a position of non-alignment in the non-alignment movement. NAM survived the Cold War and as of 2018, has one hundred twenty members.

[67] To develop and not just defend South Vietnam, Johnson envisaged a New Deal for the country, specifically a billion-dollar TVA-style project for Mekong Delta. Kevin Jon Fernlund, *Lyndon B. Johnson and Modern America* (Norman: University of Oklahoma Press, 2009), 132-134.

[68] Mahbub ul Haq, *Reflections on Human Development* (Oxford University Press, 1996), 24, 49 -51.

[69] Ibid.

[70] Carolyn Merchant, *Radical Ecology* (New York: Routledge, 1992), 236.

[71] The "Brandt Line" was proposed in the 1980s by Willy Brandt, the former chancellor of West Germany.

[72] Barbara Weinstein, "Developing Inequality," in the *American Historical Review* 113 (February 2008): 5-8.

[73] Guillermo Bonfil Batalla, *México Profundo: Reclaiming a Civilization*, trans. by Philip A. Dennis (1987; Austin: University of Texas Press, 1996), xv-xvi.

[74] Arturo Escobar, *Encountering Development: The Making and Unmaking of the Third World* (Princeton, N.J.: Princeton University Press, 1995), 3-4.

[75] Francis Fukuyama, "The End of History?" *The National Interest*, No. 16 (Summer 1989): 4.

[76] Ibid.

[77] Robert B. Zoellick, *America in the World: A History of U.S. Diplomacy and Foreign Policy* (New York: Twelve, 2020), 12.

[78] See Graham Allison, *Destined for War: Can America and China Escape Thucydides's Trap?* (New York: Houghton Mifflin Harcourt, 2017). According to Allison, a "Thucydides Trap" snaps shut when an established power, like Sparta, feels threatened by a rising power, like Athens, and the former goes to war with the latter before it is too late. This concept is based on Thucydides's thesis that Sparta's fear of Athens's growing power was the cause of the Peloponnesian War. Allison found that in twelve of sixteen past cases in which a rising power has confronted a ruling power, the result was "bloodshed." As for another trap, China's "debt-trap diplomacy," Lee Jones and Shahar Hameiri call it a myth in a research paper for Chatham House. This is a practice, of which the authors say there is very little evidence, in which China is supposed to gain control over poor, developing countries by extending to them unsustainable loans for infrastructure, as part of China's strategic One Belt and Road Initiative. See "Debunking the Myth of 'Debt-trap Diplomacy': How Recipient Countries Shape China's Belt and Road Initiative," *Chatham House*, Research Paper, August 19, 2020, https://www.chathamhouse.org/publication/debunking-myth-debt-trap-diplomacy-jones-hameiri, accessed August 24, 2020.

[79] Samuel P. Huntington, "The Clash of Civilizations?" in *Foreign Affairs*, 72, No. 3 (Summer, 1993), 22-49. In 2020, the long-standing conflict in the greater Kashmir region, which involves Pakistan, India, and China, each of which represents very old civilizations, boiled over into violence in the Galwan River Valley between the military forces of India and China. That same year, on the other hand, produced the Abraham Accord, a peace agreement between Israel and the United Arab Emirates, which was brokered by the United States. The accord was called "Abraham" after the father of the Middle East's three great monotheistic religions—Christianity, Islam, and Judaism. Clearly, as these two examples indicate, civilizations may clash as well as cooperate.

[80] See Hans Rosling, Ola Rosling, and Anna Rosling Rönnlund, *Factfulness: Ten Reasons We're Wrong About the World—and Why Things Are Better Than You Think* (New York, NY: Flatiron Books, 2018), 27-28. Within the broader ascensionist narrative of modernity, there are narrower instances of failure and even of societies

that have enjoyed booms in which they achieved a middle income status only to be reduced to poverty by painful busts, as was experienced in the Zambian Copperbelt during the 1980s, after the fall in the price of copper. See James Ferguson's *Expectations of Modernity: Myths and Meaning of Urban Life on the Zambian Copperbelt* (Berkeley: University of California Press, 1999).

The Metapattern of General Evolutionary Dynamics and the Three Dynamical Realms of Big History

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K E Y W O R D S

Big History

combogenesis

grand sequence

dynamical realms

general evolutionary dynamics

biological evolution

cultural evolution

metapatterns

A B S T R A C T

The goal of this paper is to formalize better the division of big history into three main stages (phases, eras). In my own work they are "dynamical realms," 1. physical laws, 2. biological evolution, and 3. cultural evolution. I show a deep similarity in two mighty transitions; first, from dynamical realm 1 to 2, and then from 2 to 3. The common "metapattern" in these transitions is that of generalized evolutionary dynamics, which in both cases opened up vast new arenas of possibility space. I first present relevant conclusions from my book, *Quarks to Culture*. A "grand sequence" of twelve fundamental levels was forged through a repeated cycle of "combogenesis" spanning the dynamical realms as families of levels. Next, I provide examples of other scholars who have similarly weighed in on a three-fold arc; notably Christian, Spier, Chaisson, Rolston, Salk, and Voros (following Jansch). Like me, all have nominally recognized similarities between biological and cultural evolution as important in the dynamics of realms two and three. Generally, these scholars have not placed primary emphasis on general evolutionary dynamics as a multiply-instantiated process. The PVS metapattern for evolution (propagation, variation, and selection) is well established as overarching across many patterns in biology, following life's origin. In culture the operation of general evolutionary dynamics is, I suggest, dual-tier, consisting of cognitive PVS of individuals coupled to social PVS of groups. The emergence of realm-forming PVS-dynamics twice (biology, culture) created radically new ways to explore and stabilize patterns in expansive fields of diverse types within the respective dynamics. Thus, we can recognize a fundamentally similar reason (i.e., two emergent forms of evolutionary dynamics) for why so many scholars have correctly, in my opinion, discerned a threefold arc of big history. Important as well in the flow of progress from quarks to culture were two only slightly less major instantiations of PVS-dynamics (though both crucial): an era of chemical evolution within the realm of physical laws, which led into the realm of biological evolution, and also the evolution of the animal cognitive learning PVS of trial, error, and success, which was essential to the path into cultural evolution. In concluding remarks, I note several outstanding issues: alternative proposals for five orders or four dimensions (i.e., divisions more than three in the arc of big history); the use of the word "evolution," and three matrices (cosmosphere, biosphere, civisphere) that contain and are constituted by the varieties of patterns within the corresponding dynamical realms.

Introduction: Patterns and Metapatterns

Patterns are fundamental to big history. A focus on patterns allows us to formulate a unified field of study, linking things as disparate as protons, stars, oceans, amoebas, trees, ancient cities of Mesopotamia, and democracies. Toward this end, David Christian's (2011, 505) words are spot on: "Of all the patterns that occur at many different scales, the most fundamental is the existence of pattern itself."

We patternologists are concerned not only with patterns of *things*. Things have *relations* (affordances, capabilities). Thus, relations are an important type of pattern for big history. Jack

Pearce (2018, 1) writes: "the visible, tangible Universe is the set of continuing, progressive correlations between interacting elements, forming systems of relationships." Lowell Gustafson (2017) emphasizes "sustained patterned relations," at various scales, from atoms in molecules to people in polities.

In the terms of Fred Spier (2015), things are "building blocks," relations are "connections," and over time the universe has produced "sequences." Sequences should be considered as another general type of pattern in big history; for example, David Christian's (2018) series of thresholds. With sequences, we explicitly bring in the flow of time, and thus changes in patterns and the creation of new patterns.

In *Metapatterns* (Volk 1995), I discussed a "metapattern" of "sequences of stages." In this metapattern found across scales, stages of relative continuity are ratcheted one to the next by "breaks," or changes of state. Examples are the stages of insect metamorphosis or stages in Zen's ox-herding pictures of enlightenment.

I usually use the term metapattern to refer to a pattern that exists in both biology and culture, a sort of super-convergence (Volk and Bloom 2007). Considering super-convergence makes more concrete Gregory Bateson's term "metapattern," which he somewhat enigmatically defines as a "patterns of patterns" (1979 preface). My own interest has been to seek general patterns of form-and-function that have been mostly independently discovered by pattern-making processes in biology and culture, including the mind.

We could say that certain generalities for big history already mentioned, such as sequences, building blocks, connections, thresholds, and even pattern itself are all metapatterns. So would be other big history principles, such as Goldilocks conditions or gradients. In this paper, the main metapattern to which I draw attention will be that of general evolutionary dynamics; namely, propagation, variation, and selection (PVS, or PVS dynamics). In addition, the concept of a dynamical realm is also a metapattern.

Therefore, considering the (meta)pattern of sequences of stages, we will see that a number of scholars have developed models for big history that contain, at the very largest scale of time, a threefold arc. Despite its prevalence in the big history literature (and I include those too early to have called themselves big historians, for example, Jonas Salk; see below), the threefold sequence has not really been spotlighted in big history work. At least I have not seen it referred to as *the* pattern that deserves focused analysis, nor analyzed in enough depth as a pattern that itself should cause us, I submit, to go "wow."

Therefore, what I will do here first is offer a précis of conclusions relevant to this paper from my book *Quarks to Culture* (Volk 2017). Then I will note evidence from others for a three-stage, largest scale sequence from cosmos to culture. Crucial to this paper is what I will call *general evolutionary dynamics* (or, simply evolutionary dynamics), to be spelled out as a particular kind of dynamics for how things of various classes explore possibilities and turn into new patterns.

In essence, to the extent we accept an overall threefold arc of big history, the rules of the games played by systems changed in major ways twice. Both transitions created new types of evolutionary dynamics that were different and yet that also shared a deep similarity by possessing component processes of propagation, variation, and selection (PVS). To round out the picture, we will also develop concepts about chemical evolution and animal cognition as PVS dynamics, both important precursor forms of dynamics leading into the respective next realms of biology and culture.

I will conclude with comments on the use of the word "evolution," about sequences other than the threefold one proposed here, and about other future challenges, all outstanding issues that deserve further consideration.

Combogenesis, Twelve Fundamental Levels, and Three Dynamical Realms

In *Quarks to Culture* (Volk 2017, here *Q2C*), I derived twelve fundamental levels. These twelve progressed from the first level, which includes quarks and the other fundamental particles, to the twelfth, initiated by the ancient geopolitical states. Today's world that is going 'planetary' is possibly a level 13.

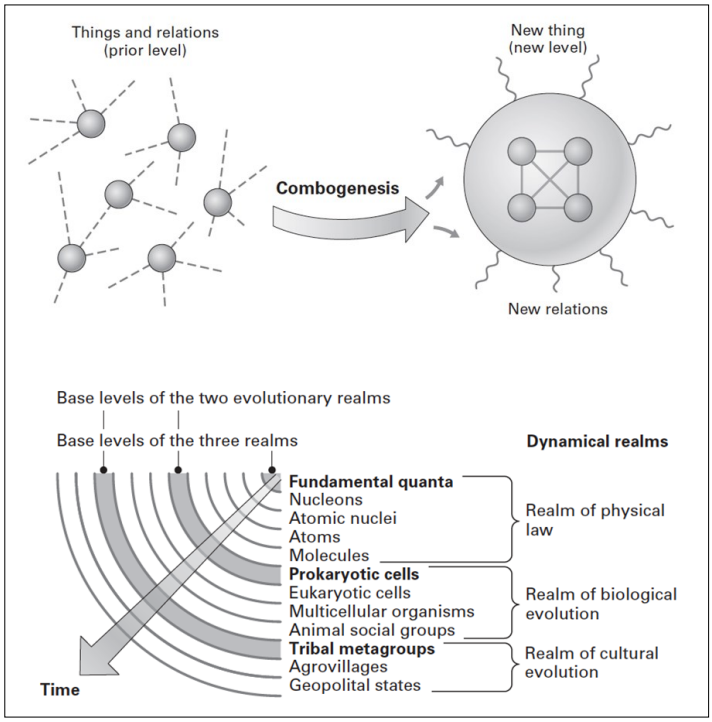

Figure 1. Upper: The logic of combogenesis. The circles on the left are the things (systems, entities) of a prior level. The dotted lines represent the relations they have with each other and with all things in their environment. The single larger circle on the right is the new type of thing (system, entity) on the new level, which results from combination and integration, combogenesis; the wavy lines radiating from the circle represent the new kinds of relations it has and is capable of having. Lower: The three dynamical realms, with particular spans across groups of levels. The base levels of the three dynamical realms are shaded in the concentric circles and are labeled in bold type in the list of levels. Note that two base levels (prokaryotic cells and tribal metagroups) initiate the specific evolutionary realms that are the focus of this paper.

I derived these levels by applying a particular logic. In a nutshell, the logic, called combogenesis, starts with the simplest things (building blocks and their relations) established by physics. Then one works along time, noting first origins of types that form a sequence of nested build-ups by combination and integration. I stay within the path of progression from small to large, toward the human body (as a special something we care about; which technically is a member of level seven, multicelluarity). Then the logic continues from the body to human social systems (as things we are within and that could exist only after we as bodies existed).

The twelve levels derived from this logic are 1. Fundamental particles; 2. Nucleons; 3. Atomic nuclei; 4. Atoms; 5. Molecules; 6. Prokaryotic cells; 7. Eukaryotic cells; 8. Multicellular organisms; 9. Animal social groups; 10. Human tribal metagroups; 11. Agrovillages; and 12. Geopolitical states. See Figure 1 for this resulting "grand sequence."

In *Q2C* I provided pointers to what was new at each level, and what were the key new attributes that enabled the formation of each next, subsequent level, considering the specific dynamics of combination and integration as things grew in scale and fundamental type from each level to the next. Furthermore, the early members of any given level could not have been achieved *directly* from the things from types two or more levels down. Space does not allow me to review the specific evidence and reasoning for each level of combogenesis in this special, unabashedly human focused grand sequence. Some additional discussion will come in later when relevant to specific purposes here.

From the fundamental levels, three groupings—three families of levels—virtually pop out. I call these three families the "dynamical realms." Before getting into the dynamical realms, let us recognize as data for this paper the fact that others have noted three largest scale groupings as well, which I will review in the section after next. Such convergence in the parsing of big history would seem to indicate an important pattern to think about. First, I will define and illustrate the concept of a dynamical realm.

Dynamical Realms and Core Dynamics across Levels in Each

According to my terminology, the three dynamical realms are (1) physical laws, (2) biological evolution, and (3) cultural evolution. Their relationship to the twelve fundamental levels can be seen in Figure 1.

I have described a dynamical realm as follows (*Q2C* 151):

> A dynamical realm is a series of levels that share special, governing operations—that is, dynamics. These dynamics are core processes of the workings of things and relations common across the levels that constitute the realm. The implication is that spans of levels form categories larger than the individual

levels themselves, promptly suggesting the existence of certain large-scale themes of the kind we seek. Thus, a dynamical realm is a kind of world or zone or space of behaviors. We see its core workings continue when general aspects of explanatory logic repeat across levels for specific events of combogenesis. The core processes under focus involve the methods of stabilizing things shared across various levels.

Thus, the things in the *dynamical realm of physical laws*—such as nucleons, atoms, molecules, planets, stars, galaxies, minerals, raindrops—all share and are basically explainable by fundamental forces of physics (and various balances, increases and decreases, concatenations, and subtle modifications of the forces). Specifically, using the model of the grand sequence of combogenesis, in this realm we have the fundamental levels of 1. the standard model, 2. nucleons, 3. atomic nuclei, 4. atoms, and 5. molecules prior to the origin of life. In a recent paper, Voros (2019) skillfully shows connections between the micro-scale build ups of these levels and macro-scale things such as planets, stars and galaxies. Such connections are an important topic but not the subject of this paper. (See, however, the concluding remarks concerning my proposal for three "super-spheres" of context that came into existence at the same time as the base levels of the three dynamical realms.)

To continue, the things in the *dynamical realm of biological evolution*—such as living cells, plants, animals, DNA, ribosomes, chlorophyll, ecosystems, biosphere, ant colonies, chimp communities— all share and, for explanation, need the pattern-finding process of biological evolution. Specifically, using the model of the grand sequence of combogenesis, in this realm we have levels 6. the prokaryotic cell and the origin of life, 7. the eukaryotic cell, 8. multicellular organisms, and 9. animal social groups. Importantly, there is a difference between types of things in this realm that can be directly subject to life-death comparative dynamics of biological evolution (such as the free-living prokaryotic cell or an animal) and those larger types that contain living things (i.e., communities, ecosystems, biosphere) but are not directly subject to evolution, even though they need those directly evolvable things in our explanations for their structure and formation. (All still use physics, of course—the dynamics of one realm do not stop when the next realm starts.)

Finally, the things in the *dynamical realm of cultural evolution*—such as conscious people, hunter-gatherer groups, cultivated wheat, samurai swords, the alphabet, medieval city walls, Plato's *Republic*, a Fender Stratocaster, and modern democracies, election districts, and billionaires—all share and, for explanation, need the pattern-finding process of cultural evolution. Specifically, using the model of the grand sequence of combogenesis, in this realm we have 10. the human tribal metagroup and the origin of cultural evolution, 11. agrovillages, and 12. geopolitical states. In my proposed model, we are still in level 12 of the geopolitical state, though it has changed greatly from the ancient states to modern nations (similar to the way that worms becoming whales was a path of change *within* the level of animal multicellularity (*Q2C* 128, 140). Like the examples in biology above, things in this realm are subject to the dynamics of cultural evolution to a greater or lesser degree, even though all require cultural evolution as parts of the explanations we give them for understanding.

This model implies that particular levels are 'base levels' that began respective dynamical realms. Again, see Figure 1. Base levels initiated those specific new core dynamics that are so crucial to understanding steps of combogenesis to subsequent levels that continued those core dynamics. The base levels are (realm 1, level 1) the fundamental starter-stuff of physics, (realm 2, level 6) prokaryotic cells, and (realm 3, level 10) human cultural metagroups.

If the proposal in this paper is correct (or gains support from a few readers), we can expect something fundamentally new at the base levels of the dynamical realms of biological and then cultural evolution. The remainder of this paper looks in more detail at these evolutionary dynamical realms 2 and 3, the transitions into them from their respective prior realms, and the importance of the multiple instantiations of the metapattern of general evolutionary dynamics, in both form-

ing new evolutionary realms and in lead-ups into them.

A Threefold Big History Structure Noted by Other Scholars

A number of scholars have proposed a similar threefold, largest scale sequence from the Big Bang to us. Examples come from David Christian, Fred Spier, Eric Chaisson, Holmes Rolston III, Jonas Salk, and Joseph Voros. Table 1 summarizes references and terms.

Table 1 provides evidence of seven scholars who note a threefold structure to big history. In some cases, they cite each other, indicating agreement or borrowing. In my opinion, for the

Scholar	Overall Term	Term for Dynamical Realm 1	Term for Dynamical Realm 2	Term for Dynamical Realm 3
Rolston (4)	Three Big Bangs Universal evolution's three phases	Matter-Energy	Life	Mind
Salk (5)	Evolution of Complexity	Pre-biological Evolution	Biological Evolution	Metabiological Evolution
Voros (6)	Phases of Cosmic Evolution's Grand Sequence	Cosmologic Evolution (Physical)	Sociobiological Evolution (biological)	Sociocultural Evolution (cultural)
Volk (7)	Dynamical Realms	Physical Laws	Biological Evolution	Cultural Evolution
Christian (1)	Big History Main parts of recent book	Cosmos	Biosphere	Us
Spier (2)	Big History Major types of complexity	Physical inanimate nature	Life	Culture
Chaisson (3)	Cosmic Evolution Phases	Physical Evolution	Biological Evolution	Cultural Evolution

Table 1: Multiple descriptions of a threefold great sequence

All terms are direct quotes from the sources. Terms may vary within a source, but this table shows what I judge to be each source's most representative terms for the great threefold sequence.

(1) David Christian (2018). Terms are titles of his book's main parts that elaborate on his eight thresholds, in one or more chapters per threshold within these parts.

(2) Fred Spier (2015). His focus, well known to the big history (BH) community, is on the relationship between energy and complexification within the sequence from physics to culture.

(3) Eric Chaisson (2014, 2015). Also well known to the BH community, Chaisson focuses on a universal metric of "energy flux density" and its increase over "cosmic evolution." Spier (2015, 58-59) identifies "a great many complications" but does conclude, "Chaisson's analysis seems fair enough as a first-order approach."

(4) Holmes Rolston III (2010). This book, *Three Big Bangs*, is not commonly cited in the BH literature but deserves applause and is directly relevant here.

(5) Jonas Salk (1985). This remarkable paper is worth attention by the BH community. It appeared in a volume honoring Salk's friend Jacob Bronowski. Salk's term "metabiological" is basically what many of us would call culture. See also Salk's book, *Anatomy of Reality*, 1985.

(6) Joseph Voros (2019, following Jantsch 1980). Voros does a service to the BH community to bring up the prescient work of Eric Jantsch. Do not be perplexed by the term "sociobiological evolution;" it is basically what several others call biological evolution. Also, Voros has a worthwhile discussion about the use of the term "cosmic evolution."

(7) Volk (2017).

most part, we should view these as independent results, showing a convergence of ideas.

Despite differences in terminology, the three divisions closely flow vertically in the table. We will ignore tricky and debatable issues about how the authors describe the beginnings of each of the three divisions. For one thing, not everyone is concerned with exact beginnings. Second, such beginnings are very much still being worked out by relevant discoveries. Indeed, the births of the three realms hold some of the most demanding questions for science (*Q2C* 188-190).

Without doubt many more examples of the threefold structure could be brought in from other scholars with notable exceptions, to be discussed toward the end. For now, let us take this convergence as meaning something. But what?

We should at least consider an answer relying on an 'observer effect': the divisions might not really be there. They might be human creations. Humans have a tendency to see things in time as having stages. We reify gradients drawn from continua by drawing lines and then putting names on stages. As ancestral humans sought God, perhaps today's big history scholars seek major stages. In my judgment this would constitute a lazy answer that would not do justice to the findings of science (though in all cases of scholarship, we do have to be cautious about the human projection of patterns).

Let us consider then that this table points to what might be an important pattern for big history. Yet, I have not seen much targeted discussion specific to this tripartite division.

To emphasize, there frankly has not been enough inquiry into this. Yes, there has been excitement about thresholds, complexity, energy flux density, and other proposed principles, as metapatterns cutting across the threefold sequence but not much about the pattern of the three sub-arcs of the entire arc. In hopes of adding some "wow," let us inquire more deeply into how this threefold pattern came about.

Possibility Space and the Exploration, Formation, and Stabilization of Patterns; or, Games that Patterns Play

The convergence implies that a number of scholars see two giant shifts in the deep nature of the universe's myriad things and relations: first, from physics-chemistry *into* biology, and second, from biology *into* humans and culture. As suggested in my analysis to come (though I look forward to being corrected), we could be making more of a point that the emergence of new, multi-level-enabling dynamics happened twice using different instantiations of the same core dynamics. In simplest terms, I think everyone in the table would agree that at some point in time on Earth, life came on the scene. That changed a lot of things in a big way! Then, at some subsequent point, humans arrived. Once again, that changed a lot in a big way!

There is a conceptual issue here. It involves the phrase, "in a big way." In my model of a grand sequence, innovations in things and their relations come into existence with each and every one of the twelve new levels of combogenesis (or, to take another model, with each one of Christian's eight thresholds). Such innovations of levels or thresholds were all big. However, at certain, special levels (or thresholds) the innovations were so momentous that they opened the doors to entire families of subsequent levels (or thresholds). How do we determine what created the truly momentous versus the merely big in the degree of innovation?

Holmes Rolston III (2010, 33-37) has wrestled with this conundrum, and thus the question of scales of innovation, through the concept of "possibility space." Rolston points out that in some sense, *everything* now existing was born in the possibility space set up at the Big Bang. Given the starter-set stuff of basic particles and rules of our universe, then jet planes and democracies—as possibilities—were 'there' at the moment of the physical Big Bang. Yet we also know that jet planes and democracies—as materialized patterns—would not have come into being unless living cells (and many other things, such as atoms, stars, etc.) emerged in sequence in the cosmic cavalcade.

Although the Big Bang opened up the total set of all possibilities we have seen manifested, something is lacking from that too simple a viewpoint. Rolston's answer (if I may interpret it as such) is his concept of "three big bangs." Following the

first big bang, what made the next two big bangs that launched life and culture so momentous was that those two origins each opened up huge new possibility spaces. The new ways of exploring patterns opened up by the starts of biology and culture allowed the creation of new fundamental levels (or thresholds) within those new two major ways of operating.

This concept of types of possibility space and how new things are achieved out of possibilities is directly related to Spier's (2015, 48-54) three basic forms of complexity (physical, biological, cultural). To have a trio of main types of complexity follow one upon the other in a sequence implies that twice new types of complexity came about from previous types. These new types were not just different, but extraordinarily impactful in that they allowed further complexifications *within* those basic types. The starts of these types of complexity created new dynamical realms (in my language), with families of levels *within* each. One might think of nestings of scales (or degrees) of innovation.

We also might think of the grand situation in the following way. Two times the rules of the processes that created patterns, relations, and sequences (smaller than and thus within the three realms of the grand sequence) changed in ontology-expanding ways. If physics and chemistry are simple, analogous, say, to the game of tic-tac-toe, then the rules of the biological games, once invented, might be more like checkers. Continuing, then culture might be more like chess (or fill in with your favorite complex game here, such as Go, or Risk). Rules of the three games allow different methods of probing possibilities, bounded, of course, to certain ranges of actualization.

I support the view that the new games are new ways of exploring possibility space. This paper's claim is that the pattern of the threefold arc of big history was made because twice new, major types of general evolutionary dynamics started. First came the dynamical realm of biological evolution from the non-evolutionary realm of physical laws. Then came the dynamical realm of cultural evolution from that of biological evolution.

I will next go into biological evolution, and then to culture, showing the relationship between evolutionary dynamics and possibility space, in terms of exploring and stabilizing patterns. The issue of scale will again come in.

The Dynamical Realm of Biological Evolution; Things with Imports of Nutrients and Exports of Wastes

I think it is no exaggeration to say that a preponderance of big history scholars see the origin of life as a crucial start to a new era of patterns on Earth. That is certainly true of those cited in table 1. For example, with the big bang of life "the rules of the game change . . . and the future is like no previous past" (Rolston 2010, 82).

A more complete list of thinkers with similar views would be expansive. We would include, for example, Schrödinger's insights (1944, *What is Life?*) into new types of entropy fluxes and information storage at the origin of life, as well as Greg Henriques and colleagues (2019) with their new "dimension of existence" that began with life.

Similarly, it is no exaggeration to say that most would specifically highlight the overarching process of biological evolution as a game changer that ratcheted up the complexity with a new playground of patterns, like progressing from the humdrum of tic-tac-toe to the upscale challenge of checkers. As John Stewart (2019a) says, "given sufficient numbers of generations, complex adaptations could be discovered by this trial-and-error searching of possibility space." (Perhaps Dobzhansky's famous quote is already reverberating in your mind: "Nothing in biology makes sense except in the light of evolution.")

Yet there are many who point not only to evolution but also to the entity called the living, prokaryotic cell as key at life's origin, and specifically drawing from a list of descriptions that typically include items such as DNA, negentropy, autopoiesis, boundary membrane, reproduction, information, CHNOPS, ribosomes, metabolism, reproduction, and more.

The importance of many items in such lists as key at life's start is not in dispute here. We can see issues of scale, particularly in two main scales of innovations. Yes, the prokaryotic cell was not only an innovation with a list of factors. On a

much larger scale, the cell also started a new dynamical realm with the pattern-exploring game of biological evolution. Thus, we should try and integrate the local, internal dynamics of the living cell upward into the larger, population-scale dynamics of evolution, the process by which prokaryotic cells could change in time, resulting in stupendously radiating and sometimes even merging lineages of life.

To bridge these two scales of cell and evolution, I concur with the logic of Fred Spier (2015, 146): "The complexity of life is fundamentally different from more simple forms of complexity, because it actively harvests matter and energy from outside . . . . Because resources are finite, at a certain point competition inevitably set in." Spier goes on to note that at this transition point, basically the process of evolution set in.

I would like to add to Spier's note of the cell's need for "harvest," which involves a transfer from a cell's outside to its inside. Let us consider as well the complementary process of waste ejection—from inside to outside. Important for generating biological evolution is the fact that both directions of fluxes will degrade the environment around the cell (*Q2C* 75-77). With respect to a cell's ability to continue living, its imports *reduce* the surrounding nutrient concentrations. A cell's exports *increase* the surrounding waste concentrations, which are presumably toxic or in some way detrimental (after all, the cell ejected the wastes as necessary for its metabolism).

Given this pair of negative effects as a double whammy, then, returning to Spier's terms, competition set in. Furthermore, because cells vary, selection follows. (Variation is a large topic, not to be discussed here because I assume it is not controversial in general, but at base the complexities of a cell's internal metabolism and the process of replication lead to inadvertent variations.)

We now have the connection between the two scales of dynamics. As a consequence from what the living cell does at its local scale of living dynamics, the larger scale of biological evolution follows. Of course, these scales intertwine and coproduce each other. Yet what a cell does itself is more fundamental. Evolutionary dynamics are an inadvertent consequence.

Biological evolution is a "blind watchmaker," in Richard Dawkins' famous phrase. It is blind, yet powerful. Though not a directly selected feature of living cells, evolution at life's origin constituted the core operations that established a new dynamical realm of pattern-shaping. Biological evolutionary dynamics were able to engender a series of subsequent levels (figure 1) because things made at those levels continued to possess the core operations that create evolutionary dynamics.

To elaborate, key to the core operations that caused evolution to cascade into the future of life are that key pair of fluxes: imports of nutrients and exports of wastes. After the prokaryotic cell (level 6), the eukaryotic cell (level 7) also imports and exports. So does the multicellular organism (level 8). Level 9 of the animal social group is trickier. If we disregard the controversy of "group selection," the animals (which contain eukaryotic cells, which contain mitochondria) in a social group have collective imports and exports summed from the number of individuals. Furthermore. individual animals are subject to evolution, within the context of a group. (To be clear, similar-species groups are what I consider to be level 9.) The animal social group is generally not subject to direct life-death dynamics as a whole thing. There is a close tie between the individual animal in certain groups that have social learning and the larger-scale, behavioral organization of a group itself, a topic not to be expanded here. I assume it is not controversial to this readership that evolution can work on individual animals to facilitate their behavioral adaptations for life in complex groups.

Thus, evolutionary dynamics continued on all these levels that followed the origin of the prokaryotic cell. Evolutionary dynamics followed as a consequence of what living things do to live. Again, in this view, the imports and exports are the essential, fundamentally new relations of the things with the new form of complexity at the base level of life. These relations continue up the levels of the grand sequence.

PVS Dynamics as a Metapattern

Next let us generalize evolution as a metapattern. There is P: propagation, a necessity of living

things. There is V: variation, noted earlier. There is S: selection. All together, this is: PVS, or PVS dynamics. This trio of sub-processes together make the 'recipe' for evolution. As a scale independent metapattern, PVS dynamics need not be confined to biology.

The generalized evolutionary process has been called by various names: an algorithm (Dennett 1995), a recipe (Wilson 2007), a formula (Buskes 2013). Its sub-processes are commonly three in number, like my PVS. These go by slightly different names, which will not be debated here. Though I prefer the term propagation over equivalent alternatives for the P subprocess, others use reproduction, replication, or inheritance. The term variation is almost universal. So is the term selection. As one more example of how terms can vary, instead of selection, Spier (2015, following Chaisson) prefers "non-random elimination," and psychologist Donald Campbell (1960) uses "selective retention."

Two brief asides suggest one can tease out these three sub-processes and how they work to produce evolution in Darwin's famous final paragraph of *The Origin of Species*. Also, the PVS as a recursive system is, of course, not a standard cycle like the phases of the moon; it is more like a braid whose length is time and in which all strands are interwoven in the ongoing generation of patterns. See Figure 2.

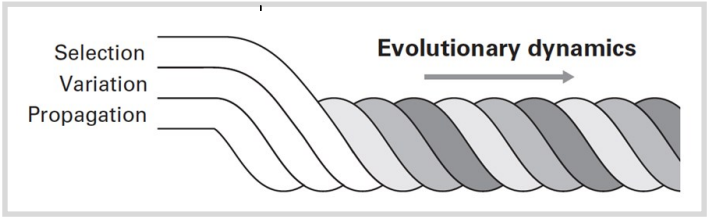

Figure 2. Evolutionary dynamics (in the general sense not limited to biology) consists of three component processes, depicted here as the interwoven strands of a braid of sub-processes: propagation, variation, and selection.

The philosopher Chris Buskes (2013), in his paper, "Darwinism Extended: A Survey of How the Idea of Cultural Evolution Evolved," makes cogent points about what he calls "Darwin's formula" and how it is applicable to both biological and cultural evolution. The "three elements" of this logic constitute an overall dynamical process that is substrate neutral. Daniel Dennett also notes the importance of substrate neutrality in his general evolutionary "algorithm." Whether formula, algorithm, or recipe, the application of PVS dynamics over and over again produces "cumulative selection" (Buskes 2013), and thus cumulative change, from bacteria to brontosauruses in the case of biology, and from hand axes to hand sanitizers in that of culture.

The application of the term evolution to culture requires more discussion to support my aim to promote the PVS metapattern as a key principle in big history. For example, what about the P sub-process? Propagation as a general subprocess clearly needs to be more expansive than the self-propagation of life forms, such as in biological reproduction. A discussion on how to expand P to culture will come. First, to show a clear application of evolution as a metapattern, let us turn to what many have called "chemical evolution," which led 'up' and into biological evolution.

Chemical Evolution Preceded Biological Evolution

We can now make a first concrete application of the PVS metapattern to a region of pattern formation that is outside biology. For this we go first not directly forward in time's grand sequence to culture, but backward, to chemistry.

Many scholars have talked about "chemical evolution" as a transition to the origin of life. Chemical evolution refers to the ability of molecules to make autocatalytic loops that can complexify by PVS dynamics operating upon those loops as variable wholes. What gives the loops (or nested systems of loops, see Kauffman, 2019) the ability to evolve follows as a consequence of their complexity, with the inherent potential for small variants to arise and differentially propagate.

One theorist whose formulation I have found particularly useful is the theoretical and organic chemist Addy Pross. In papers and books (e.g., Pross 2012; Pross and Pascal 2017), he and colleagues distinguish "thermodynamic stability" from "dynamic kinetic stability" (DKS). Briefly, the more complex chemical DKS systems (the autocatalytic loops in the preceding paragraph) can

exhibit evolution because they require imports of fresh substrate molecules as feed stocks in their semi-closed reactions. They also require the ejection as exports of dead-end 'waste' molecules made within their internal reaction loops. Thus, DKS chemical systems are import-export things. They were possible within what I call the level of molecules within the dynamical realm of physical laws.

In his newest book, *A World Beyond Physics*, Stuart Kauffman (2019) shows how these pre-life, biochemical DKS systems would inherently propagate as chemical 'things,' how they would inherently vary by blebbing off sets of sub-reactions and accepting blebs from others, and thus how these DKS systems could indeed evolve by cumulative change. The DKS things explore possibility space and manifest new forms from what Kauffman calls "the adjacent possible."

Because of their export-import lifestyles, such DKS systems would compete and thus improve (dare we use that word?) in their possession of internal functionalities that support their 'lives,' as they progress in time from simple chemistry toward the complex prokaryotic cell at the base level of life.

Yes, so much about getting from complex chemistry to the base level of life is still damn mysterious. Nonetheless this scenario has growing experimental evidence and theoretical support, involving entities that Eörs Szathmáry (2015) calls "protocells."

If we accept the basic outline, then the relevance for the proposed PVS metapattern for big history is that chemical PVS dynamics preceded and led into full on biological PVS dynamics. Chemical evolution transited into biological evolution, which from our distance in time, was a major leap.

Should the era of chemical evolution be considered a separate dynamical realm?

This is an interesting, open question, worthy of discussion. I do not expect it to be answerable in an absolute way. Even so, I raise it now and will return to it again later in the paper.

On one hand, if we use the start of a new form of PVS as the definitive mark for a new dynamical realm, then it might seem that the answer is "yes." This viewpoint should be considered.

On the other hand, I am inclined to a soft, albeit noncommittal, "no." For one, in the chemical wilderness of nature today we apparently do not confirm protocells or autocatalytic loops clearly on the path toward life. If this absence of evidence continues, it would appear that the postulated types of primordial chemical loops have disappeared, perhaps as they long ago chemically evolved and merged into the operations of the cell of the Last Universal Common Ancestor at the origin of life and biological evolution. However, back-pedaling a bit, if we have not found the wild protocells yet, we should be open to what might be out there awaiting discovery (perhaps in deep sea vents).

Another, related reason for my soft "no" is that the two forms of PVS-dynamics in the scenario sketched—chemical PVS leading to biological PVS—are in some sense so continuous in time that they might seem to be not independent inventions of the PVS metapattern. Both chemical and biological evolution involve selection upon variants of propagating chemical patterns of import-export systems (for a moment, biology considered as complex chemistry). Thus, the first transitioned—how smoothly, it is unknown—into the other.

I think the case is much stronger when we come to cultural evolution, for a new evolutionary dynamical realm that arises from an innovative instantiation of PVS dynamics. To that we turn next.

Cultural Evolution Is a Form of Evolutionary Dynamics, Dual-tier with Both Individual and Social PVS Dynamics

We find a real breakthrough in the manifestation of the PVS metapattern when we consider cultural evolution. The innovation is substantial enough to call the result a new dynamical realm. I will show that the overall PVS dynamics of cultural evolution is a system of both mental and social operations that, therefore, couples two tiers of specific (because to some degree separable) PVS.

The awareness of culture as evolutionary—more than metaphorically so —goes deep in the big history literature. As shown in Table 1, many scholars explicitly call culture a form of evolution. Even those who do not use the word in the table use the term at times in their writings. For example, Christian (2018, 335) cites Alex Mesoudi, one of the leaders in cultural evolution theory. Spier sees teacups and large buildings created by "adaptive radiations" within the "artificial complexity" component of his third major type of general complexity, that of culture (Spier 2015, 253).

I suggest that cultural evolution—and specifically as a new realization of the PVS metapattern—should become (even) more prominent in the big history literature. One advantage for upping the focus is that this entangled power trio of P-V-S can be studied by unraveling it into its separate players. There might be rich potential for integrative scholarship here: How is cultural possibility space explored by variants at all scales of culture from material objects to conceptual systems such as religion or science? How are cultural patterns selected, by degrees—inadvertently, individually, and collectively across multiple scales of groups? What various mechanisms that change over time propagate these patterns? What about the conscious mind? Recent work is spotlighting the high fidelity, complex copying abilities of humans and also their specific innovation of teaching (Laland 2017; Buskes 2019; Tomasello 2019).

Using evidence from the anthropological literature, I have proposed a transition of combogenesis from animal social groups (level 9) to human tribal metagroups (level 10; *Q2C* Ch. 13). This is key: tribal metagroups (i.e., beginning with hunter-gatherers in extended social organizations) were not just a larger group of primates but consisted of local 'post-primate' groups networked into a larger cultural sea of groups. The metagroup is thus a new fundamental level of combination and integration. Indeed, this new level was so significant that it launched not just a new level but a unique dynamical realm because its 'things' possessed cultural evolutionary dynamics.

The new, extended and extendable social organizations depended on language and material things such as tools, shelters, and symbolic material artifacts. Language and material culture served as mutually-reinforcing, interstitial bindings among people, integrating local, smaller groups into landscape-spanning, fuzzily-bounded socio-cultural 'things.'

A larger-scale social organization was one necessary condition for the emergence of *cumulative cultural evolution* (Tomasello 2019, 19). The larger 'thing' maintained itself broad enough to be self-propagating. In this new level, people in a local group could stay connected in the larger metagroup to others who might be living on the other side of a mountain or kilometers down the river.

That culture was evolutionary—in the sense that at some point it had PVS-dynamics—is supported in detail by the many scholars cited earlier (for a good overview, see Buskes 2013). Truly, cultural PVS of some sort cannot be controversial. Look around at restaurants as flowers beckoning to potential pollinators from pedestrian throngs along Bleecker Street in the Big Apple (not at the moment, in April 2020, but hopefully again soon). Cultural PVS dynamics are often brought up with regard to information, but I like to point to examples that more directly drive the point home, such as restaurants or cars.

Many—Buskes and Tomasello have been cited but there are many—use the term "cumulative" culture (the apt metaphor of a cultural "ratchet" is also popular). My only slightly new point along these lines has been to place culture in sequence as a new dynamical realm, worth formally defining in the entire grand sequence as realm number three, and which began in a particularly innovative fundamental level of the tribal metagroup during the recursive process of combogenesis. The key to the innovative quality of that level was the explosive upscale of pattern-making powers from the new form of PVS.

More specifically, I claim that the special, human form of cultural dynamics can be usefully studied and positioned as *dual-tier* PVS (*Q2C* 177-180). The two tiers are as follows:

Tier one: There is PVS in the minds of individuals (more about this in a bit). Mental PVS has

been recently noted in this journal (Stewart 2019; Voros 2019).

Tier-two: There is social PVS, in the group decision-making systems that began at least by the time of the extended societies of hunter-gatherers, the exemplars for the original metagroup origination. This social PVS is largely operational within the daily groups. Relevant to his emphasis on "collective learning," Christian (2018: 178) points to contacts and thus vital networks among neighboring groups. There is even evidence that Neanderthals had occasional multiband gatherings (Hayden 2012) as crucial to their culture. Indeed, I envision the invention of the active use of the word "we" as some sort of threshold. See, for example, the focal importance of "we-intentionality" of John Searle (Plotkin 2003) or the unique human capacity during a child's development to progress from joint intentionality to collective intentionality (Tomasello 2019).

Putting these two tiers together—and they likely coevolved in early cultural evolution—produced cultural systems that enabled a 'Rolstonian' third 'big bang.' The dual-tier cultural systems opened up vast new types of possibility spaces and allowed newly generated cultural patterns to undergo expansions and progressions.

Learning as PVS Dynamics in Cultural Evolution

Learning has much been emphasized in big history literature as key to the human realm, and for many good reasons. What I would like to suggest here is we might try and merge big history's emphasis on learning to an equal emphasis on dual-tier PVS dynamics in cultural evolution. We should explore what learning and dual-tier PVS might have to do with each other. I think it is a very close relationship.

Spier (2015, 141) sees the correspondence between biological evolution and human history close enough to call "both . . . driven by learning processes." One can therefore surmise that learning contains PVS dynamics. I mean that as a strong statement. I would guess that, ultimately, learning is likely the larger set of phenomena. If so, it would be interesting to distinguish the PVS parts of learning (of various kinds) from the non-PVS parts. Perhaps, as Christian's system of collective learning (2018) includes both decision-making (which clearly is PVS) and modeling, this would make learning larger than the PVS portion of learning. One's models improve as well, and thus are progressively created from a PVS process that likely has both cognitive and social components. If an anatomization of cultural evolution could be figured out, a general analysis of the role of learning in big history might benefit.

For example, scholars noted above cite teaching as a major innovation that helped forge humanity in a step from a more basic social learning like that possessed by fission-fusion animal social groups. If the scholars are right, then teaching would be one large innovation of the P (propagation) function of cultural evolution's overall PVS. Laland (2017) notes how culture requires, above all, the primary ability to employ cultural mechanisms for propagation. Teaching is also a new form of selection in its complex, personal evaluations.

Once Invented, the Continuation of Cultural Evolutionary Dynamics in the Grand Sequence

From a perspective on big history, we can see a metapattern repeated: a major new form of PVS dynamics came in with culture, and culture was linked to the form.

Similar to the way that the PVS of biology continued into the biological levels of the grand sequence, the dual-tier, cognitive-social PVS of culture continued into subsequent cultural levels. Once started, cognitive PVS systems of internal "testing" of ideas and scenarios and decision-making were always there and linked to evolving, social forms of decision-making, scenario-building, and attempts at persuasion and influence, to note just a few forms of social PVS available.

Once started, the overall, combined, dual-tier PVS of culture continued into innovations and complexifications (inexorable from our retrospective perspective?). A new fundamental level within the dynamical realm of culture came about when the metagroup structure of level 10 incorporated plants and animals into the human cultural system, leading to level 11 of agrovillages.

Then came level 12 of geopolitical states, in which the main innovation was the discovery of how to do socio-cultural political combogenesis with takeover and incorporation by various power games, enabled by the innovation of the extendable bureaucracy (Q2C, 137ff.). All these advancements required minds with cognitive PVS dynamics and social PVS operations for making group decisions and incorporating changes that emerged as trials involving at various scales language and material culture.

From Animal Cognition to Human Dual-tier PVS and a Full-on Cultural Dynamical Realm

Given that biological evolution was in place with its inadvertent PVS, then PVS as a metapattern could potentially be found by biological evolution, if the pattern forming properties of a PVS system was advantageous. In other words, the pattern or process of PVS could be discovered and established *within* an organism as an *adaptation*. One well known example is the adaptive immune system possessed by most vertebrates (Czisko 1995).

How did the transition to the major innovation of cultural evolution occur? My proposal will be limited to showing the involvement of a biological type of PVS dynamics as an adaptation prior to the PVS dynamics of cultural evolution (*Q2C*, 176ff.). The specific claim is that animal cognitive PVS led to the more complex PVS of human mind, a key partner of the dual-tier PVS-system that also included an explicit social-PVS for full-on cultural evolution.

Here is where learning as a PVS system comes in again. Learning is a tricky concept and, in some interpretations, could even be applied to behavioral changes of a bacterium (LeDoux 2019). Pertinent to our seeking for PVS as an evolved adaptation directly relevant to human evolution, the neuroscientist Joseph LeDoux also emphasizes how crucial was the step of animal evolution that enabled more complex trial-and-error learning as an adaptation (specifically, Thorndikian learning). In animal evolution, this type of learning was a cognitive advance from one-shot, simple conditioned learning, which can happen, for example, in threat-response conditioning.

In the way LeDoux sees this transition, simple trial and error behavior was supplemented by mental modeling in some mammals. Then primates developed forms of cognitive deliberation to simulate mentally their trial-and-error experiments and avoid some of the risks of harm or even death always present in actual tests of behavior. Another leap occurred in humans with language and especially syntax and hierarchical reasoning (personal communication). The question of consciousness, or its gradual evolution, is of course open and controversial.

Trial-and-error animal learning, therefore, is a PVS system that shapes relatively sophisticated behavior from successful experience (and from failure, which can induce behavioral extinction or a switch in behavior). The idea described is that the animal brain of sufficient complexity has some sort of PVS cognitive 'metabolism.' Let us call it animal PVS-learning. These cognitive operations are useful to an animal's life.

Once evolved, the basic operation of animal cognitive PVS could be further sculpted and complexified by biological evolution. As described, the PVS capacity of animal learning, as a useful adaptation, could progress in a ratchet into more and more powerful mental PVS-systems to advanced, multi-layered human PVS in the brain-mind. Somewhere back in time, in our ancestral lineage, culture emerged from abilities that ever more advanced PVS-learning enabled.

The importance of an innovation in animal learning is consistent with Henriques and colleagues' (2019) proposal that animal cognition is a landmark new "dimension," because it involved a "behavioral selection" feedback loop that "builds mental complexity" from "variation, selection, and retention." Their proposal for this new dimension will be revisited toward the end of this paper.

It seems reasonable that this cognitive PVS of animals (again, of a certain complexity) grew in potential and operational power during the genesis of cultural humans along with *social abilities*, as noted above. These changes in the mental and social capabilities would have at first both been linked closely to biological evolution but then more and more were running on their own, cou-

pled in special cultural evolutionary dynamics (Boyd and Richerson 1985). Specifically, the human mind became capable of imaginative prospection. We even make individual, whole-life choices or selection, from ancients deciding to go on a vision quest, to moderns making career plans.

John Stewart nails it: (2019, 142) cognitively, an "evolutionary process was internalized within the minds of humans." Stewart also notes the often-cited words of Karl Popper, as this capability "permits our hypotheses to die in our stead." Similarly, Rolston discusses the importance of "ideational variation" (2010, 98) in the cultural big bang.

It is important to state that the individual's mental PVS was most likely not an inadvertent byproduct. In this way, the animal cognitive PVS is thus unlike the overall process of biological evolution's PVS, which at its start was an inadvertent consequence of the metabolic import and export fluxes of the cell. The difference is that animal cognitive PVS evolved within the animal as a biological adaptation with advantages for the animal.

In my view, to repeat, in the progress to humans from animal cognitive PVS (say, of the level of chimps or bonobos), the cognitive PVS cooperated with and was coupled to changes that led to human social structures, in particular the metagroup systems that enabled culture. Thus, we need to bring in the social and some significant innovation of social PVS dynamics. This is consistent with the views of numerous theorists, such as Tomasello (2019).

How do the human tiers of cognitive and social PVS connect? Details are beyond the scope of this paper and my mind. Specifics are easily seen to be truly entangled and complex. For example, one's own thought processes are subjects of discussion by others, even groups of others, who then influence the individual via training with encouragement and its opposite. We would have to consider here all the complexity that social networks have as control systems for propagating culture as individuals enter and leave through births and deaths. The cultural anthropologist Christopher Boehm (2012, 354) has described an ancient era in which bands had "fierce egalitarianism" (based on hunter-gatherer data), which they maintained by group discussions and decisions, for example, about how to handle a problem individual.

Today humans possess both internal complex decision-making processes that range in their degree of complexity. For example, decision-making modalities divide into fast and slow mental systems (Kahneman 2011). More generally, we weigh options and juggle possibilities in an inner cognitive possibility space, filled with yeses and nos, and these decisions are connected to intricate demands and nuances of support and rejection from others, and those 'others' can be groups in both real and even imagined social spaces (Luhmann 2012).

This is all generally consistent with Christian's discussion of the importance of collective learning (2018) in the emergence of culture. My specific emphasis here is on the PVS metapattern, and the repeated manifestation of it as a principle in big history, for the dynamical realms of biology and culture, because of that metapattern's power in exploring possibility space and bringing in the real from the unmanifest. Discoveries and syntheses are gradually filling in the specifics of the still greatly mysterious transition from biology to culture (Tomasello 2019; Laland 2017; many others), so my broad-brush answer is therefore limited to a perspective that uses the PVS metapattern as a principle to propose large-grain structures in that remarkable emergence.

The transition would have been fuzzy in time, of course. I do not see how it would be pinned down precisely, but we can see its brush strokes when far enough away, sometime from the emergence of hominids to the Upper Paleolithic. My personal review of the literature (*Q2C* 115-117) would place the transition by or in the Middle Paleolithic (also, Mesolithic, or Old Stone Age, a term used for the same period in African paleoarcheology).

Parallels from Using the Metapattern of PVS Dynamics as a Logical Principle That Is Invented Multiple Times and When Modified Radically Enough Creates Particularly Consequential Thresholds

We now can synthesize the main points above to show several parallels between the emergence of the two great evolutionary realms of biology and culture.

The singular major parallel has been noted well enough: these two realms deserve to be called "evolutionary" because they each initiated a new form of PVS that facilitated multiple subsequent fundamental levels of combogenesis. The respective families of levels in biology and culture all share realm-unique, core operations of their respective forms of PVS. I will assume that this point has been made adequately so that a reader at least knows what I am putting forward for evaluation.

A second parallel occurred in the ways that the base levels of the two evolutionary realms, with their realm-forming PVS innovations, were formed from earlier, transitional PVS dynamics born in the advanced levels of the previous realm. This parallel took place in the way that the transitions *into* the realms of biology and then culture used transfers and then further changes of a prior PVS-system that continued 'up' from the terminal levels of the respective previous dynamical realms. (To be clear, by "terminal" I mean only patterns within a realm that had innovations that we can see led directly into a next realm. The terminal levels were thus launch pads, not dead-end terminations).

I will elaborate on the two parts of this second parallel:

First, the emergence of life: *Within* the realm of physical laws, molecules (level 5, see Figure 1) were able to complexify into autocatalytic loops of chemical reactions with chemical PVS dynamics. This type complex chemistry with dynamic-kinetic stability (DKS) was capable of exploring molecule-space in an era of chemical evolution, which led into the profound shift *to* the origin of life (level 6) and the start of the dynamical realm of biological evolution. See Figure 3.

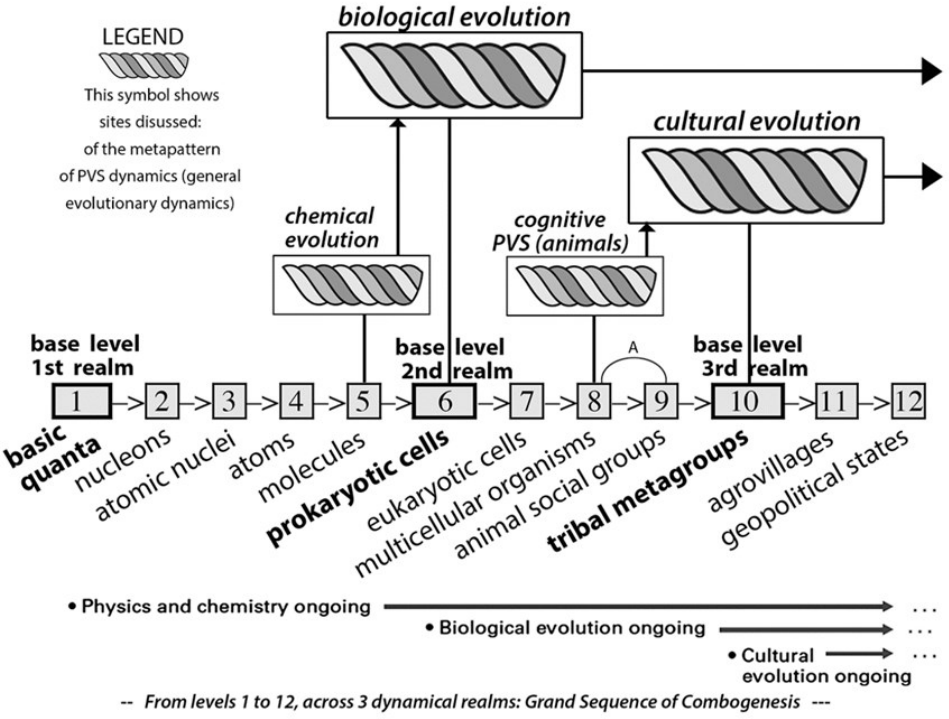

Figure 3. This shows the locations of the instantiations of PVS dynamics discussed in the paper. The two large boxes of the icon (see legend above) show the locations of the respective starts of biological and cultural evolutionary dynamics. The two smaller boxes of the icon show the locations of the evolutionary dynamics of chemical evolution in the realm of physical law and animal cognitive learning in the realm of biological evolution. The letter "A" is placed to indicate biological evolutionary feedbacks between animal cognitive PVS and animal social groups. The start of cultural evolution took the animal cognitive PVS and advanced it into the human mind's capability for simulation and decision-making, and also included social decision-making, as described in the text, and thus the direct link from animal social groups (with very weak group decision-making, certainly nothing linguistic) and human tribal metagroups, i.e., groups of groups, and on the path of combogenesis from animal groups to human groups of groups.

Second: the emergence of culture: *Within* the realm of biological evolution, animals (level 8, see Figure 1) were able to evolve cognitive PVS "learning" dynamics as adaptations that enhanced their lives. Types of animals in more complex social groups (level 9) were able to evolve into self-aware humans with their more sophisticated cognitive PVS systems, living in human tribal metagroups, or groups of groups (level 10), with language and material culture binding the crucially networked local groups within the much larger metagroup of a cultural millieu. Thus, the animal mind with cognitive-PVS became complex human mental PVS and this co-evolved with the special, new social PVS systems for cultural transmission and deliberative group decision-making that came into being. Together, the coupled cognitive and social PVSes generated the overall dual -tier PVS of cultural evolution. See figure 3.

Thus 'advanced' systems in both the realms of physical laws and biological evolution developed a kind of evolutionary dynamic that was still within their realms but then was also able to transition into more radically new forms of evolutionary dynamics. These new dynamics, respectively, and extraordinarily potent at exploring possibility space, started the evolutionary realms of biology and culture.

A Summary of These Parallels as Relevant to Big History

We can now utilize the metapattern of PVS dynamics to create a grand sequence for big history, with the main plot line following sequential instantiations of the metapattern:

The dynamical realm of physical law began with the fundamental particles of physics, initiating what became a nested climb via serial events of combogenesis toward more complex types of things, until populations of one of those types, namely the molecules, were able to enter into chemical evolutionary dynamics, which then transitioned (how is still quite mysterious) into the origin of life and biological evolutionary dynamics. In that dynamical realm of biological evolution, biological PVS-dynamics continued to produce new patterns, including serial events of combogenesis, until animal cognition was able to obtain a degree of learning complex enough to be called a cognitive PVS dynamics. This continued to evolve in animals within the context of certain animal social groups until, in an important transition of combogenesis, language and material culture could connect groups into groups of groups, or metagroups of humans. In this dynamical realm of cultural evolution, those metagroups contained dual-tier cultural evolutionary dynamics: individual cognitive PVS coupled to a complex social PVS. Subsequent serial events of combogenesis led to the next fundamental levels of agrovillages and geopolitical states, all within the realm of cultural evolution.

It is, therefore, possible both to frame and also further analyze important steps in big history using PVS as a core principle of generalized evolutionary dynamics, both to distinguish and to a large extent define three dynamical realms and also to better understand high-level types of modes of pattern-formation from possibility spaces.

The Number of Realms, Orders, Dimensions

The view in this paper supports a threefold arc of big history, defined by two major innovations in PVS dynamics: biology and culture. However, others have made cases for more than three main stages. I will discuss two of these alternatives.

First, Lawrence Cahoone has proposed five "orders of nature" (Cahoone 2013). They are the physical, the material, the biological, the mental, and the cultural. I cannot do justice to his thought-provoking, book-length treatment in a few sentences and, therefore, will limit my remarks to the several most relevant.

Cahoone develops an ordering of "increasing complexity," one that distinguishes a "small set [five] of wide strata with properties distinctive enough to be the objects of differing sciences arranged in a hierarchy of dependence and complexity."

Below, I will return to Cahoone's order of the mental ("activities of certain neurologically complex animals species"). For now, let us note that his physical and material orders would together fall under the single, physical column ("Dyn. realm 1") of Table 1, or what I call the dynamical realm of physical law. More detail on these two of

Cahoone's orders that should be compared to the single stage of Table 1's other scholars is not possible here.

Second, and recently in this journal, Greg Henriques and colleagues (2019) in a highly relevant paper reviewed Henriques' prior work on four "dimensions of existence": Matter, Life, Mind and Culture. Their goal was to compare and contrast the four dimensions of this "Tree of Knowledge System" (ToK) to David Christian's eight thresholds. Their dimension of Matter corresponds to the column of "Dyn. realm 1" of Table 1. Their dimension of Culture corresponds to the column of "Dyn. realm 3" of Table 1. So far, so consistent, but what about their other two dimensions, namely, of Life and Mind?

In the ToK, the dimensions of Life and Mind are closely equivalent to Cahoone's two orders of the biological and the mental. As described, ToK's dimension of Mind began with animals with complex enough brains. Furthermore, the "brain and neural networks are to an animal what DNA and genes are to a cell: a centralized, information relay and storage system." Indeed, following ToK's dimension of Matter, the dimensions of Life, Mind, and Culture are all analyzed to "emerge as a function of different semiotic or information processing systems" (Henriques et al., 2019: quotes from pages 11 and 1, respectively).

Though this emphasis on innovations of information processing as main criteria that defined new dimensions sounds quite different from my proposal for defining new dynamical realms by major innovations in PVS dynamics, the proposals are quite similar in many aspects. Specifically, Henriques and colleagues make specific points that the new dimensions of information processing all have new kinds of feedback loops of "variation, selection, and retention" that produce the various subtypes of complexity within each respective dimension. Thus, after 'my' realm of physical laws (their Matter), Henriques and colleagues basically define subsequent "joint points" (i.e., major transitions) into the emergence of new dimensions by new PVS-dynamical cycles of causation.

Here a key and worthwhile future conversation might involve the placement of animal cognition. In my proposed system of combogenesis and the grand sequence, the cognitive-PVS of animals (as described above) is not a separate dynamical realm but *within* the realm of biological evolution. I am going to leave this discussion hanging with that point. I need to contemplate the difference in more detail, hopefully in another paper. Indeed, the five "orders" of Cahoone and the four "dimensions" of ToK are both models worthy of further consideration.

Outstanding Issues, Concluding Remarks

I would be pleased to see the ideas developed here discussed and debated. I have made a case for three dynamical realms, which closely map to the threefold arcs of other models (Table 1). The key here has been to propose major innovations in the sequential addition of PVS dynamics, first with biology and then with culture, as defining characteristics of new dynamical realms.

I have noted that all models of others in this paper have given some nod to something similar going on in the operations of biology and culture. The metapattern of PVS dynamics is what I have tried to bring forward as an explicit, foundational principle for big history and for the drawing of patterns out from possibility spaces into reality spaces.

Thus, I suggest that to move ahead with the scholarly field of big history, we should consider PVS as a repeating principle—a metapattern—that is powerful and thus momentous. PVS dynamics opens up ways of exploring possibility spaces and gaining actual patterns that can undergo further thresholds or, in my terms, events of combogenesis.

The metapattern of PVS dynamics, thus, would join other proposed principles, such as Goldilocks gradients, energy fluxes, types of complexity, and, potentially, information (if carefully defined for broader applications). Future progress should continue making connections among principles relevant to big history. In addition, my proposal leaves open a number of other avenues of inquiry that seem to me ready for and worthy of further development. I will briefly discuss several.

What Is This Kind of Logic That Uses Metapatterns such as PVS Dynamics?

I am perplexed by this issue. What is the epistemological basis for principles of big history that evoke words and diagrams but not necessarily math? For example, the principle of PVS dynamics cuts across biology and culture. Even more cross-cutting is Christian's metapattern of "pattern itself." Similarly, Spier works with "building blocks, connections, and sequences." Are we dealing with a science (or study) of all pattern? A scholarship-based ontology? A patternology?

Spier clearly sees the issue. He asks, "how would we rate the different aspects [of things we want to connect] and which equations would we use?" He concludes, "for the time being, we have to rely on qualitative, rather than subjective statements of how to assess all the levels of complexity in the known universe" (Spier 2015, 50).

Stuart Kauffman (2019) sees the issue, too. Evolution, even though quantifiable in equations when put in terms of populations of competing degrees of fitness, produces a logic of patterning that goes beyond math. Key is the emergence in biology of "function." One is never (at least not yet) going to mathematize all possible functions that a new biological adaptation is capable of evolving into during the subsequent course of evolution.

Similarly, consider the work of the former president of the International Society for Systems Science, Len Troncale, and the systems theorist George Mobus. They focus on logical concepts such as, respectively, integration-diversification cycles, and an ontology of system properties (see note 3). The point is that there is significant progress using techniques that are not math-based. In the scholarship of big history itself, the Goldilocks gradient is a repeating principle expressed in verbal logic, not requiring math to explain, and perhaps not easily made into math in all cases. I make these remarks and point to just a few others who weigh in on this issue of the type of logic. I personally would like to see more work on these ideas.

Use of the Term "Evolution"

This is another issue I would like to see debated. Look how many scholars in Table 1 use the term evolution not just for biology and culture, but for their prebiological realm 1. Many even call the entire flow of big history "cosmic evolution" or "universal evolution."

On one hand, I am fine with the use of the term "cosmic evolution." I know (or think I know) what the speaker is referring to: the whole shebang, the cosmic promenade, pageant, or cavalcade from quarks to culture. For example, John Smart (e.g., Ref) has developed a 'big history' concept of the "evo-devo universe." His concept synthesizes both the processes of evolution and development to refer to cosmic evolution and its repeating patterns across scales. Space does not allow me to discuss this interesting model in more detail here.

On the other hand, I am less than sanguine about dubbing the whole shebang of time as an "evolution." Yes, the general dynamics of both biology and culture is indeed worth terming "evolutionary" (with care, to distinguish things subject to direct evolution from those that are merely affected by the directly evolving things; ecosystems, for example, do not evolve according to my preferred usage). However, the metapattern of PVS dynamics in biology and culture is something quite different from how patterns change in the physical cosmos.

Though many astronomers refer to the 'evolution' of stars and galaxies, their usage of the term is loose, referring to directional change. They are not doing big history, nor stating that stars and galaxies have PVS in the same deep way that is shared by biology and culture. Joseph Voros (2019, 63-64) notes two camps that are using the term "cosmic evolution" (for the non-biological physical cosmos versus the entire promenade from quarks to culture). His issue is different from the one I am raising, but I commend him for acknowledging variants, or at least preferences, in using the term evolution in the context of big history.

On yet another hand, some have informally pointed out to me there is a kind of variation in atomic nuclei as they are forged in stars, and also a kind of selection as certain nuclei stabilize in

islands of minimizations of energy potential. Thus, from this viewpoint there can be argued to exist some sort of selection dynamics even in the nonbiological cosmos.

Even so, I will say, that if we use "evolution" for everything from quarks to culture, then we need a distinct term for what is going on in biology and culture that is shared between them and also distinctly different from what is going on with galaxies, stars, and planets. I thus leave the use of the word "evolution" as a hanging issue.

Three Main Contexts for the Things in the Nested Build-up of the Grand Sequence

In the diagrams presented by Voros (2019) for "evolution" of the physical, biological, and cultural stages, connections between macro and micro scales are prominent for all three of the stages. Similarly, Christian (2018) and Spier (2015) weave back and forth between micro and macro as they discuss changes in their types of complexity.

What I propose here is that we might aim to formalize a relationship between the micro and macro scales at the three dynamical realms. For this, I follow the inspiration provided by Voros, as noted, and also by Cahoone (2013), who borrowed the word "causal thicket" from the philosopher of biology William Wimsatt (1994). Systems of change do so within causal thickets of context initiated with the start of the major "orders."

For example, at the Big Bang a cosmos started. Within that causal thicket we had the internal, nested build-up of levels of combogenesis from fundamental particles to molecules, as well as a myriad of types of meso- and macro-scale things, such as (and not in temporal order) planets, galaxies, stars, nebulae, gases, layers of the Earth, mountains, and oceans. We might say that the changes within the realm of physical laws took place within a largest surrounding context, or causal thicket, of a "cosmosphere."

In my view, then, Earth's biosphere began with the first prokaryotic cells that required inputs of nutrients and exports of wastes (Volk 1998). Living things in the biosphere's interconnected system of atmosphere, ocean, soil, and life do require the sun coming downward through that great "sphere's" upper boundary, and also require the volcanic gases that ascend upward through its lower boundary. But the biosphere is the material container or cauldron for the changes that take place within and across communities, populations, ecosystems, food webs—namely, multiple types of micro-, meso-, and macro-things that require biology for their creation (but not only biology), and which have occurred and altered during the evolution of life for nearly four billion years. We might say that the changes within the dynamical realm of biological evolution took place within a largest context, or causal thicket, of the "biosphere."

For the main context for my proposed third dynamical realm of cultural evolution, we frankly need a word. By the middle or upper Paleolithic (and perhaps earlier), people would have encountered and consciously noted traces of others outside one's specific tribal metagroup. Think of trodden paths, former campsites of fires with areas of debris where took place food preparation or flint knapping and the cave art beheld long after the creators became ancestors. This cultural container is contiguous with the biosphere, but it got specially shaped and folded together as a surrounding matrix of ongoing things of globally connected cultural evolution (albeit incredibly sparse at the start). This matrix continued upward in time into and through the things of agriculture and upward to today's technological systems with their massive impacts to an era of the "anthropocene."

What about a word for this big, planetary culture-affected context, which started with humans, their languages, and their artifacts? Anthroposphere? Culturosphere? Noosphere? Is noosphere too limited to the mental? Some might like "technosphere." To me, that also is too limited for this purpose. Planetary civilome? For the moment, I like civisphere.

In summary, this proposal is that the start of each dynamical realm also started a super-sphere (or super crucible, super context, super causal thicket) within which the myriad things of a given realm were formed and are forming, guided by the dynamics of the respective realms. (Things across the realms do interact with each other, of course.) All super-spheres have multiple scales of

things within them. I offer this proposal as open to discussion. Refining these ideas might give us an ability to cross-compare patterns at various meso-scales within the dynamical realms.

Using Principles of Big History to Help Us Think about Challenges Faced by Humanity Today

Much of the impetus for those who are working toward principles of big history comes from the fact that principles can help us clarify, frame, and hopefully propose solutions or new analytical perspectives for global challenges taking place and looming large. I believe that the elucidation and potential application of grand principles is worth our attention.

One can cite almost all those referenced in this paper as examples of scholars connecting big history with the ongoing challenges; space does not allow more detail here. I will suggest that the metapattern of PVS dynamics has a role to play in this endeavor. Specifically, human today are creating a new form of PVS dynamics, in the AI evolutionary systems (deep learning, algorithms that get refined to sell us stuff or surveil us, to improve traffic flows, etc.). Might these new PVS dynamics be one indication that a new level of combogenesis is starting to operate with humanity at the planetary scale? That would be level 13 of my proposed grand sequence. Could these new PVS dynamics indicate a new dynamical realm, which would be a fourth part of the overall big history arc (*Q2C* Epilogue)?

The new, eternalized PVS of technical and AI systems as decision-making new 'things' is a general concern, as well as possible helpmate for humanity. I personally see these new PVS systems as a definite concern for the future integrity of human nature, a concern that is not being discussed nearly enough in our current traditions and institutions of dual-tier PVS cultural dynamics. These new PVS systems are (so far) external to the human body, and different from traditional technologies, which were mostly under the control of individual cognitive and social PVS of the dual-tier decision-making processes of cultural evolutionary dynamics. Might we be adding another tier of PVS dynamics to cultural evolution, and, if so, what is that shaping for us as time moves ahead?

Concluding Remarks

To be interested in all things—the big bang, stars, galaxies, planets, the first cells, animals, trees, human hunter-gatherer bands, the ancient civilizations—is to be interested in general pattern generation. To participate in this scholarly field, one integrates past the boundaries of disciplinary fields and considers how pattern-making operates over the entire quarks-to-culture cavalcade.

According to the analysis here, biological evolutionary dynamics emerged (or developed) from a dynamical realm of physical laws that had, at the level of molecules, an advanced kind of complexity with chemical evolutionary dynamics. Within those biological evolutionary dynamics developed animal cognitive evolutionary dynamics. That adaptation was able to complexify within the context of animal social systems, eventually leading to culture-embedded humans in expandable metagroups with cultural evolutionary dynamics. Thus, a second major type of realm-forming evolution dynamics came from the first (culture from biology). The proposal in this paper is that this threefold division—of physical laws, biological evolution, and cultural evolution—makes sense because we are able to define transitions in pattern-making processes that came from new forms of PVS-dynamics in biology and culture. The metapattern of general evolutionary dynamics manifested at various points of the cosmic cavalcade and thus can both define and tie together major features of the threefold arc of big history.

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Endnotes

[1] I personally regard this as a significant sentence in the BH literature. My own, sympatico viewpoint: "What if we were to truly embrace everything in a study of everything? Then, would the phenomena being studied involve pattern itself? I think so. Everything that can be studied has pattern, from atoms to societies." (Volk, 2017: 9)

[2] I do think a new level 13 of the planetary scale as a combogenesis of nations might be a-birthing (Q2C Epilogue). This is similar to the concerns of other big historians in their positing of a new threshold happening right now, and the fact that we can learn from previous "successes" of pattern creation, to seek principles to help formulate this new level.

[3] After Q2C was published, I became aware of intriguing overlaps with concepts developed by systems theorists Len Troncale ("concrescence," Unbroken Sequence of Systems' Origins) and George Mobus ("ontogenesis"). Their models are more general than mine, for they include, for example, stars. Without denying any importance of stars in forming the pathway to human emergence, for the logical purposes I pursued, I limited the "grand sequence" to a nested build-up that progresses strictly from small to large, as I developed a case for what each new level had

that could produce to the next. For complementarity in what is happening in the field of systems theory, both these researchers are worth looking into. See Troncale (lentroncale.com, or https://vimeo.com/363045415) and Mobus (2015).

[4]I noted (Q2C, 228) terms used by others for "possibility space," such as "design hyperspace," "adjacent possible," "design space," and "nonmanifest order." Stewart (2019) uses "possibility space." Renn (2020) uses "horizon of possibilities."

[5]A word about my preferred term, "propagation," rather than the term "inheritance" that many (but not all) use. I can see the advantage to "inheritance," with ideas being transmitted horizontally and vertically, like DNA. I also would insist that we use a term that easily includes material artifacts. This follows archeology's focus on material culture as an integral part of culture. Cars are propagated. (OK, they do not self-propagate, but humans propagate those material patterns.) I do see that inheritance could be stretched to fit. I've wrestled with the issue quite a bit, and obviously it depends on personal comfort in interpretation of the meaning and application of words. In the end, I personally think the word propagation is better because inheritance is more likely to keep one's mind overly (in my opinion) attached to thinking that cultural evolution is mostly about informational pattern transfer among humans. Instead, I would side with Renn (2020), who sees material culture as exerting a degree of regulatory control (by its pattern transfer) on humans, so there is mutual feedback, which also closely follows the concept of "entanglement" between humans and things by Hodder (2012).

[6] We see actions of cultural PVS in dynamics of cars as a system of change over time: designers play with options in their minds for new models (mental, cognitive PVS). The social comes into play as well. Plans are passed up and down the corporate hierarchy. Eventually, new heavy metal realities are produced. They are then chosen and driven by the public. The hopes from the designers and company are for success, but that is not guaranteed. The market adds another layer of the selective (S) sub-process. Successful models can be iterated in greater quantities of near clones, or modified to form lineages, as exponential propagation of both models and lineages of models is possible. Extinctions abound, too. At many scales the various forms of individual cognitive and social PVS are coupled.

Crossing the Threshold of Cyborgization

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ABSTRACT

Cyborgization is a hot topic these days. This is an intriguing process that is the subject of many futuristic novels and which at the same time takes place right before our eyes. In the present article we discuss the development of cyborgization, its place in Big History, its background and future directions, as well as the problems and risks of this interesting process. The authors are concerned about the question of whether the time will come when a person will mainly or completely consist not of biological, but of artificial material. The article also touches upon other problems and risks associated with future scientific and technological progress.

Introduction: Cyborgization in Big History

The process of cyborgization can be considered as part of the technological evolution. On the whole, all human history, especially the last few centuries, is the history of the triumph of science and technology. Since the advent of *Homo sapiens*, people have been tied to technology (given the popular idea that labor transformed apes into humans, while the labor consisted primarily in the "production" of stone tools). As a result, mankind, the creator of technology, becomes increasingly dependent upon it (L. Grinin and A. Grinin 2015, 2016). Today, technology serves almost every aspect of our lives, but in the near future, more serious transformations are possible when complex mechanisms and technologies can merge with the human body and mind.

Cyborgization is the process of replacing parts of the human body with cybernetic implants. To some extent, this process began a long time ago. The earliest evidence of prosthetics is recorded in Ancient Egypt. Researchers have discovered a prosthetic big toe made of wood and leather in Cairo, dating from between 950 and 710 BC (Finch et al. 2012). Another oldest recovered prosthesis was found in a tomb in Capua (Italy) in 1858, dated from the Samnite wars in 300 BC. It was made of copper and wood (Bennett Wilson 1964). In the Middle Ages, prostheses of iron were made by armorers for knights who had lost limbs in battles (Sellegren 1982). A famous example is the prosthetic arm of the German Imperial Knight, mercenary, and poet Götz von Berlichingen, made at the beginning of the 16th century, which had a complex mechanism for that time (Goethe n.d.).

Progress in the field of artificial body parts has become so significant that almost every one of us today is a bit of a cyborg. Without a doubt, most people on the planet have either false nails or artificial teeth or glasses or contact lenses. The FDA estimated that 324,200 people had received cochlear implants worldwide (Technavio 2016). In 2016 the Ear Foundation in the United Kingdom estimated the number of cochlear implant recipients in the world to be about 600,000 (The Ear

Foundation 2017). Artificial heart (DeVries et al. 1984), kidney, liver, pancreas (Stamatialis et al. 2008), bionic eyes (Boyle et al. 2003), bionic limbs (Farina and Aszmann 2014) and many more are reality now.

Unfortunately, although cyborgization is actively developing, there are not many theoretical concepts that shed light on the origin and trends of this process. Among the popular ones are transhumanism, whose fundamental ideas were first put forward in 1923 by the British geneticist J. B. S. Haldane (Haldane 1924; Huxley 2015), and the singularity by Ray Kurzweil (2010).

We suppose that the origin and trends of cyborgization can be well understood within the framework of Big History. Cyborgization is an important milestone in Big History. It is the intersection of the human (or Upper Paleolithic) revolution and a new "post-human" revolution whose consequences are not yet clear in many respects, but which will obviously start the era of an intensive impact on the human body. We see the origins of cyborgization in collective learning, which is the sixth threshold of Big History. "Collective learning" is a term adopted by David Christian (Christian 2012, 2018). It is a sufficiently powerful system of communication and sharing information in such volume and with such precision that new information accumulates at the level of the community and even the species (Christian 2015). The collective learning process has become the basis for the development of technology, which provided the next important thresholds: "Agriculture" and The Modern Revolution" (David Christian et al. 2014; Spier 2015). The future ninth threshold in our view will be the threshold of cyborgization. Collective learning will develop into a global system of information exchange between the human brain and computer interfaces. Thus, a new system of collective learning will appear, which will give an impetus for the further development of Big History, or, perhaps, it will start a new kind of evolution. As R. Dawkins writes, "Whenever conditions arise in which a new kind of replicator can make copies of itself, the new replicators will tend to take over and start a new kind of evolution of their own" (2006).

The Cybernetic Revolution

We are now at the threshold of the post-human revolution. Perhaps, it will be less radical than the transhumanists and other followers of practical immortality imagine. Anyway, we are speaking about a considerable extension of life, the replacement of an increasing number of organs and cells of the human body with non-biological materials, and the implantation of electronic and other elements into the human body.

In the 1950s and 1960s the world (first, the developed countries) became a witness to the largest technological revolution in history, which continues to this day. At the end of the twentieth century, the achievements of this revolution, especially in the field of information technologies, has spread all over the world. We call this revolution the "Cybernetic revolution," because cybernetics is the science about information and its transformations in various complex systems (L. Grinin and A. Grinin 2015). During its first phase (from the 1950s to the present day), the Cybernetic revolution has radically changed information processing and provided a breakthrough in the regulating of complex processes in a wide range of natural and artificial systems that became part of the production process. In the future it will provide the ultimate breakthrough by creating a fundamentally new environment, a world of self-regulating systems. The Cybernetic revolution became the third largest production revolution in the history of humankind after the Agrarian (Neolithic) and Industrial ones, but it has not yet ended. We consider the revolutionary changes, which the world will face in the coming six to seven decades, will happen during the second (the final) phase of the Cybernetic revolution.[1]

The development of cyborgization is one of the trends in this period that has important implications for the coming phase of the Cybernetic revolution. First of all, it is a general trend resulting in the improvement of human quality of life and longevity. Second, it is a trend in the development of various self-regulating systems and technologies (defined as those systems and technologies that can operate without direct human intervention).

Some of the most important drivers of this final phase of the Cybernetic revolution will be in medicine: additives, bio- and nanotechnologies, robotics, information and communications technologies, and cognitive technologies, which together will form a sophisticated system of self-regulating production. We abbreviate this complex as *MANBRIC-technologies*. There are reasons why medicine will become the core of the Cybernetic revolution. First, medical services are rapidly growing at around ten per cent of the world GDP (WHO 2020), and will continue to grow. Second, peripheral countries develop a huge middle class, with a reduction in poverty and illiteracy. As a result, their focus will shift from the elimination of unbearable conditions to the problems of raising the standards of living, health care, etc., so, there is a great potential for the development of medicine.

The third important issue is the problem of population aging (Vollset et al. 2020). An aging population will soon become characteristic not only of developed countries, where it will become crucial for democracy, but also for a number of developing countries, in particular, China and India. The problem of pensions will become more acute (as the number of retirees per worker will increase) and at the same time the lack of a qualified labor force will increase (which in a number of countries is critical). Thus, countries will have to solve the problem of labor force shortages and pension contributions by increasing the retirement age by ten to fifteen years. It also applies to people with disabilities whose full involvement in the work process could be realized thanks to new technologies and medical advances. At the same time the birth rates in many developing countries will significantly decrease (Vollset et al. 2020). On the whole, these conditions will entail government involvement, as well as major investments, business activity, and science development in order to provide a breakthrough in health care. The formation of such unique conditions is necessary for the beginning of a new phase of the Cybernetic revolution. This, most likely, will also be facilitated by the danger of pandemics (as it is shown by COVID-19), which will require urgent solutions in medicine and will necessarily require large financial resources.

Leading Technologies of Cyborgization

There are a growing number of self-regulating technologies in different branches of medicine even today, for example, life support systems or artificial organs. Other systems only move in the direction of self-regulation, for example, flexible controlled instruments, which allow doctors to perform a surgery in the most inaccessible parts of human body with minimal incisions (often using endoscopes and video cameras). One can anticipate that in the nearest future many operations, robotic operations, will be conducted without human participation at all (*Fortune Business Insights* 2019).

We suppose that many self-regulating systems will play a crucial role in cyborgization, among them different biosensors or bio-chips. This is a new trend representing a combination of medicine and nanotechnologies. Biochips are able to register a wide range of physiological changes and respond to them or perform specific actions. In the long term biochips will permit continuous control of a person's health. Because of the constant diminishing of a resistor's size (Peercy 2000), some biochips are so small that they can be inserted into cells (so they are often called nanochips). These biochips can be used for different purposes, for example, for targeted drug delivery (Wang et al. 2015). Further miniaturization will allow the creation of a system, which will constantly monitor important parameters of the body, record activities, and track the location of a person. Such systems will be common in the second phase of the Cybernetic revolution.

Another important self-regulating technology is the brain–computer interface (BCI). This is an interaction between the brain and computer systems that can be realized via electrode contact with the skin on the head or via electrodes implanted into the brain. Today BCIs are widely used, especially in medicine, for example, in artificial visual systems, or in bionics. In the future they will significantly improve rehabilitation for people with strokes, head trauma, and other disorders. BCIs can become an essential way to make artificial parts of the body directly controlled by

the brain. It will be especially important in orthopaedics or bionics. According to the World Health Organization, more than one billion people are living with some form of physical disability, and about 190 million adults have a major functional difficulty (World Bank 2011).

Another important issue will be the manufacture and use of artificial organs, which are complex self-regulated systems. At present, there are many different artificial organs: heart, ear, eye, limbs, liver, lungs, pancreas, bladder, ovaries, trachea, etc. (Murphy and Atala 2014; Stamatialis et al. 2008). Artificial organs will also be able to change human reproductive capabilities. The artificial womb will be able to provide an opportunity to have children for all people irrespective of age and gender (Corea 1986; Rosen 2003).

Of course, in reality, cyborgization will be based on a combination of these and other technologies. Also, the same result can be achieved by means of different technologies, for example, a bionic eye will most probably be an artificial eye (an artificial copy of the natural one). It can be a camera, integrated into eyeglasses, which captures images and transmits them to the optic nerve via BCIs. (Such technology already exists; see, for example, Ong and da Cruz 2012).

Speaking of cyborgization, it is impossible not to mention the development of robots. Robots will develop as highly self-regulating systems and will spread to virtually every area of our lives. The robotics market is going to grow (Technavio 2020), especially healthcare robots, for instance surgical robots, as we mentioned before, or robots for rehabilitation therapy (Burgar et al. 1999).

Waiting for Radical Changes

Many researchers suppose that we have already approached, or are approaching, some significant quite serious transformation, and that human civilization will experience considerable changes in the next decades. Some speak about approaching the singularity point. This is a certain unprecedented level of technological progress, after which the curve of technological development will change to a new trend. It is a popular idea that after the singularity point a new radical phase of human development will start. (Here we should especially mark out Raymond Kurzweil's works, e.g. (Kurzweil 2010), which can be evaluated as an extreme technological optimism).

We assume that technological growth will not be infinite, but our analysis shows that there are a number of reasons to expect that in the forthcoming decades the global technological growth rate will return for some time to a hyperbolic trajectory when the final phase of the Cybernetic revolution begins (Grinin et al. 2020b). This acceleration will continue up through the late twenty-first century. According to our calculations, technological growth at the end of the twenty-first century will gradually slow down to the singularity point, approximately in the year 2106. It is significant that the global aging factor will play a leading role here. After the singularity point, the rate of technological progress will slow down compared to the previous epoch, and the pattern of scientific-technological development itself will change dramatically. However, toward the end of the twenty-first century we should expect a rapid increase in the possibilities for changing human nature.

From a Human to a Cyborg

A popular idea in the study of transhumanism suggests that cyborgization will develop by placing the brain and consciousness in an abiotic immortal body. Immortality in general is one of the main concerns of transhumanism (Fukuyama 2004; Haldane 1924; Hansell 2011; Huxley 2015; More 2013). To what extent is this possible? On the one hand, this direction seems logical, as medicine has been moving this way for many decades. Currently, bioprinters can create different tissues and organs (Murphy and Atala 2014), and neural interfaces allow the control of some devices and equipment "by power of thought" (Schalk et al. 2004). Besides, it looks like there will be an increase in technologies in terms of the rapprochement of people and artificial systems, in particular in the construction of humanoids (Hirose and Ogawa 2007). Since these robots will be used not only for work and entertainment, but also for very close or even intimate contacts

with people (Yeoman and Mars 2012), the borders between the human and artificial anthropomorphous systems might start dissolving. Already we have technologies such as virtual reality, where it is becoming difficult to distinguish reality from illusion (Burdea and Coiffet 2003).

On the other hand, over millions of years, biological evolution has balanced all the elements of organisms and their functions in an optimal and efficient (but sensitive to change) way. It is doubtful that the human brain is able to work without the body because the main purpose and function of the brain is to control the body. It also seems irrational to change all organs and parts of the body, usually most of which work fine. It might be much more efficient and less expensive to change only broken or less durable parts. It is likely that the process of cyborgization will never go too far; it will always remain "supplementary" for the biological components of organisms, capable of both significantly improving the quality of, and prolonging, life.

Today, also exists an opportunity to create artificial biological tissues and parts of the body by means of stem cells or other biotechnologies. We suppose that this path of "mending" the body will be the most common. In the case of basic vital organs, such as the heart, lungs, liver, etc., mending can be preferable and more effective than the introduction of artificial non-biological organs. Even today, we know a case when a person's heart was successfully replaced six times (and a kidney one time).[2] Now only a very rich person can afford it. However, in the future it will be possible "to mend" quite a large number of people by means of laboratory-grown organs.

Systematizing the Risks

When new medical technologies are introduced, there is, initially, euphoria, but later come an understanding of the problems that new technologies can bring, an awareness of the risks involved, and then sometimes restrictive measures to reduce the perceived negative consequences. We may ask, then, why discuss the dangers today, if they will not come soon? The fact is that the future can turn out to be quite unexpected and even terrible. It is necessary to anticipate and think about all these issues in advance.

Ethical and Moral Problems

The development of artificial organs, biochips, genetic engineering, etc., raises questions: What will future humans be made of—natural biological or artificially made biological substances, or will they be entirely non-biological beings? How will humans reproduce? How will the brain and consciousness function? Any of these options will dramatically change human fundamental institutions, including morals and interpersonal relations. Morality and human relations do not exist separately from technology, especially from human physiology and, in a broader sense, from the biological basis. They are the result of complex sociobiological evolution and may disappear after the loss of its material biopsychic shell.

We assume that cyborgization as a whole is a process of the transformation of human nature by changing the biological and adaptive abilities of a person. Real cyborgization comes with a change in a person's feelings and consciousness. A recent study presents a conceptual framework for the development of cyborgization, which should be based on the collaboration and fusion of biological and AI units that will shape the intelligence of cyborgs (Wu et al. 2016).

The moral side of the cyborgization is not a new problem (Bernal et al. 1929; Haldane 1924). With increasing technological development today, we can read more specific studies on this topic, such as the impact of the ethical judgment of others on a person's decision to become a cyborg (Pelegrín-Borondo et al. 2020), or even on the ethical issues of cybo-animals, that is, the modification of the body parts of animals with electronic or mechanical devices, such as a cyborg beetle (Xu et al. 2020).

An important problem is raised by Bill Joy about increasing dependence on machines. This weans humans from thinking and solving problems, thus eliminating any practical choice, since all the decisions will be machine-made. Yet, Joy probably overestimates when writing, "The human race might easily permit itself to drift into a position of such dependence on the machines that it would have no practical choice but to

accept all of the machines' decisions" (2000, 2). Possibly, Joy also exaggerates when he writes, "Eventually a stage may be reached at which the decisions necessary to keep the system running will be so complex that human beings will be incapable of making them intelligently. At that stage the machines will be in effective control. People won't be able to just turn the machines off, because they will be so dependent on them that turning them off would amount to suicide" (2000, 2). In the future, when the systems will perform most of the human mental work, our brain will be able to work less and, therefore, can become weaker than the brain of the modern person, just as muscles of many our contemporaries, who have no need of physical activity, weaken. Naturally, more systems facilitating and supporting intellectual work will appear. Here the positive feedback will come to the fore: mind does not want to work, devices facilitate its work, and the mind weakens even more. Therefore, it is not surprising if in the future "a mental gymnastics" will be promoted as an exercise, similar to simple physical activities today. Nevertheless, the danger of heavy reliance on technological systems is not so speculative. This is an important moral issue since the exploitation of this reliance is quite possible, and the future "freedom of choice" for independent thinking is unclear.

Another important moral problem is the resistance to scientific-technological progress, which has a long history. The best known example is the Luddites, a radical organization of English textile workers who destroyed machinery as a form of protest in the nineteenth century (Binfield 2004; Jones 2013). Each manifestation of this fight against machinery or technology was caused not only by obscurantism, but also by real, grounded fears, since so-called progress would often exacerbate the situation, lead to many bankruptcies, and throw overboard many professions; sometimes it would even desolate whole cities and territories and also often deteriorate the quality of products. Sometimes it opened unexpected opportunities for abuses or was the source of a desperate social fight and oppression. Nevertheless, nobody managed to slow down this process. The toughening requirements for new drugs, banning GMO or cloning today, as well as many other things, are modern manifestations of this fight. It is clear that many of these restrictions and bans are absolutely necessary. On the one hand, it is difficult to expect that it is possible to get the development of scientific and technical progress under a full control. On the other hand, progress in the fight for the environment-oriented production of safe drugs shows that it is quite possible to achieve a certain level of control here. In general, the mechanism of minimizing the damage from innovations consists in establishing certain institutes and rules optimizing the control over technologies; but it is especially important to make it beforehand.

The Irreversible Demographic Transformations

Each phase of a production revolution is connected with demographic change. During the initial and intermediate phases of the Cybernetic revolution (the phases we are now in), a tremendous growth in world total population has taken place and is continuing. This growth is occurring primarily in developing countries and is an ongoing trend in the demographic revolution of the industrial era. On the other hand, in developed countries the demographic revolution has been completed by the so-called demographic transition, which means a decrease in birth rate. At the same time, life expectancy and the quality of life have increased considerably. The demographic transition is actually the result of the initial phase of the Cybernetic revolution. Not without reason, in an increasing number of developing countries, the fertility rates have been declining; in some of them we also observe a noticeable population aging. During the Cybernetic revolution demographic structure has significantly changed. It has transformed from pyramidal (where children and youth make the main part of the population) to rectangular, where the number of older persons is almost equal to the number of youth. (For more information about global aging and technological progress, see L. Grinin et al. 2020). In the coming decades, we will observe an aging of the world population, as a result of which its structure will take the form of a reverse pyramid (where the

number of children and young cohorts will be smaller than that of the elderly people). In some developed countries the life expectancy can increase up to 95–100 years old, and generally, it can reach the level of today's most successful countries (such as Japan), that is 80–84 years, but it may even become higher (Statista 2015; Vollset et al. 2020). Meanwhile, an especially rapid growth of elderly cohorts will be observed in the next three decades. As a result, in three decades the world will be divided not into the first and third worlds, but into the worlds of old and young nations. By this time, an aging population will be noticeable in most countries of the world (with the possible exception of African states). At the same time, the slowing down of fertility rates, and the exhausted demographic dividend in most countries of the Third World, will lead to considerable changes in the demographic structure, and the percentage of children and youth will decrease while the proportion of the elderly people will increase (L. E. Grinin et al. 2016; Vollset et al. 2020).

The Decline of Democracy and the Struggle between Generations

Population aging can lead to the decline of the democratic system. Democracy can evolve into gerontocracy, from which it will be difficult to escape (Berry 2012; Tepe and Vanhuysse 2009). A crisis of democratic governance is quite probable in the context of the struggle for votes. With growing life expectancy and a reduction of youth as a share in the population structure, the number and role of elderly people will inevitably increase along with a probable sexual distortion: women in the western countries and men in some eastern countries. Also, since the elderly generation is sometimes more conservative in its preferences and habits, it can influence the choice of policy and many other political, social and economic nuances that can disadvantage young and middle generations.

Especially alarming is the fact that growing life expectancy can cause a conflict between generations since an increasing number of elderly people will require an increase in working age and working capacity by ten to twenty years or more. In addition, we will see the full involvement of people with disabilities in the workforce due to the new technical means and advances in medicine--although even within the category of disabled workers there will be a generational gap where the young are impeded by the old. Furthermore, an elderly population can contribute to society's growing conservatism, which will both slow technological growth and make it difficult to rehire, retrain, and retain elderly workers as the technology changes anyway, even at a slower pace as predicted. Negotiating these generational differences will remain a challenge and may eventually force societies to adopt a form of institutional “ageism” in order to allow young people to enter the workforce in the world with high expected life duration.

It is important to note that such a turn to gerontocracy will be most quickly achieved in European countries and in the USA. These countries have the strongest democratic traditions, but they are also states wherein the ethnocultural imbalance is pronounced. Thus, in the future, in the USA for example, one can expect an opposition between the young Latin and elderly white population, while in Europe it will be between a younger generation of Muslims and older, white, Christian populations. It means that the North–South divide will be reproduced in every country where the elderly indigenous people will live alongside a much younger population having different cultural traditions. The conflicts between generations in these countries caused by the above-described crisis of democracy will inevitably affect the fate of the whole world within globalization.

The Geopolitics of an Artificial Reproduction

At the end of the last century, it became clear that the opportunities to influence human genome and reproduction can generate a plethora of complex social, political, ethical and legal problems in the future. Nevertheless, modification of human embryos has already begun. For example, in 2015 China declared the conducted work on modification of the human embryo (Cohen 2019), as well as Russia in 2019 (Cyranoski 2019). If such researches and methods of rearing

children outside the maternal placenta develop, the structure of population reproduction will change dramatically. We have considered this issue with respect to the breaking links between generations, but there is also a global aspect. Will the countries and the world in general be ready for such changes? Will some countries not want to derive benefit from their demographic advantages (which would be quite a natural course of things)? There is some room for imagination. On the one hand, it is obvious that in the future, when creating some planetary structures and developing quotas for different states, a country's population number will become much more important than it is today, especially in international relations. (Today a country's status is rather measured by its wealth and military power.) Will the West accept that countries with a much larger population will dictate their terms? On the other hand, why do not some political elites use new reproductive technologies and, for example, launch a population growth race.

Conclusion: Between Technological Optimism and Reasonable Caution

The faster changes proceed, the more difficult it is for society to follow them and the more heterogeneous those changes become both in social and often ethnocultural terms. During the cybernetic revolution, the amount of information increases dramatically. This makes it difficult for many people to learn new technologies and divides the society. "The young see themselves as 'digital natives,' and look down a bit on the 'digital immigrants,' the elderly who grew up with books and pens and paper," write the presidents of the Club of Rome (von Weizsäcker and Wijkman 2018, 46). In some way technological progress accelerates itself by increasing the necessity to adapt and to learn and to rely more and more upon technologies. This forms a new collective learning, which will be a combination of human experience and technological capabilities and which will give impetus for the future ninth threshold and the further development of Big History.

Human power increases with the growth of technology, but along with this many previously unknown problems occur. That is why, if we want to make use of the new opportunities (and why shouldn't we?), it is necessary to foresee problems and to minimize their consequences and "future shock."[3] Unfortunately, mankind does not learn much from its own mistakes and pays little attention to future problems. It is also rather difficult to foresee problems; therefore, we need institutions or administrative-legal systems to take technological development under control and to develop it in cooperation with the technologies themselves while preserving their functionality. However, for this purpose it is necessary to regulate the rate of scientific and technological progress in the world. We believe that sooner or later it will become possible; although, unfortunately, so far it is unachievable, because the competition among countries is primarily based on the different levels of economic growth. It becomes obvious that the control over hazardous changes will also require certain political transformations that can turn extremely complicated and sensitive (L. Grinin and Korotayev 2013).

Societies have always had two main regulators without which they cannot exist: morals and laws, both of which are based in turn upon the psychological structures of those societies (L. Grinin and A. Grinin 2016). As technologies develop faster, it seems morals are becoming less clearly defined and are failing to find a new balance. It is possible that beyond a certain limit of the speed of scientific-technological development, a noticeable destruction of morals, or their disintegration into different varieties, may begin. It is all the more dangerous as powerful technological opportunities for the transformation of the human body develop. Due to the lack of moral restrictions and the desire to make big profits, various dangerous phenomena may prevail: from the fashion for body corrections to attempts to become superhuman with the help of new medical technologies.

Having appeared first in agrarian and craft societies, law became mature during the period of industrialism (while the rule-making process takes place within any society). The law, being more flexible than moral codes, nevertheless demands a certain stability, which is hardly

achievable in conditions of rapid technological change (Lem 1968, 269). Societies and their legal systems can become weak in the face of technological innovations, and sometimes there are direct conflicts between those technologies and the law. As Lem notes, "the intensity with which 'simplifying' technology undermines values is positively correlated with their effectiveness." This means that the more effectively technologies solve certain issues, the more they change a society's moral and legal pattern, the consequences of which are realized only much later. In what ways future societies will organize themselves is not yet clear. In earlier epochs, moral and legal codes were the two feet on which societies stood, firmly, and if there were any imbalances, for example, if laws were insufficiently developed, a society could become destabilized. Figuratively speaking, however, in the future, if one "foot" (morals) disappears, and the other (the law), weakens, will societies be able to keep their balance on such weak bases and at such a high rate of change?

It is difficult, and actually senseless, to try to impede progress. However, there is always the question of what we define as progress in any given epoch. We must always ask what the costs are? It is preferable not to rush into making changes when we are unsure of their consequences. Caution is called for. Rapid and unplanned technological development in the name of a vaguely defined "progress" can lead to new and unforeseen moral, legal, and economic problems; they can cause disputes, conflicts, trade wars, and phobias. Public consciousness always lags behind technological development. Uncontrolled technological development can be compared with the Roc, the legendary bird from the *Arabian Nights* that can carry humanity to safety but demands human sacrifice. Are we ready for it? What are we prepared to sacrifice for the sake of progress?

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Endnotes

[1] It is important to mention that Cybernetic revolution itself is a continuation of a major trend. On the macro scale, technological growth has been increasing, at least over the past 40,000 years, albeit with fluctuations (Grinin, Grinin, Korotayev 2020).

[2] This is multi-millionaire David Rockefeller, who underwent his last operation, a heart transplant, at the age of 99.

[3] We are constantly facing such shocks; therefore, the issue raised by Alvin Toffler in his well-known Future Shock nearly half a century ago still remains relevant (Toffler 1970).

ПЕРЕСТУПАЯ ЧЕРЕЗ ПОРОГ КИБОРГИЗАЦИИ

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КЛЮЧЕВЫЕ СЛОВА

Киборгизация,

Большая

История,

коллективное обучение,

Кибернетическая революция.

АННОТАЦИЯ

Тема киборгов уже давно волнует умы людей. Однако то, что было только предметом фантастических романов и фильмов, уже становится реальностью. Мы живем в удивительное время, когда воочию наблюдаем, как разворачивается киборгизация. Под киборгизацией мы имеем в виду постепенную замену частей человеческого тела различными технологичными имплантантами. В настоящей статье мы рассмотрим развитие процесса киборгизации, его предпосылки, а также его место и роль в Большой Истории. Авторов волнует вопрос о том, придет ли когда-нибудь время, когда человек будет в основном или полностью состоять не из биологического, а из искусственного материла? В статье также затрагиваются и другие проблемы и риски, связанные с будущим научно-техническим прогрессом.

ВВЕДЕНИЕ. КИБОРГИЗАЦИЯ В БОЛЬШОЙ ИСТОРИИ

Процесс киборгизации можно рассматривать не только как часть истории медицины, но и как часть технологической эволюции. В целом вся человеческая история, особенно последние несколько веков, — это история триумфа науки и техники. С самого появления Homo sapiens, жизнь древних людей была связана с технологиями (учитывая популярную идею о том, что труд, в основном «производство» каменных орудий труда, превратил обезьян в людей). В результате человечество, создавая новые технологии, становилось все более зависимым от них (Grinin L, Grinin A. 2015, 2016). В наши дни технологии обслуживают практически все аспекты нашей жизни, однако в ближайшем будущем возможны более серьезные преобразования, когда технологии будут самоуправляемыми и смогут слиться с человеческим телом и разумом.

Киборгизация — это процесс замены частей человеческого тела различными технологичными имплантантами. В какой-то степени этот процесс начался очень давно. Самые ранние свидетельства протезирования зарегистрированы в Древнем Египте. Исследователи обнаружили в Каире протез большого пальца ноги, сделанного из дерева и датируемого 950 –710 годами до н. э. (Finch et al. 2012). Еще один старейший протез был найден в гробнице в Капуе (Италия), в 1858 году. Он датируется самнитскими войнами 300 г. до н. э. Протез этот был сделан из меди и дерева (Bennett Wilson 1964). В средние века были довольно распространены протезы из железа, которые изготавливались оружейниками для рыцарей, потерявших конечности в боях (Sellegren 1982). Один из

самых известных примеров подобных протезов –железная рука немецкого рыцаря, наемника и поэта Гетца фон Бирлихнгена. выполненная в 16 веке, и которая имела весьма сложный механизм для того времени (Goethe n.d.).

Прогресс в области искусственных частей тела рос, и достиг сегодня уже таких пределов, что каждый из нас сегодня может считать себя хотя бы в малой степени киборгом. Без сомнения, у большинства людей на планете есть накладные ногти, искусственные зубы, очки, контактные линзы или искусственные хрусталики. По оценкам Управления по контролю за продуктами и лекарствами США, во всем мире уже 324200 человек имеют слуховые имплантаты (Technavio 2016). В 2016 число носителей слуховых имплантатов составляло уже около 600,000 (The Ear Foundation 2017). Сегодня такие искусственные органы как сердце (DeVries et al. 1984), почки, печень, поджелудочная железа (Stamatialis et al. 2008) становятся реальностью. Разрабатываются бионические глаза (Boyle et al. 2003), бионические конечности (Farina и Aszmann 2014) и многое другое.

К сожалению, несмотря на то, что практическая киборгизация быстро развивается, в литературе обнаруживается явный недостаток теоретических концепций, систематично описывающие это явление и показывающих его происхождение и тренды развития. Среди наиболее популярных теорий стоит выделить трансгуманизм, который был заложен в 1923 годы британским генетиком Дж. Б. С. Холдейном (Haldane 1924; Huxley 2015), а также широко известную теорию Курцвейла (Kurzweil 2010).

На наш взгляд, происхождение и направления развития киборгизации могут быть хорошо поняты в рамках Большой Истории. Киборгизация в ее зрелых чертах может быть рассмотрена как важная веха в Большой Истории, она является пересечением между Человеческой и новой «Постчеловеческой» революциями. Поскольку мы только входим в эру киборгизации, последствия этого процесса пока еще не ясны, но уже очевидно, что "Постчеловеческая" революция будет периодом интенсивного воздействия на организм человека. На наш взгляд, основы киборгизации уже проявилось в коллективном обучении, которое начинается с шестого этапа Большой Истории. Коллективное обучение – термин, введенный Дэвидом Кристианом (см. например Christian 2012; 2018) Под ним понимается развитая система общения и обмена информацией в таком объеме и с такой точностью, что новые информация накапливается на уровне сообщества и даже вида (Christian 2015). Коллективное обучение стало основой развития технологий и обеспечило переход на новые рубежи Большой Истории: «Сельское хозяйство» и «Современная революция » (David Christian et al. 2014; Spier 2015). На наш взгляд, коллективное обучение будет развиваться в глобальной системе обмена информацией между человеческим мозгом и компьютерными интерфейсами. Процесс совмещения человеческого мышления с технологиями станет важным этапом киборгизации и даст импульс для дальнейшего развития Большой Истории. Возможно, это даже положит начало новому виду эволюции. Как писал Р. Докинз, «всякий раз, когда возникают условия, в которых новый тип репликатора может создавать копии самого себя, такие репликаторы стремятся взять верх и основать новый вид собственной эволюции» (Dawkins 2006)

КИБЕРНЕТИЧЕСКАЯ РЕВОЛЮЦИЯ

Как мы уже отметили, сегодня мы стоим на пороге Постчеловеческой революции. Возможно, и даже скорее всего, она будет менее радикальная, чем представляют себе трансгуманисты и другие последователи практического бессмертия. Однако, в любом случае она значительно увеличит продолжительность жизни, приведет к технологиям выращивания биологических искусственных тканей и органов и замены ими или их небиологическими аналогами

вышедших из строя естественных оргакнов, интеграции мозга с электронными устройствами и др.

В 1950 и 1960 годах мир (в первую очередь, развитые страны) стал свидетелем крупнейшей технологической революции, которая продолжается и по сей день. В конце 20-го века, достижения этой революции, особенно в области информационных технологий распространились по всему миру. Мы называем ее Кибернетической революцией (Grinin L. и Grinin A. 2015, 2016), поскольку наука кибернетика изучает информацию и ее преобразования в различных сложных системах. Кибернетическая революция на первом этапе (с 1950-х до наших дней) радикально изменила процессы обработку информации, а также обеспечила прорыв в регулировании сложных процессов в широком спектре естественных и искусственных систем, которые стали частью производственного процесса. (а в будущем он обеспечит прорыв, создав принципиально новую среду саморегулируемых систем).

Кибернетическая революция, стала третьей по величине производственной революцией в человеческой истории после Аграрной и Индустриальной. Мы считаем, что революционные изменения, с которыми мир столкнется в ближайшие 60-70 лет, произойдут во время второй (заключительной) фазы Кибернетической революции.[1]

Развитие киборгизации в завершающей фазе Кибернетической революции уже сегодня имеет важные предпосылки. В первую очередь, это общая тенденция повышения качества жизни и долголетия. Во-вторых, это тенденция развития различных саморегулируемых систем и технологий (последние мы определяем как способные работать без прямого управления человеком).

Одной из важнейших движущих сил заключительного этапа Кибернетической революция станут медицина, аддитивные, био - и нанотехнологии, робототехника, ИКТ и когнитивные технологии, которые вместе образуют сложную систему саморегулируемого производства. Мы называем этот комплекс МАНБРИК-конвергенцией.

Существует ряд причин, почему медицина станет ядром Кибернетической революции. Во -первых, медицинские услуги быстро растут, составляя около 10 процентов от мирового ВВП (WHO 2020) и они продолжат расти. Во-вторых, на периферии страны формируют огромный средний класс, одновременно с сокращением бедности и неграмотности. В результате, акцент сместится в сторону устранения условий мешающих повышению уровня жизни, здравоохранения и т.д.

Другая важная причина – это глобальное старение населения (см. например Vollset et al. 2020). Старение населения скоро будет характерным не только для развитых стран, где это станет критически важным для демократии, а также для Китая, но и для ряда развивающихся, в т.ч. Индии. Во всех странах обострится проблема пенсий (так как количество пенсионеров будет расти) и одновременно увеличится нехватка квалифицированной рабочей силы. Таким образом, многим государствам придется решать проблему нехватки рабочей силы и пенсионных отчислений за счет повышения пенсионного возраста на 10-15 лет. Это также относится и к людям с ограниченными возможностями, поскольку их вовлечение в рабочий процесс будет расти благодаря новым технологиям и достижениям медицины. В то же время рождаемость во многих развивающихся странах странам значительно снизится (Vollset et al. 2020). В целом эти условия предполагают участие государства, а также крупные инвестиции, деловую активность, развитие науки, чтобы обеспечить прорыв в здравоохранении. Рост уровня жизни, образования и среднего класса в развивающихся странах также будет способствовать росту значения медицинских услуг. Формирование таких уникальных условий необходимо для начала новой фазы Кибернетической революции. Этому, скорее всего, также будет способствовать угроза пандемий (что показал COVID-19), требующая

срочного решения ряда медицинских проблем и дополнительно привлекающая в эту область огромные капиталы и крупные финансовые ресурсы.

ВЕДУЩИЕ ТЕХНОЛОГИИ КИБОРГИЗАЦИИ

В настоящее время наблюдается значительный рост саморегулируемых и умных технологий в различных отраслях медицины, таких, как системы жизнеобеспечения. Другие же системы только движутся в направлении самоуправления. Например, гибкие управляемые инструменты позволяют докторам оперировать в труднодоступных частях тела с минимальными повреждениями и разрезами. Можно ожидать, что в ближайшем будущем многие операции будут рутинно проводиться роботами без участия людей, (см. например, Fortune Business Insights 2019). Мы полагаем, что самоуправляемые системы будут играть очень важную роль в киборгизации.

Один из ярких примеров самоуправляемых технологий – различные биосенсоры или биочипы. Это относительно молодое направление, представляющее сочетание медицины и нанотехнологий. Биочипы способны регистрировать широкий спектр физиологических изменений и реагировать на них или выполнять определенные действия. В долгосрочной перспективе биочипы позволят постоянно контролировать здоровье человека. В результате постепенного уменьшения размера резистора (Peercy 2000) некоторые биочипы стали настолько малы, что их встраивают в клетки (их часто называют наночипами). Эти миниатюрные биочипы могут использоваться для разных целей, например, для адресной доставки лекарств (Wang et al. 2015). Дальнейшая микроминиатюризация позволит создать систему, которая будет постоянно отслеживать важные параметры тела, фиксировать действия а также отслеживать местонахождения человека. Мы полагаем, что подобные самоуправляемые системы будут очень распространены в завершающей фазе Кибернетической революции.

Другое важное направление самоуправляемых технологий – это нейроинтерфейсы, системы взаимодействия между мозгом и компьютером, которые могут быть реализованы посредством контакта электрода с кожей на голове или посредством электродов, имплантированных в мозг. Сегодня нейроинтерфейсы уже широко используются, особенно в медицине, например, в искусственной визуализации или в бионике. В будущем возможно существенное продвижение в области реабилитации людей с инсультами и травмами головы. Также нейроинтерфейсы станут основой для развития искусственных конечностей, которые будут контролироваться напрямую мозгом. Особенно это будет актуально в ортопедии или бионике, поскольку по данным Организации Здравоохранения, более 1 миллиарда человек имеют тот или иной физический недостаток, и около 190 миллионов взрослых имеют существенную функциональную сложность (The World Bank 2011)..

Важным направлением являются искусственные органы, которые тоже являются сложными самоуправляемыми системами. В настоящее время разработаны и используются уж множество различных искусственных органов: сердце, ухо, глаз, конечности, печень, легкие, поджелудочная железа, мочевой пузырь, яичники, трахея и т. д. (Murphy и Atala 2014; Stamatialis et al. 2008). Более того прогресс искусственных органов также может существенно изменить репродуктивные возможности человека. Так, развитие искусственной матки теоретически может в отдаленном будущем обеспечить возможность иметь детей людям, независимо от пола и возраста (Corea 1986; Rosen 2003).

Безусловно, в действительности киборгизация станет комбинацией применения этих и других технологий. Кроме того, важно отметить, что один и тот же результат может быть достигнут с помощью различных технологий. Например,

бионический глаз, вероятно, будет реализован как искусственный орган (искусственная копия настоящего). Или же это может быть техническая реализация его функций, например, камера, встроенная в очки, которая фиксирует изображения и передает их на зрительный нерв через нейроинтерфейс (такая технология уже существует, например (Ong и da Cruz 2012)

Говоря киборгизации, нельзя не упомянуть развития роботов. Роботы дойдут до уровня развитых самоуправляемых систем и распространятся во многие сферы нашей жизни. Рынок робототехники, согласно прогнозам, будет расти (Technavio 2020), особенно роботов для медицинской помощи (например, хирургические, как мы упоминали ранее, или роботы для реабилитационной терапии (Burgar et al. 1999).

В ОЖИДАНИИ РАДИКАЛЬНЫХ ПЕРЕМЕН

Многие исследователи полагают, что мы уже приблизились или приближаемся к довольно серьезным изменениям в разных отношениях, в т.ч. в плане радикального влияния на человеческий организм (а киборгизация является частью этого процесса), и человеческая цивилизация испытает значительные изменения в ближайшие десятилетия. Многие говорят о приближении к точке сингулярности, то есть периоду, в котором прежние тренды развития сильно изменятся. Распространено мнение, что после точки сингулярности начнется новая радикальная фаза развития человечества (здесь следует особо выделить работы Раймонда Курцвейла, например: Kurzweil 2010).

Технологическая сингулярность – это определенный уровень (невиданный ранее) технического прогресса, после которого кривая технологического развития сменится на новый тренд. Мы полагаем, однако, что технологический рост не будет бесконечным. Наш анализ показывает, что есть ряд причин ожидать, что в ближайшие десятилетия, в период когда начнется завершающая фаза Кибернетической революции, темпы глобального технологического роста вернутся на некоторое время к гиперболической траектории, (Grinin et al. 2020b)). Это ускорение будет продолжаться до последних десятилетий 21 века. Согласно нашим расчетам, технологический рост в конце XXI столетия начнет постепенно замедляться до точки сингулярности, которая наступит, ориентировочно в 2106 году (там же). Важно, что глобальный фактор старения будет играть ведущую роль в этом процессе. После точки сингулярности темпы технического прогресса замедлятся по сравнению с предыдущей эпохой, а патерн развития научно-технического развития резко изменится. Однако в конце двадцать первого века следует ожидать силдьного увеличения возможностей влиять на изменение человеческой природы.

ОТ ЧЕЛОВЕКА К КИБОРГУ ДО КАКОГО ПРЕДЕЛА?

Сегодня довольно популярна идея трансгуманизма, которая подразумевает возможность киборгизации человека вплоть до изоляции мозга и переноса сознания в абиотическое бессмертное тело. Бессмертие является вообще одной из главных проблем трансгуманизма (Fukuyama 2004; Haldane 1924; Hansell 2011; Huxley 2015; More 2013). Насколько, это действительно возможно? С одной стороны данное направление выглядит довольно логичным, так как медицина шла по этому пути уже многие десятилетия. В наши дни биопринтеры могут создавать различные ткани и органы (Murphy и Atala 2014), нейроинтерфейсы позволяют управлять устройствами "силой мысли" (Schalk et al. 2004). Кроме того, есть своего рода встречное движение технологий в плане сближения людей и искусственных систем, В частности в конструкции человечекоподобных роботов (см. например, Hirose и Ogawa 2007). Поскольку эти роботы будут использоваться не только для работы и развлечений, но и для очень близких или даже интимных контактов с людьми (Yeoman и Mars 2012), границы системы человеческой и искусственной

антропоморфных систем могут начать растворяться. Не говоря уже о технологиях виртуальной реальности, где даже сейчас становится трудно отличить реальность от иллюзии (Burdea и Coiffet 2003).

Однако, с другой стороны за миллионы лет развития биологическая эволюция сбалансировала все элементы организма и его функции, обеспечив оптимальное и эффективное взаимодействие. Сомнительно, что человеческий мозг может работать без тела, потому что основная цель и функция мозга – это как раз контроль работы организма. Также кажется нерациональным менять все органы, большинство из которых обычно работают нормально. Было бы намного эффективнее и дешевле заменить только вышедшие из строя или менее прочные части. Более вероятно, что процесс из киборгизации никогда не зайдет слишком далеко, и всегда будет «вспомогательным» для биологической составляющей организма, способной значительно улучшить качество жизни и продлить ее.

Сегодня развивается возможность создавать искусственные биологические ткани и модели тела с помощью стволовых клеток или других биотехнологий. Мы считаем, что этот путь «починки» нашего организма будет очень перспективным. Для основных жизненно важных органов, таких как сердце, легкие, печень и т. д., он может быть даже более предпочтительным и более эффективным, чем искусственные небиологические органы. Сегодня мы уже знаем случаи, когда человек имел шесть пересадок сердца (и один раз почку) на протяжении жизни.[2] Сейчас это может себе позволить только очень обеспеченный человек. Однако в будущем это станет возможным для довольно большого количества людей, но не скорее не с помощью трансплантации, а с помощью выращенных в лаборатории органов.

СИСТЕМАТИЗИРУЯ РИСКИ

Развитие новых технологий обычно начинается с некоторой эйфории от ИХ внедрения, и только гораздо позже приходит понимание проблем, которые технологии приносят, и только после этого принимаются ограничительные меры по снижению некоторых негативных последствий. Возникает вопрос: зачем нам сегодня обсуждать опасности, которые не встретятся в ближайшее время? Однако, дело в том, что будущее может оказаться довольно неожиданным и даже ужасным. И думать об этом нужно заранее. 2020 год показал, что никто не готовился к таким проблемам, как COVID-19, и результат нашей неготовности обошелся миру в десятки триллионов долларов и более, чем один миллион смертей. В этом разделе мы скажем не только о рисках, связанных с движением по пути киборгизации, но и о других, которые могут возникнуть в результате научно-технического прогресса, поскольку все направления последнего тесно связаны.

Этические и моральные проблемы

В связи с появлением искусственных органов и тканей вопрос встает уже в отношении материальной биологической природы, то есть в самом прямом смысле: из какого материала – будет сделан человек будущего – из биологических естественных или хотя бы биологических искусственных материалов, либо это будет уже вовсе небиологическое создание? Как он будет размножаться? Как будут функционировать его мозг и сознание? Любое такое изменение очень глубоко затронет фундаментальные институты человечества, включая мораль и межличностные отношения. В самом деле, что станет с моралью и какова она будет, если речь идет о смене биологической природы? Мораль и человеческие отношения – это не что-то, существующее отдельно от технологий, тем более от человеческой физиологии и – шире – биологической основы. Это результат очень сложной социобиологической эволюции, и без своей материальной биопсихической оболочки мораль в привычном понимании этого слова может исчезнуть.

Мы предполагаем, что настоящая киборгизация, если она когда-то все же начнется, будет связана с изменением чувств и сознания человека. В этой области уже ведётся работа. Так, например, недавнее исследование представило концептуальную основу для разработки киборгизации на слиянии организма и ИИ (Wu et al. 2016).

Моральная сторона технологического прогресса не является новой проблемой (см. например Bernal et al. 1929; Haldane 1924). Однако с ростом технологического развития мы встречаем более конкретные и более вызывающие исследования по этой теме, такие, например, как влияние этического суждения о решении человека стать киборгом (Pelegrín-Borondo et al. 2020) или даже по этическим вопросам киберживотных (Xu et al. 2020).

Билл Джой в своей работе поднял важную проблему, касающуюся возрастающей зависимости от машин, опасность «перестать думать и решать ситуацию все большей зависимости от машин, когда люди, потеряв возможность практического выбора, начнут принимать все решения машин» (Joy 2000, стр.2). Вероятно, Джой сгущает краски, когда пишет: «В конце концов, может быть достигнута ступень, на которой решения, необходимые для управления системой, будут настолько сложны, что интеллект людей окажется неспособным к их генерации. На этой стадии эффективное управление перейдет к машинам. Люди уже не станут способными даже просто выключить их, потому что будут столь от них зависеть, что выключение оказалось бы равносильным самоубийству» (Там же). Тем не менее опасность попасть в довольно сильную зависимость от технологических систем вовсе не умозрительная. И что тогда в итоге останется от «свободы выбора» человека, совсем неясно. Кроме того, ситуация, когда системы возьмут на себя бóльшую часть умственной работы людей, вполне может привести к тому, что ум людей будущего станет работать меньше, чем у современного человека, в результате он ослабеет, подобно тому как слабеют мышцы множества наших современников, не имеющих необходимости выполнять физическую работу. Естественно, в помощь интеллекту будут появляться все более удобные и облегчающие работу мысли системы. Включится положительная обратная связь: ум не хочет напрягаться, устройства облегчают его работу, ум ослабляется еще больше. Поэтому неудивительно, если в будущем «умственная гимнастика» (в виде какой-нибудь таблицы умножения) станет пропагандироваться как очень полезное упражнение, так же как сегодня простые физические нагрузки. Таким образом, указанная и возрастающая опасность попасть в зависимость от технологических систем поднимает и важные моральные аспекты.

Еще одна важная моральная проблема – это неприятие или даже сопротивление научно-техническому прогрессу, что имеет давнюю историю. Самый известный пример — луддиты, радикальное движение английских текстильных ремесленников и рабочих в первые десятилетия XIX веке, которое разрушала машины в качестве формы протеста (см. например Binfield 2004; Jones 2013). Эта борьба не было вызвана лишь невежеством, но и классовым и интересами, поскольку ткачи ясно понимали, что машины отнимают у них заработок. И это не единственный в истории пример, когда прогресс обострял ситуацию в обществе, приводил к банкротствам, уничтожал многие профессии; иногда он даже приводил к запустению целых городов и территорий, а также часто ухудшал качество жизни. Иногда это открывало неожиданные возможности для злоупотреблений или было источником отчаянной социальной борьбы и угнетения. Тем не менее, замедлить этот процесс никому не удалось. Ужесточение требований к новым лекарствам, запрет ГМО или клонирования, а также многое другое – это современные проявления такой борьбы с технологическим прогрессом. Очевидно, что многие из подобных ограничений и запретов абсолютно необходимы. С одной стороны, трудно ожидать, что можно поставить под полный

контроль развитие научно-технического прогресса. С другой стороны, достижения, сделанные в процессе борьбы за экологически ориентированное производство или безопасные лекарства показывают, что здесь вполне возможно добиться определенного уровня контроля. В целом минимизация ущерба от инноваций должна осуществляться путем создания определенных институтов и правил, оптимизирующих контроль над технологиями. Но особенно важно делать все это заранее.

Необратимые демографические трансформации.

Каждая фаза любой производственной революции связан с демографическими[3] изменениями. Начальная и промежуточная фаза, на которой мы сейчас находимся в Кибернетической революции, создали условия для колоссального роста населения мира. Этот рост происходит в основном в развивающихся странах и во многом является трендом демографической революции индустриальной эпохи. Но с другой стороны, в развитых странах демографическая революция завершилась так называемым демографическим переходом, другими словами – снижением рождаемости. При этом значительно увеличилась продолжительность жизни и ее качество. Демографический переход во многом стал результатом начальной фазы Кибернетической революции (именно на ее первой фазе удалось добиться прорыва в вопросах планирования семьи). Недаром во все большем числе развивающихся стран коэффициенты рождаемости снижаются, в некоторых из них также наблюдается заметное старение населения. Но в процессе той же Кибернетической революции демографическая структура существенно изменилась. Из пирамидальной структуры (когда дети и молодежь составляют основную часть населения) она двигается в сторону превращения этой структуры в прямоугольную, когда количество пожилых людей почти равно количеству молодежи (подробнее о глобальном старении и технологиях прогресса см. L. Grinin et al. 2020). Мало того, в ближайшем десятилетия мы будем наблюдать старение мирового населения, в результате чего его структура приобретет форму обратной пирамиды (когда количество детей и молодых когорт будет меньше, чем у пожилых людей). В некоторых развитых странах ожидаемая продолжительность жизни может увеличиться до 95–100 лет, и в целом она может достигать уровня наиболее успешных на сегодняшний день стран (например, в Японии), то есть 80–84 года, но может даже быть и выше (Statista 2015; Vollset et al. 2020). Между тем, особенно быстрый рост числа пожилых когорт будет наблюдаться в ближайшие три десятилетия. В результате разделение будет не на первый и третий миры, а на миры старых и молодых наций. Но к этому времени старение населения будет заметно в большинстве стран мира (возможно, за исключением африканских государств). В то же время замедление темпов рождаемости и исчерпание демографических дивидендов в большинстве стран третьего мира приведет к тому, что демографическая структура существенно изменится, и доля детей и молодежи уменьшится, а доля пожилых людей увеличится. Сказанное о текущих и будущих демографических процессах имеет важное значение и для будущих трендов развития, и для киборгизации в частности, поскольку сокращение доли молодого населения и одновременное увеличение доли пожилого поставят перед обществом проблемы замены выпадающих трудовых ресурсов и обеспечения качество длительной биологической жизни людей 80+ и 90+. И все это будет решаться за счет технологий и связанных с киборгизацией среди них..

Упадок демократии и борьба поколений

Старение населения может привести к упадку демократической системы. Демократия может превратиться в геронтократию, из которой будет уже трудно выбраться (Berry 2012; Tepe и Vanhuysse 2009). Кризис демократического управления еще

более вероятен в контексте борьбы за голоса. С увеличением продолжительности жизни и сокращением доли молодежи в структуре населения количество и роль пожилых и старых людей неизбежно возрастут. Вероятны также и изменения в половой пропорции. Кроме того, поскольку пожилое поколение более консервативно в своих предпочтениях и привычках, оно может влиять на выбор политического курса, а также социальные и экономические вопросы, которые могут поставить в невыгодное положение молодое и среднеевозрастное поколения.

Особую тревогу вызывает тот факт, что рост продолжительности жизни может спровоцировать конфликт между поколениями, поскольку растущее число пожилых людей потребует увеличения трудоспособного возраста и трудоспособности на 10–20 лет и более (наряду с вовлечением нетрудоспособных людей в связи с появлением новых технических средств и достижений медицины). В этом случае старшее поколение, вероятно, будет препятствовать развитию карьеры молодого поколения. Также пожилое население может способствовать растущему консерватизму общества, что может замедлить технологический рост в будущем. Убрать пожилых людей с пути молодежи станет сложной задачей, и на этом пути, как говорил Ф.Фукуяма,нам, возможно, в конечном итоге придется найти формы институционального «эйджизма», чтобы позволить молодым людям войти в рабочий процесс в мире с высокой ожидаемой продолжительностью жизни.

Важно отметить, что такой поворот к геронтократии наиболее быстро наметится в странах Европы и США. С одной стороны, эти страны имеют сильнейшие демократические традиции, а с другой стороны, здесь в них наиболее заметен этнокультурный дисбаланс (в будущем в США можно ожидать противостояния молодого латинского и пожилого белого населения, тогда как в Европе это будет между молодым исламским и пожилым белым христианским населением). Это означает, что разрыв между Севером и Югом может воспроизводиться в любой другой стране, где пожилые коренные нации будут жить бок о бок с гораздо более молодым населением, имеющие различные культурные традиции. Конфликты между поколениями в этих странах, вызванные описанным выше кризисом демократии, неизбежно повлияют на судьбу всего мира в условиях глобализации.

Геополитика искусственного воспроизводства

В конце прошлого века стало ясно, что возможность влиять на геном и систему воспроизводства человека может породить множество сложных социальных, политических, этических и юридических проблем в будущем. Тем не менее, модификация человеческих эмбрионов уже началась и идет полным ходом. Например, в 2015 году Китай заявил о проводимых работах по модификации человеческого эмбриона (Cohen 2019), а несколько позже об этом заявили и в Россияи (Cyranoski 2019). Если такие исследования, а также методы выращивания детей вне материнской плаценты будут развиваться, структура воспроизводства населения кардинально изменится. Помимо отношения к вопросу о разрыву связей между поколениями эта проблема имеет и глобальный аспект. Будут ли страны и мир в целом готовы к таким изменениям? И не захотят ли некоторые страны извлечь выгоду из своих демографических преимуществ (что было бы вполне естественным ходом вещей)? Тут открывается простор для фантазии. С одной стороны, очевидно, что в будущем при создании каких-то международных структур и выработке квот для разных государств численность населения страны станет намного важнее, чем сегодня (в наши дни статус страны скорее измеряется его богатством и военной мощью). Но согласится ли Запад с тем, что страны с гораздо большим населением будут диктовать свои условия?

С другой стороны, почему бы некоторым политическим элитам не использовать новые репродуктивные технологии и, например, не стартовать новую гонку в приросте населения.

ЗАКЛЮЧЕНИЕ. МЕЖДУ ТЕХНОЛОГИЧЕСКИМ ОПТИМИЗМОМ И РАЗУМНОЙ ОСТОРОЖНОСТЬЮ

Чем быстрее происходят изменения, тем сложнее обществу следовать за ними и тем более неоднородным оно становится в социальном (а часто и этнокультурном) плане. Кибернетическая революция привела к взрывному росту информации. Это затрудняет для многих людей освоение новых технологий и серьезно разделяет общество. «Молодые люди считают себя «цифровыми аборигенами» и снисходительно смотрят на «цифровых иммигрантов», пожилых людей, выросших с книгами, ручками и бумагой», - писали президенты Римского клуба (von Weizsäcker и Wijkman 2018, p.46) В некотором смысле технический прогресс ускоряется за счет возрастающей необходимости адаптироваться и учиться, и, следовательно, все больше и больше полагаться на технологии. Это формирует новое коллективное обучение, которое будет сочетанием человеческого опыта и технологических возможностей, и даст импульс для будущего этапа развития Большой Истории после преодоления 9-го рубежа (трешхолда).

Сила человека увеличивается с ростом технологий, но вместе с этим возникает много ранее неизвестных проблем. Поэтому, если мы хотим воспользоваться новыми возможностями (а почему бы и нет?), необходимо предвидеть проблемы и минимизировать их последствия и «шок будущего.[4] К сожалению, человечество не всегда учится на собственных ошибках и мало обращает внимания на будущие проблемы. Кроме того, довольно трудно предвидеть проблемы. Вот почему нам нужны определенные институты или административно-правовые системы, которые взяли бы технологическое развитие под контроль и развивались бы в сотрудничестве с технологиями, сохраняя при этом их функциональность. Однако для этого необходимо регулировать темпы научно-технического прогресса в мире. Мы верим, что рано или поздно это станет возможным. К сожалению, пока это недостижимо, поскольку конкуренция между странами в первую очередь основана на разном уровне экономического роста. Становится очевидным, что контроль над опасными изменениями также потребует определенных политических преобразований, которые могут стать чрезвычайно сложными и чувствительными (L. Grinin и Korotayev 2013)[?].

Между тем в обществе с давнего времени и до сих пор действовали два главных регулятора, без которых оно не может существовать. Это мораль и право, которые также опираются на психологические структуры общества и населения, действующие на почти подсознательном уровне (L. Grinin и Grinin 2016). Но чем быстрее развиваются технологии, тем менее признана мораль, поскольку она не может найти свой новый баланс. Также вполне возможно, что за определенным пределом скорости научно-технического развития может начаться заметное разрушение морали (или ее распад на разные виды морали). И это тем более опасно, когда развиваются мощные технологические возможности трансформации человеческого организма. Из-за отсутствия моральных ограничений и стремления к большой прибыли могут преобладать различные опасные явления: от моды на коррекцию тела до попыток стать сверхчеловеческим с помощью новых медицинских технологий.

Юридическое право, появившись в аграрно-ремесленных обществах, обрело зрелость в период индустриализма (но нормотворчество имеет место в любом обществе). Право, будучи более гибким, чем мораль, тем не менее требует определенной устойчивости, которой, как мы видим, сложно добиться в условиях быстрой смены технологий. По словам С. Лема: перед технологическими

инновациями общество и его правовые нормы чаще всего оказываются практически бессильными, если только они не вступают в откровенно прямой конфликт с законами» (Lem 1968, стр. 269). И, как справедливо отмечает Лем, интенсивность, с которой «упрощающие дело» технические средства подрывают ценности, имеет положительную корреляцию с их эффективностью. Это значит, что чем эффективнее технологии решают какие-то частные проблемы, тем сильнее они изменяют общество, его морально-правовую ткань, последствия чего начинают осознаваться гораздо позже.

Как будет самоорганизовываться будущее общество в таком случае, неясно. В предшествующие эпохи мораль и право можно было сравнить с двумя ногами, на которых общество стояло довольно крепко (причем там, где был перекос, например право было недостаточно развитым, чувствовался и крен общества). Но, образно говоря, если одна «нога» (мораль) исчезнет, а другая (право) ослабеет, устоит ли общество на такой слабой опоре при столь высокой скорости движения вперед?

Трудно и фактически бессмысленно пытаться помешать прогрессу. Всегда возникает вопрос о том, что считать прогрессом в каждую конкретную эпоху и каковы издержки? В любом случае лучше не торопиться с изменениями с неопределенными последствиями. Ступая на новую землю, лучше быть осторожным, чем торопиться. Наука, инновации и изменения слишком быстро ставят много новых правовых, моральных и экономических проблем и вызывают острые споры, конфликты, торговые войны и фобии. Общественное сознание однозначно отстает. Неконтролируемый технологический прогресс можно сравнить с Роком, легендарной птицей из Арабских ночей, которая быстро несет человечество, но при этом требует человеческих жертв. Готовы ли мы к этому? И чем мы готовы пожертвовать ради прогресса? Эти вопросы — должны стать одними из самых важных при оценке

нашего будущего. И тем более они важны на пути к киборгизации человека.

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Endnotes

[1]Важно отметить, что Кибернетическая революция сама по себе стала продолжением основного тренда производственных революций. В макромасштабе технологический рост увеличивался, по крайней мере, за последние 40,000 лет, хотя и с некоторыми флуктуациями (Grinin, Grinin, Korotayev 2020).

[2]Речь идет об уже умершем мультимиллионере Дэвиде Рокфеллере, перенесшим последнюю операцию по трансплантации сердца в возрасте 99 лет.

[3]Мы выделяем три производственных революции: Аграрную, Индустриальную и Кибернетическую.

[4]Мы постоянно сталкиваемся с такими потрясениями, поэтому вопрос, поднятый Элвином Тоффлером в его известном «Шоке будущего» почти полвека назад, по-прежнему остается актуальным (Toffler 1970).

Ethics and Fragmented Knowledge in McEwan's *Solar*: Implications for Big History

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K E Y W O R D S

Two cultures
Natural sphere
Cultural sphere
World view
Epistemology
Ethics
Anthropocene
Big History

A B S T R A C T

This essay is a reflection on the consequences and outreach of the "two cultures" (as conceived by C. P. Snow) that resorts to a reading of McEwan's acclaimed novel *Solar*. Michael Beard, the main character, is a Nobel Laureate who, at a very young age, gained recognition, and who then spent most of his adult years wasting his ingeniousness on futile and personal pursuits. He is unable to understand the ethical and humanitarian implications of his gained knowledge. Even though he ends his career by trying to address the problem of climate change, he does so in a detached manner, as though human and nonhuman lives were not implicated in this Earth phenomenon. At the root of it all lies an assumption that nature and culture belong to distinct ontological spheres. Hence, we aim at investigating how Beard's worldview can be read as a symptom of epistemological assumptions that no longer serve us. This article explores the ethical implications of a rigid disciplinary perspective in a moment of global urgency – the Anthropocene –, and how Big History can help to narrow the gap between different forms of human knowledge. It also makes brief remarks on how Big History should avoid the ethical perils represented by the idea of a "grand unifying theory of the past" by assuming a permanent and coherent critical stance on its methods and concepts.

Can science still be morally neutral in times of climate change? How do personal stories and planetary ones intertwine in this new geological epoch called the Anthropocene? How does the entanglement between humans and nonhumans affect personal stories? In *The Great Derangement*, Amitav Ghosh claims that the novel may seem inappropriate to depict the natural disasters we are soon to experience. Perhaps the same can be said about conventional thought all across the academic fields (and, especially, in the humanities). Climate change, according to Gosh, seems unfit for a literary genre (the novel) that focuses on the individual, on the probable, and in the insertion of the everyday in narratives. The mark of the modern worldview, which the novel embodies, is the assumption, in literature and in geology, that

(Ghosh 2016, 22), that it makes no leaps, that it is predictable. Any hint of the uncanny is then relegated to less serious fiction. Serious fiction, the novel, on the other hand, represents the mastery of techniques that help conceal the scaffolding of events. Events should bear the mark of probability, one leading naturally to the other, following probable chains of cause and consequence. It is no wonder then that Amitav Ghosh asks himself whether serious fiction could face the obstacles posed by climate change. Doesn't climate change disrupt our deep-rooted epistemological assumptions? Doesn't it question the existence of a nature out there ready to be tamed? Doesn't it beg the revision of time-space scales? Of background-foreground relationships? Likewise, is not academic thought expected to face the same questions, for the same reasons? Is Big History fit for the job? The climate crisis, Ghosh would go on, is a crisis not only of culture, but also a crisis of the imagination (Ghosh 2016, 9). How could the novel accommodate the discontinuities of climate change? How can we imagine and represent the unthinkable? How can academic knowledge cope with this?

Ian McEwan, following his own personal engagement with Cape Farewell, a think tank that gathers creative minds willing to address the reality of climate change, publishes the novel, *Solar*. The story of the novel revolves around a physicist, a Nobel Prize winner, Michael Beard, who in the midst of his own personal entanglements – failed marriages, affairs, expeditions, revenge, grants, disease, etc. – carries out his research on clean energy. Beard's interest in clean energy is not motivated by the world crisis, though. He is not impressed by climate change or any political or external motive for that matter. In a way, the novel as a whole avoids grappling with the representation of climate change. Climate change is presented as a given, as a background noise that clings to the events that unfold. Even though Beard claims to be unimpressed about climate change, his work relies on this fact: that the planet is getting warmer and every now and again the topic is brought up in conversations. Even if at first *Solar* may seem to be a textbook example of how serious fiction, as Amitav Ghosh stated, is unfit to deal with the problems presented by climate change, many tensions are brought to the surface throughout the novel.

If the allegorical mode is at play in McEwan's novel, as many critics have noted (Kellish 2013; Tate 2017; Trexler 2015), allegory here should not be reduced to the structure of the synecdoche, a continuous relationship between part and whole. Beard's life is not necessarily the microcosm of the planet. Clear distinctions between contexts and boundaries, ones that would allow for microcosm and macrocosm relationships, become blurry in a novel that seems well aware of the interconnectedness of all. Beard's life may be a microcosm and a macrocosm at the same time, and even more, if carefully scrutinized. It is not difficult to realize then that the structure of the synecdoche is at its breaking point in the novel, showing its cracks and tensions as the world is about to reach its climate tipping points.

This essay aims, this way, at investigating the cracks left wide open as the story unfolds. These cracks and tensions relate to outdated worldviews that do not align with a planet in peril, an unthinkable situation that blurs cherished distinctions.

"[H]e was paralyzed by shame, by the extent of his humiliation" (McEwan 2011, 5). In the very first pages of *Solar* a description of Michael Beard's state of mind is provided: it is a sense of humiliation that infuses his life with a renewed desire for his wife. Knowing about her betrayal makes her desirable again, makes him, Beard, eager to do whatever it takes to have her back. All of a sudden, Beard longs for Patrice and all his thoughts revolved around her: "These days, desire for Patrice came on him out of nowhere, like an attack of stomach cramp" (McEwan 2011, 5). Note that he is not overtaken by higher feelings of love or admiration for his wife; quite the contrary, his feelings are likened to corporeal reactions; he is a body reacting to stimuli and nothing more.

He is a body desiring another he can no longer possess, and humiliation is the driving force behind it all. If he could have her back, would he overcome this sense of humiliation? Would the cramp cease? Would his body give him a rest?

Michael Beard, the Nobel Prize winner, is driven by his corporeal urges: food, drink, sex. He is a body craving for more and more, even when he is diagnosed with melanoma, even when the doctor warns him that metastasis is a possibility unless treatment started right away, Beard is resolute in his pursuits, he cannot stop: "'Don't be a denier,' Doctor Parks had said, appearing to refer back to their climate-change chats. 'This won't go away just because you don't want it or are not thinking about it'" (McEwan 2011, 328). Beard is not willing to accept this external imposition. We seem to have reached an impasse here. Beard, the physicist, is driven by material urges but not willing to respond to the call of his own body? What is Beard's relation with the material realm?

The material world represents this uncomplicated space governed by laws that can be easily described, understood, manageable: "The material world simply could not be so complicated. But the domestic world could" (McEwan 2011 29). According to Michael Beard, then, the human and the material realms constitute two different worlds that could not be less akin to each other, separate worlds that are governed either by predictable or unpredictable laws that do not interfere with one another: "All the excitement and unpredictability was in the private life" (McEwan 2011, 19).

There is the human world and its despicable human affairs and there is the clean orderly world of physics. At the root of Beard's thought and his apparent despise for culture and society lies a thought, on the surface, contrary to what drove Western civilization:

> In the Western tradition, in fact, most definitions of the human stress the extent to which it is distinguished from nature. This is what is meant, most often, by the notions of "culture," "society," or "civilization." As a result, every time we attempt to "bring humans closer to nature," we are prevented from doing so by the objection that a human is above all, or is also, a cultural being who has to escape from, or in any case be distinguished from, nature (Latour 2017, 14).

At first, Beard's conviction seems to contradict the western attempt to free itself from natural constraints. That is, it seems to contradict modern conceptions that oppose the natural and human worlds. According to this modern view, human consciousness and its ability to elevate itself from nature guaranteed the progress of human history. It sees the natural world as a mere background to human history. To put it another way, it means that mankind's freedom and consequential progress is made possible only by silencing nature: "Freedom has been the most important motif of written accounts of human history of these two hundred and fifty years" (Chakrabarty 2009, 208).

Michael Beard's conviction—that there is a separation between the human and natural worlds—resonates with what Bruno Latour in *We Have Never Been Modern* (1993) calls the Great Divide. Modernity's rupture with the pre-modern world entailed conceiving the world through a clear separation between natural and human realms, that is, between nature and society and, as consequence, between subject and object. The natural world is seen as stable and constantly equal to itself, as background. It is not allowed consciousness or intention. It may only bear witness to human actions, intentions, progress. The natural world does not interfere with human actions and intentions and remains always the same. Let's listen to Beard again: unpredictability is relegated to the human realm, only. The material world, the world of physics, is the orderly world of predictability. If at first Beard seems to elevate the material realm, he does so by means of restating the modern epistemological assumptions. The material world is elevated due to its silence, its lack of agency and volition, but what about his body?

If Michael Beard's claims initially seem to downplay human affairs, they do so by means of undermining the material realm as well. The world of physics, the background, is the world of laws, of physical states, the world of facts, then. Its laws, therefore, cannot be applied to the human realm: "Beard said that the principle had no application to the moral sphere. On the contrary, quantum mechanics was a superb predictor of the statistical probability of physical

states" (McEwan 2011, 106). From the beginning of the novel Beard is quite clear about his line of reasoning: the need to separate human affairs from the world of physics, the clear-cut division between facts and values. The philosophers of science should not tell him otherwise! Michael Beard, the Nobel Prize winner, is an almost hyperbolic depiction of a modern scientist. His claims, his utterances, restate time and again his alignment with the facts, as opposed to any value these facts may embody. As a scientist, facts are just facts for him and nothing more. The laws of physics have no say in the moral sphere and vice versa.

This simplistic view, however, does not fully grasp how multi-faceted McEwan's novel is. *Solar*, alongside *Oryx and Crake* by Margaret Atwood, is one of the first novels written by literary giants to grapple with climate change. Climate change, nonetheless, may not seem to be a main concern in the novels at first glance: while in Atwood's novel, according to Adam Trexler, climate change is nothing more than a footnote; in McEwan's novel, science is the least of Beard's concern. What to expect, then, from Beard, whose ingeniousness was supposed to save the dying planet?

> Throughout the novel, science remains the least of Beard's concerns: the novel's comic force comes from Beard's self-centered preoccupation with his next meal and the repercussions of his last, foggily fighting the effects of drinks he didn't mean to take, pursuing women and mitigating the effects of his affairs, keeping sinecures and securing patents, and attracting undue credit to consolidate his reputation, even if the fate of the world, apparently hangs in balance. And this is much the point of the novel: Beard's immediate desires continually displace action that should prevent climate change (Trexler 2015 47).

Interestingly, in spite of Beard's continual claims about physics' awkward superiority, superior precisely because it is free from human taint,[1] throughout the novel, science, or even physics, becomes a mere background, whereas "human affairs" come to the forefront. His research occupies little of his time; it becomes almost irrelevant after the Nobel Prize winner discovers he is a cuckold, and saving the planet from the sixth mass extinction seems less important than regaining his wife's love and affection. Notice the parallelism, which is one of many in the novel: the fifth marriage and the impending sixth mass extinction, both of which could have been averted by him—Michael Beard: the husband and the Nobel Prize winner. When posed with the impossible choice of which should be salvaged, Beard, without a moment of hesitation, gravitates toward human affairs: "At no point did he remember that the planet was in peril" (McEwan 2011, 51). Beard did not love Patrice, though; he was overtaken by a sudden craving for her. Shame and humiliation were behind his new impulses. Adam Trexler would say Beard was a victim of "evolutionary urges," "the result of evolutionary instincts operating just beyond his awareness" (Trexler 2015, 48). Andrew Tate would add that "regressive forces" prevented him from focusing his attention on saving the Earth:

> These confrontations display McEwan's fascination with scientific materialism and a certain clumsily allegorical mode: the liberal, progressive conscience finds itself in continual opposition to antagonistic, regressive forces that are not just wrong-headed but literally pathological. Michael Beard belongs to this trope of masculinity in crisis but instead of finding some vicious doppelgänger, Beard's own adversary is himself: he is clever enough to have been awarded a Nobel Prize as a young man but not smart enough to keep himself in good physical or moral health (Tate 2017, 7).

Humiliation, the novel says. Curiously, humiliation is also the term Timothy Morton chooses to describe how hyperobjects, global warming being one, affect our perception of the human. In his words, "Hyperobjects seem to continue what Sigmund Freud considered the great humiliation of the human following Copernicus and Darwin" (Morton 2013, 16). The list of humiliators goes on to include Freud, Marx, Derrida, Heidegger, Nietzsche and his lineage, thinkers

that displaced the human from the center of psychic activity, the center of meaning-making, or displaced human social life; hyperobjects, following this line of thought, seem to push this displacement to a new limit, one in which, according to Morton, we are forced to "realize the truth of the word *humiliation* itself, which means being brought low, being brought down to earth" (Morton 2013, 17). These objects, massively distributed in space and time, impose the painful realization that "*we are always inside an object*" (Morton 2013, 17). We cannot escape global warming. It is in our bodies, in our simple conversations about the weather; it reaches remote territories and big cities; it affects the Earth in its entirety. Global warming viciously attaches itself to our human affairs, as the hyperobject it is, showing us time and again that there is no away. We are humiliated, circumscribed by circumstances we cannot escape, limited by the unintended consequences of our own actions. Michael Beard is also humiliated—by the unintended consequences of his actions? The parallelism, nevertheless, between his decaying marriage and the planet does not mean Beard responded the same way to both threats. Climate change "comprised the background to the news," but was not his major concern:

> And he was unimpressed by some of the wild commentary that suggested the world was in 'peril', that humankind was drifting towards calamity, when coastal cities would disappear under the waves, crops fail, and hundreds of millions of refugees surge from one country, one continent, to another, driven by drought, floods, famine, tempests, unceasing wars for diminishing resources. There was an Old Testament ring to the forewarnings, an air of plague-of-boils and deluge-of-frogs, that suggested a deep and constant inclination, enacted over the centuries, to believe that one was always living at the end of days, that one's own demise was urgently bound up with the end of the world, and therefore made more sense, or was just a little less irrelevant. The end of the world was never pitched in the present, where it could be seen for the fantasy it was, but just around the corner, and when it did not happen, a new issue, a new date would soon emerge (McEwan 2011 20-21).

For Beard, the real emergency was his marriage. The end of the world belonged to a future he was not even able to anticipate. Would he even see this future? It seems as though there were different types of humiliation, one that could be ignored, dismissed, overlooked, and another that demanded action. Earth's call, in Beard's view, could be silenced. But why is that?

Once again Beard's distinction between humans and nonhumans resonates with our modern assumptions. The silencing of the nonhumans, their removal from our moral sphere, results in being desensitized to their call. Nature's call is, quite the contrary, too loud. Kant perceived it. Nature's potency could easily belittle us humans by disclosing our impotence when confronted with nature's powers. We had to learn to be insensitive to nature's call: "To become moral in the modern way, it is necessary to take shelter from the world and to observe nature as a spectacle, all the more attractive for its fearfulness" (Hache and Latour 2010, 317). Without this separation, without the glass that separates humans and nonhumans and safeguards our humanity, the sense of the sublime evaporates and our humanity is faced with its constitutional weakness:

> Nature's appeal from inside us amounts to little: we need not "bow down" to it, and "this saves humanity in our own person from humiliation." Note the seesaw effect: the sense of humanity within rises as the appeal of nature is lowered (this order of precedence will be reversed by Lovelock) (Hache and Latour 2010, 317).

There is, therefore, a need to lower nature's appeal in order to save our humanity from humiliation. Curiously, humiliation plays a role in Kant's thought as well. Relegating the nonhumans to the world of facts saves humanity from humiliation. There needs to be a glass of separation, the world should be viewed as a spectacle; otherwise, what might happen?

Otherwise, we would feel humiliated, Timothy Morton would say. Isn't that what the reality of global warming makes us face? Suddenly, nature,

the background to human actions, is no longer immutable: "Now what happens when global warming enters the scene? The background ceases to be a background, because we have started to observe it" (Morton 2013, 102). The concepts of background and foreground reach their breaking points, as we are no longer able to tell one from the other: "In an age of global warming, there is no background, and thus there is no foreground" (Morton 2013, 99). Are we part of the spectacle now?

> In short, the relationship of human beings to the natural world we inhabit has been upended. None of this could have been foreseen a century ago, or even three decades ago. Yet now we must face up to the fact that this situation, an irreversible and dangerous shift in the Earth's trajectory, is our future and the ideas that we have inherited from the era before the break must all be open to question. Among many that I will later challenge, one is worth mentioning here. It appears that the wanton use of our freedom and technological power have led us to the brink of ruin. The very cultivation of our powers has left us exposed to a nature that refuses to be tamed and is increasingly unsympathetic to our interests (Hamilton 2017, 35).

Michael Beard, the physicist, is unimpressed by climate change, though. Being impressed by it would definitely mean, as Clive Hamilton mentioned, revising our concepts and beliefs, accepting that former ideas about nature, science, humanities, ethics, facts and values no longer fit our new geological age. Nature cannot be observed from a distance anymore since the glass that allegedly separated humans and nonhumans cracked. Beard clings to outdated modes of thinking as though nothing had changed, as though the reality of global warming did not challenge our views on science, as though facts and values could still be viewed as separate entities. When faced with too many humiliations, he attends to the one that does not challenge his scientific views. That is, the novel as a whole explores parallelisms: the comparison between his marriage and the six mass extinctions, between his relationship to his body and the planet, between McEwan's personal experience and episodes in the novel,[2] situations that don't necessarily mirror one another, but that, when paired, expose clear contradictions. If there is a mirroring effect between his marriage and the planet in peril, why is the planet's call silenced? Focusing his attention on Patrice's moves, trying to regain her love would still mean being safe within the boundaries of human affairs. Human affairs might be unpredictable, as Beard thinks; nonetheless, there was still a line, a boundary, a limit. Responding to the planet's call, on the other hand, signified crossing a line between humans and nonhumans, between facts and values, and acknowledging that "Scientists would have to accept their responsibilities, in Donna Haraway's sense: they would have to become capable of responding, would have to acknowledge that they have 'response-ability.'" (Latour 2017, 29). Beard did not want to take that chance, however; he was a scientist who would stick to the facts, "He was aggressively apolitical" (McEwan 2011, 53). But what is to be done when the facts are such that they are almost prescriptive, when their call to responsibility is just too much to be ignored?

> We owe to the astute Republican strategist Frank Luntz, a psychosociologist and unrivalled rhetorician, the celebrated inventor of the expression "climate change" in the place of "global warming," the best formulation of this profound philosophy: the description of the facts is so dangerously close to the prescription of a policy that, to put a stop to the challenges addressed to the industrial way of life, one has to cast doubt on the facts themselves (Latour 2017, 34).

When facts and values are so intertwined, as in the case with global warming, that accepting the facts signifies a change in behavior, sacrificing beliefs and systems, the only possible solution is to deny the facts, to minimize their relevance, and to demand more proof. The facts are not enough, one could say; we need more evidence, others may retort. "Don't be a denier," that is Doctor Parks' response. Global warming won't go

away, the melanoma won't go away, even if we don't think about it.

> But we will not rescue the earth from our own depredations until we understand ourselves a little more, even if we accept that we can never really change our natures. All boot rooms need good systems so that flawed creatures can use them well. Good science will serve us well, but only good rules will save the boot room. Leave nothing to idealism or outrage, or even good art. (We know in our hearts that the very best art is entirely and splendidly useless) (McEwan 2005).

In a way, Michael Beard is a sorrowful, ideal-type for the anomie-stricken modern man, adrift in the vastness of complexity. Unable to grasp the all-relatedness of nature, which dilutes the cultural, the biological, and the physical realms in a continuum, he goes astray under the stars, with lighthouses and seagulls in sight. He cannot find a path for reconnecting his life as an individual to the life of the cosmos because he is saturated by an ideological conviction—in spite of all the evidence—that his life and the life of the cosmos are ontologically and epistemologically unrelated and, therefore, should be encased in different vacuum chambers.

That is an old epistemological, existential and political stance, but, all in all, recentness and oldness are just a matter of scale. In the early nineteenth century, a man like Alexander von Humboldt—a scientist, like Beard—was bold enough to see the universe in a big picture (in the biggest picture he could get), and, actually, he was in good company at the time. Humboldt's *Kosmos* (1845-1862) was one among many attempts to grasp the lines of unification between multiple scales of existence in space-time (a concept coined latter, of course) (Christian 2018b, 5).

> In considering the study of physical phenomena, not merely in its bearings on the material wants of life, but in its general influence on the intellectual advancement of mankind, we find its noblest and most important result to be a knowledge of the chain of connection, by which all natural forces are linked together, and made mutually dependent upon each other; and it is the perception of these relations that exalts our views and ennobles our enjoyments (Humboldt 1864, 1).

For sure, Humboldt's willingness to see the integrative fluxes between extraterrestrial cosmic phenomena and planetary biological and physical ones goes as far as the *Zeitgeist* of his age admitted, and, on this matter, he was far from being a New Age guru. In spite of this, a "search for conceptual unification" motivated much of the efforts of other nineteenth century thinkers like Comte, Marx, and even the controversial Spencer, favoring macro-narratives that allowed (some) convergence between natural history and—let us use this term—human history. Even Leopold von Ranke, the Teutonic godhead of all positivist historians, could not avoid the claim for unification and warned against the perils of the emphasis on short-term histories (Christian 2019, 5). Was not Maxwell showing that electricity and magnetism were slightly different expressions of the same force, even if he had to rely on the supposed existence of a phlogiston-like stuff, spread all around the cosmos, called ether? (Hawking 2015, 32-33). Good science proceeds with caution and parsimony, and we should not bother too much about an *ad hoc* hypothesis made for bridging gaps because, sooner or later, it will be supplanted by the "real" thing. Patience requires a refined perspective about time, and both are lacking in Beard's portfolio, among other things.

Maybe we could say that a "consilience" stance, as would be defended by E. O. Wilson (2018, 29-31), was taking its primeval steps in the 1800s, and that we are insisting on this idea just to highlight the amount of anachronism brought forth by the disturbed personality of a twenty-first century climate scientist—and compulsive denier—such as McEwan's Michael Beard. Perhaps this could be good if we stopped blaming the entire Enlightenment movement for our mainstream short-sightedness and started to consider that, duration-wise, the fragmentation of academic knowledge is much younger than that, and the reaction against that fragmentation is probably one of the most pressing matters of our time.

> Most Enlightenment thinkers were convinced that a better and more coherent understanding

> of reality would advance the progress of humanity as a whole. It is possible to identify two overlapping colours or qualities to the Enlightenment's unifying project. [...] It assembles diverse types of knowledge, like so many coloured tiles or pixels, into coherent accounts of how things came to be. Such narratives can be found at the heart of most religious traditions. The second approach can also yield large unifying narratives, but its primary emphasis is on conceptual unity, on the search for networks of ideas that are locked together tightly enough to provide a foundation for most of knowledge (Christian 2019, 5).

The Age of Enlightenment had room for consilience efforts; actually, some were made, but Beard would not be authorized to reclaim this heritage even if he declared such intentions. What Michael Beard inherited from his intellectual ancestors was not this desire for "conceptual unification;" instead, he received the keys and the deed to a Victorian manor, with many compartments, rooms and doors, the vast majority of them closed from inside, with plenty of skeletons in all closets.

The foundations of this house were laid in the last decades of the nineteenth century, and by the early twentieth century, the edifice was quite complete. It was built with the most modern science and techniques, but over ancient burial grounds, where all the past martyrs of Anthropocentrism were put to rest. They should be remembered for their contribution to the human understanding of the universe and our place in it. Yet, as Comte once said, "the living are always, and progressively, governed by the dead" (1978, 151), and even if the agreed meaning of this phrase can be different from the one we are suggesting here, overall, the idea fits well. With German universities as a model for a wide reformation of academic environments around the world, "specialization and professionalization [broke] scholarship into ever-smaller compartments." Not only were the natural sciences and the humanities split apart, but inside each one of these major compartments, a myriad of smaller ones emerged, encapsulated and disconnected from each other. Then "the idea of a single world of knowledge, whether united by religious cosmologies . . . or by scientific scholarship . . . was abandoned," (Christian 2018b, 5), and in the wake of this process, "discipline based research flourished, a bit like potted plants because it was confined," and "where thought threatened to sprawl unmanageably, the disciplines pruned overreaching branches and root systems, creating the intellectual equivalent of a bonsai garden" (Christian 2019, 6). "In order to accommodate the rising flood of information, scientific disciplines were dividing into specialties at near-bacterial rate" (Wilson 2018, 30).

During this process the humanities quickly emerged as a field of study, carving its name on the pantheon of human knowledge with bones dug up from newly turned earth. In the core of this freshly arisen academic bubble, redivivus, anthropocentrism reigned. In tandem with the idea that the "human realm" and the knowledge about it should belong to a discrete epistemological and ontological sphere, unrelated to anything "natural," anthropocentrism would end up flirting with dystopia, in spite of its good intentions (of which hell is full, some people say). Secular conservatives and liberals alike were fast to condemn the "heresies" of Darwin in the late nineteenth century in an almost hygienist struggle to clean up the miasmatic vapors blown over the "high culture" and the "civilization" by the mere image of a monkey-man. They were followed by the Boasians and other tribes of cultural anthropologists, diffusionists and relativists, in their relentless crusade to save human dignity from being bestialized by the impurities and the brutishness that sprout from the "natural world" (Foley 2003, 17-19). Holistic thinkers should have known better by that time: consilience became a lost cause in the beginning of the twentieth century, and academic institutionalization would not be of any help in this situation.

It was not just a sublime matter of epistemology that drove Michael Beard to a nihilistic, careless posture toward climate change. Academic work, as a job, became dictated by bureaucratic whims and a sort of industrial division of labor, with expected products to be sold in a competitive market. "Western intellectual life is ruled by

hard-core specialists . . . Starting with the deliberations of department-level search committees, then recommendations to the dean of the faculty . . . the pivotal question asked was, 'is the candidate the best in the world in his research specialty?'" (Wilson 2018,: 31). For a long time, there would be no place for people eager to sprint over no-man's land, over the dead zones at the borders of two or many of the so-called "disciplines". The situation would become even harder for transdisciplinarity advocates (spiritual heirs of the polymaths of the past) after the horrors imposed by Nazi-fascism and its reliance on nefarious pieces of pseudoscience such as Social Darwinism. "These undermined the credibility of the Enlightenment project, and encouraged a turning away from unifying schema towards less ambitious scholarly agendas," especially after the Second World War (Christian 2019, 8).

In the aftermath, not even a glimpse of naturalistic epistemology could be traced in the core of the humanities without raising disgust and accusations. Christian says that the chasm between the two cultures became even wider in the Anglophone world, where the word "science" is exclusively related to the natural sciences (Christian 2018b, 6). We do not believe it made any big difference. To the speakers of the "sweet language," the "last flower of Latium," *ciência,* in general, means a "knowledge that is acquired through reading and meditation, instruction, erudition, wisdom" (Ferreira 1975, 324). In spite of this all-encompassing reference, the two cultures, neglecting dictionary definitions, became deep-seated in the academic environment in the Lusophone world, in tune with its English-speaking counterparts.

Why does Michael Beard believe in a human domain tainted by chaos and unpredictability, and in a stereotyped physical domain full of regularities? Even the most reluctant student of astrophysics comes to a time when she or he must face the fact that the entire cosmos is created by quantum fluctuation events, and that quantum gravity is certainly the key to unlocking the secrets for the unification of general relativity and quantum mechanics (Susskind 2006, loc. 1063-1074). Quantum probabilities and wave functions would not confer the exactness expected by a man so full of certainties as Michael Beard; so, we have to presume that he is either a cynic with a full-time job—and not of the Athenian type—, or a very bad physicist, with a Nobel medal in a case.

It is known that laureates tend to display patterns of behavior and ideas considered obnoxious, extravagant, or arrogant; Linus Pauling (a double laureate, by the way) claimed he found the cure for cancer in high doses of vitamin C and felt that his unmatched excellence would permit him to reach that conclusion with just a few unstandardized trials. Was Michael Beard showing signs of "nobelitis", whose "most common symptom . . . is megalomania" and a personal belief that the affected person has "super-human powers," and that they will "go on and do even bigger and better things" (Diamandis 2013, 1573)? Were the fixation on his cheating wife and the disregard of his medical condition both evidence of aberrant behavior produced by standing on the top of an ivory tower? Was Beard deluded about his power of doing "bigger and better things," not for the world, but for his ego? Is denialism just a nastier form of egolatry? In a way, we could say so, but we are not in favor of appealing to a malady in order to make Beard's behavior make sense. Beard's epistemological disjunction is a collective, societal, civilizational matter. If it were a disease, it would be a widespread endemic one. Prophylactic measures would be a colossal endeavor in order to flip upside down an entire set of mentalities crystallized for centuries and deeply reinforced by academic institutionalization in the late nineteenth century.

Deniers come in many colors and shapes, and their agendas may vary. Nonetheless, they are all believers in the unconstrained power of human action, whether justified by a simplified understanding of free will, or sanctioned by the allegiance to big moralizing gods. In any case, a denialist stance imbues the agent with a strong sense of individual power and invulnerability; at the same time, it establishes an antagonistic relationship with anything considered "external." Narratives about the "taming" of nature, considered a savage and fearful enemy or, at least, a dangerous landscape, reinforce the denialist posture. Tales

like that—the human epic against nature—are probably as old as mankind, but they were much bolstered by the ideological framework of the industrial society and, unfortunately, by most of the Enlightenment movement.

With the compartmentalization of human studies in the late nineteenth century, the myth of human supremacy was strengthened even further.

In spite of all the efforts in the field of sociology, and the slight exception represented by Marxism,[3] the apparent lack of genuine verifiable statements, the imperviousness to quantitative methods, and the inadequacy of law-like structures of explanation reinforced the notion that human studies have "freedom" and "indetermination" not only as its subject, but as an epistemological assumption. By that time "Historical scholarship seemed to have splintered into multiple, incommensurable, stories about the past, each representing a particular perspective, and none confident about its claims on historical truth" (Christian 2018b, 8), while economics, trying to escape from "subjectivism's gravitational pull," lost its "humanity" and became a sort of behavioral engineering with the Neoclassical school.

So, Michael Beard is a late heir to this historical epistemological split in academic culture, but not of a regular kind.

> The non-scientists have a rooted impression that the scientists are shallowly optimistic, unaware of man's condition. On the other hand, the scientists believe that the literary intellectuals are totally lacking in foresight, peculiarly unconcerned with their brother men, in a deep sense anti-intellectual, anxious to restrict both art and thought to the existential moment (Snow 1961, 5-6).

In this pool of mutual prejudice, Beard contradicts both expectations. Let's imagine for a moment that C. P. Snow's aforementioned image is something factual in its terms, and not just an expression of biased visions reinforced by the academic chasm between the humanities and the natural sciences. While literary intellectuals would believe that Beard, as scientist, should be naïve in relation to "man's condition," he proves to be well aware of the supposedly tricky, unpredictable aspects of personal and social life (a stereotypical notion, of course). On the other hand, his fellow scientists would believe that he is "concerned with their brother men," but his obsession with a failed marriage in spite of the incoming climatic disaster would prove the opposite.

Solar may not be a full-fledged cautionary tale, but perhaps Beard's pre-cataclysmic folly can teach us a thing or two about the dilemmas faced by academic knowledge in the Anthropocene. Michael Beard's views are a construct formed by the worst of two worlds. His understanding of human affairs is not just a *cliché*; it is also based upon an impoverished approach to the epistemology of the humanities, and his views about "nature" and the knowledge about it are also incomprehensibly inaccurate. Beard somehow sees the universe as a static background, a scenario through which definable entities formed by matter and energy, with intrinsic properties, move in deterministic ways. It is as though Beard is unwilling to let the Newtonian atomism die.

> According to the atomistic view, particles simply have the properties they have, regardless of context . . . [and] there is no reason for a world composed of atoms with fixed properties to be complex. . . . The common view, which we have inherited from Newtonian science, is that we live in a universe composed from a great many identical parts. The parts—the elementary particles—are each very simple, and each is identical to every other of its kind (Smolin 1997, 218, 220).

Beard seems to be unprepared for a more challenging approach to physics and cosmology, one that takes into consideration not circumscribed entities, but relationship networks.

> If there is no absolute space then the position of a particle cannot even be spoken of without bringing in its relationship with the rest of nature. . . . Atomism compels us to postulate that the world is essentially simple, while relationalism pulls the opposite way, towards a vision

of the world as a complex system (Smolin 1997, 218).

He also seems incapable of understanding that the humanities (history, in particular) in a largest scale approach must also be fully relational, like non-atomist physics: In order to have "a history of the largest possible scope that can be affirmed for all human beings—an enabling assumption is required, namely, the assumption that some sort of ultimate coherence underlies humanity in general" (Megill 2015, 313).

Readers of this journal are probably aware of Big History's objectives. In Christian's words,

> Big history recognizes no disciplinary barriers to historical knowledge. . . . It tries to link the findings of specialist scholarship into a larger unifying vision. . . . With these qualifications, Big History aims at a comprehensive understanding of history, the intellectual equivalent of a world map of the past. Like a world map, the big history story can help us see not just the major nations and oceans of the past, but also the links and synergies that connect different scholarly continents, regions and islands into a single knowledge world (Christian 2018b, 13).

The recent "historical turn" in the natural sciences did much for creating bridges to the humanities so that transversal efforts could be made having the idea of consilience as a north. Big historians are not the only ones to have the search for consilience as a guideline; the call to rescue this old objective—attaining forms of knowledge as unified as possible—was made initially by the British polymath William Whewell in the early nineteenth century (Snyder 2019), and was echoed by the biologist E. O. Wilson in the late twentieth century (Wilson 1998). Researchers not involved in the Big History movement—in the sense given by Katerberg (2018)—have also embraced this objective, albeit sometimes with more modest ambitions and relying a little more on disciplinary safe grounds (Haldon et al. 2018).

Big History is not only a transdisciplinary project; it is also a symptom of the challenges we are facing. In fact, much has been done in terms of accumulation of information and of "vertical" knowledge (ultra-specialized) since the late nineteenth century. Nevertheless, the most important questions that affect us—the planet, all life, humans included—in this first half of the twentieth-first century are on such a gargantuan scale (spatial and temporal) that it makes disciplinary knowledge insufficient.

> We will need the broad scale of big history to see the Anthropocene clearly, because it is not just a turning point in modern world history, but a significant threshold within human history as a whole, and even in the history of planet [E]arth. Most contemporary historical scholarship studies the last 500 years. The danger of this foreshortened perspective is that it can normalize recent history, making the technologically and economically dynamic societies of recent centuries seem typical of human history in general (Christian 2018b, 15, 18).

What Big History brings to the table is the idea that "the very notion of detail is relative." So "what is central at one scale may be detail at another and may vanish entirely at the very largest scales," and, therefore, "larger objects [must] come into view, objects so large that they cannot be seen whole from close up" (Christian 1991, 226). This is, give or take, the same general principle we can adopt to understand the nature of spacetime in a superstring M-theory approach.

> If you look at a hair under a magnifying glass, you can see it has thickness, but to the naked eye it just appears like a line with length but no other dimension. Spacetime may be similar: on human, atomic, or even nuclear physics length scales, it may appear four dimensional and nearly flat. On the other hand, if we probe to very short distances using extremely high energy particles, we should see that spacetime was ten- or eleven-dimensional (Hawking 2001, 173).

Big History can be understood as a collective response to the defiance posed by the contemporary relationship between humans and nonhumans.

> The Anthropocene is radically de-centring humans and has led to the placing of human

> activity in deep co-evolutionary time. . . . It has afforded an opportunity to conceptualize history in a completely new and unexpected manner, to give up the traditional view of "human exceptionalism" and to integrate the environment and other forms of life into history writing, but no longer as passive objects or external decorations, but as active agents in their own rights (Tamm 2018, 6-7).

That is the kind of challenge accepted by a consilience-driven initiative like Big History. It seeks to raise public awareness about historical processes on scales so large that they are not visible from a regular, individual, common sense perspective. To do so, Big History must investigate the feedback mechanisms between human agency in the short term; the long-term institutional frameworks (rules and expectations that emerge in a given society in order to regulate social interactions); and processes occurring at cosmological, geological and evolutionary scales. Therefore, Big History embraces the idea of a continuum between humans, the biosphere, and the cosmos, a continuum that produces different types of phenomena in different spatial and temporal frames. Most of these phenomena, in spite of changes in cosmological and/or evolutionary rhythm and scale, affect the daily lives of many species—humans included.

Let us, for a moment, assume the perspective of modernization theorists like W. W. Rostow (1971). We should believe that economic and demographic growth is some kind of "propensity" in human societies, and that the "failure" of attaining high levels of income, production and population are due to endogenous handicaps. Rostow restricted his analysis to processes and events since the nineteenth century, so he did not have any *longue durée* expectations about the problem of growth; but maybe we could dare a little and consider that since the agricultural revolution, "growth" is something on the horizon. We should have ten thousand years of this epic of progress and the taming of the elements. In one way or another, this is just a glimpse of 300,000 years of the presence of *H. sapiens* on this planet, and we can easily accept that for 290,000 years (or even more), there had been no economic or demographic growth capable of calling the attention of an economist.

> Human history consists of about 250,000 years of relative stasis followed by a mere 10,000 years of growth, most of which has been concentrated into the last few hundred years. . . . To the extent that population growth can serve as a surrogate for growth in average levels of productivity, we must conclude that growth, far from being the normal condition of humanity, is an aberration (Christian 1991, 230).

This is the "play of scales" that Big History, based on a consilience stance, employs in order to raise public awareness about decisive challenges that we, as members of societies, as part of the biosphere and of the cosmos, are facing right now. Human-induced climate change is the result of the combination between the accumulation ethos (with free-market, planning or planification, whatever), the industrial revolution, geopolitical strife, the fossil economy, human supremacy as cultural standpoint, and the unconscious social ethology that gives rise to conflict, status-seeking and agonistic behavior. Human-induced climate change is literally a "time bomb," not because it is about to explode—unfortunately, it already did—but because the vectors of causality run in different temporal scales, and converge to a single point in time—now.

Modernization theorists and most of the economists, historians, political scientists, sociologist, and geographers—you name it—chose to remain unaware and entrenched in their disciplinary strongholds; the incursions of some of them into sustainability, environmental studies and holistic approaches are not always convincing, because a deep change in epistemological, ethical and existential stance hardly results from it. Even flesh and blood climate scientists fall prey to the negative side of the emotional detachment toward their research objects and to the "objective" approach to those objects (as "serious" science demands). So did the fictional Michael Beard, who, confronted with the consequences of the Anthropocene, chose 1) to make a sinecure of his academic job, a source of personal prestige; 2) to

embark upon the soothing fantasy of an ordered and predictable universe as a counterpoint to his messy personal life; and 3) to devote the remainder of his years to his love affairs and bodily pursuits. We are not resorting to a cheap moralism here; Beard was free to pick his path according to the given circumstances. Rather, the point is that in Beard's story climate change remains in the background. It is there; what a pity; let's move on with our lives just the way we always did. Beard's life is not transformed by knowledge. He simply chooses not to care.

This brings us to the last subject of this essay. How transformative should *ciência* be? We are not referring to *science*, isolated, self-absorbed, but to the entire Portuguese above-mentioned definition, in full: human knowledge, from many sources, combined. What is it for? What should it be for? If Big History can work as a hub, attracting researchers from many fields, guiding them toward transdisciplinarity, we could have it not only as a source of ideas, information and achievable solutions to concrete problems, but also as a beacon, attracting all agents of knowledge—and their interlocutors—to a commitment with an "integral ethical responsibility" once and for all. According to Christian,

> Big history is an origin story for the Anthropocene Epoch. . . . Big history builds on the intellectual achievements of modern science, but it is also the product of an increasingly globalized world (Christian 2018b, 17).

> Origin stories attempt to hold together and pass on all that is known in a given community about how our world came to be as it is. . . . As far as we know, origin stories can be found at the core of all forms of education (Christian 2018b, 16).

Christian resorts to the image of ethno-narratives as an analogue to Big History for a purpose. "Ethno-narratives are a special genre of narratives that involve a transformation of the self and the community, in a mutual interrelationship" (Bhattacharjee and Dev 2006, 5).

> Narrative identity is also based on a responsibility towards the other. The self of the narrator is enacted through this responsibility of constructing spaces for dialogue and solidarity in situations of conflict. Narrative, through a programme of shared meanings and memories reconstructs cultural and political communities, creating new spaces for living together" (Bhattacharjee and Dev 2006, 2).

About the origin stories of some Australian aborigines groups, Christian says,

> Told over many nights and days, their stories describe the big paradigm ideas of the Lake Mungo people. . . . As they talk about the stars, the landscape, the wombats and the wallabies, and the world of their ancestors, the teachers build a shared map of understanding that shows members of the community their place in a rich, beautiful, and sometimes terrifying universe: this is what you are; this is where you came from; this is who existed before you were born; this is the whole thing of which you are a small part; these are the responsibilities and challenges of living in a community of others like yourself. . . . [Without them] people could fall into a sense of despair and meaninglessness (Christian 2018a, 7-8).

Big History would provide a source for ethno-narratives of a different kind, one that is built ". . . on the global traditions of modern science. . . . [And] like the origin stories of Confucianism or early Buddhism, the modern story is about a universe that just is. Any sense of meaning comes not from the universe, but from us humans" (Christian 2018a, 9).

> The social imaginary offers explanations of how 'we'—the members of the imagined community of mostly strangers—fit together, how things go on between us, the expectations we have of each other and outsiders, and the deeper normative notions and images that underlie those expectations (Patomäki and Steger 2010, 1057).

Moreover, in the light of the Anthropocene, the future would not entail different fates according to affiliation to sub-planetary collectives. We should expect stark geopolitical and social inequalities in the impacts of human-induced

climate change, but, all in all, there is no escape for any human living on the planet, not to say any living creature in the biosphere. "The modern origin story tells of the heritage all humans share, and so it can prepare us for the huge challenges and opportunities that all of us face at this pivotal moment in the history of planet Earth" (Christian 2018a, 10).

> The starting point of non-Eurocentric and planetary 'Big History' is that—as human capacities emerged from nature—human societies remain part of nature. . . . Big History narratives draw on a series of mutually strengthening prototypes, metaphors and framings that logically lead to envisioning the place of 'us' in the framework of 'global,' 'planetary' or even 'cosmic' time and space. It encourages new framings of human activities in terms of a new geological era, an anthropocene, as the most recent period in the Earth's history involving human activities that have a significant impact on the Earth's climate and ecosystems (Patomäki and Steger 2010, 1061).

So, the knowledge gained through Big History research can provide an origin story that raises public awareness about our future as a species and about the responsibilities that we must assume because of the destructive power—to the planet, to other species, to ourselves—that we achieved through our collective action. There should be no space for fairytale-like narratives, and the worst of humankind should be brought to the surface with the support of the most solid transdisciplinary knowledge available. Maybe we should consider Big History less around-the-bonfire storytelling and more as an exercise in species-wide psychoanalysis.

As should be expected, not everyone is comfortable with the idea, and this fact will bring Michael Beard once more to the scene for a final act. The study of Big History can provide such a comprehensive narrative about the cosmos, life, and the unintended consequences of human societies that its likely outcome is leading to ethical reasoning among students and researchers. This is not guaranteed, of course, but the doors are open. Attaining a macro and micro-ethical stance through the acquiring of knowledge—natural sciences and the humanities as one—would certainly be considered a public good, a citizenship gold standard. Because of all of this, Christian says that Big History, with its pervasiveness, could be understood as a "modern creation myth" (Chris tian 2004, 1). This mention of a mythological condition refers to foundational aspects of the psyche and of human cognition inscribed in hundreds of thousands years of evolution (Stevens 1990). As Jung stated,

> From the unconscious there emanate determining influences which, independently of tradition, guarantee in every single individual a similarity and even a sameness of experience, and also of the way it is represented imaginatively. One of the main proofs of this is the almost universal parallelism between mythological motifs, which, on account of their quality as primordial images, I have called archetypes. (Jung 1936/1968, *CW 9* pt.1 §118).

Notwithstanding, Big History has been accused of "remythologizing" scientific facts (Hesketh 2014, 176), as though a mythical narrative structure were something inferior, savage, primitive, pagan, or an apostasy against the Modernity god. That is a trivial understanding and cannot be taken seriously. "The standard modern meaning of myth has been that of a narrative that has no basis in reason and cannot be true. Mythos is opposed to logos" (Patomäki 2019, 77), but, as Giambattista Vico asserts, "mythos and logos are mutually implicated." In this case, "If a myth is lived by people in their everyday practices and institutions, the resulting social order testifies to the truth of that myth. Hence, in order to know the human world, we must know its constitutive myths." Big History, as a creation myth in the Anthropocene, founded on fair and sound academic practices, is open to criticism and permanent revision and, therefore, is averse to dogmatism. In no way is this a necessary contradiction to the definition of myth; so "the stories we are telling, involving anticipations of possible futures, must be open to criticism and revisable in a systematic fashion" (Patomäki 2019, 78).

The kind of criticism presented by Hesketh is

deeply instructive because it signals the epistemological expectations of most of disciplinary-modern-Eurocentric academic thought. Hesketh believes that "the notion of remythologizing science is an implicit rhetorical move of much popular science literature" (Hesketh 2014, 181), and that it should come with criticism. In fact, however, this is something that attests to the social responsibility of both genres in trying to make complex academic knowledge understandable to a wider audience.

There is something derogatory in Hesketh's allusion to popular science, as though well-accomplished scientists like Lee Smolin, Stephen Hawking, Neil deGrasse Tyson and Sean Carroll woke up one day and decided that writing baloney and earning big money would compensate for tossing their professional reputations in the dustbin. Sound scientific ideas are offered both in Big History and in popular science books, and if they come in a format that widens the readership, some academicians, on the top of their ivory towers, may fail to notice.

This takes us back to Michael Beard. Perhaps intoxicated by success and western, modern epistemology, the Nobel laureate could not grasp at all the ethical and social responsibility entailed by knowledge, especially his own knowledge; Beard was entombed by anomie, and he had no tools to get out of it. Hesketh was troubled by the fact that Big History and popular science books "seek something closer to revelation than to enlightenment" (Hesketh 2014, 181). Well, like many real life academicians, we are pretty sure that our fictional laureate was well-served by Enlightenment thinking over the course of his life, but that deprived of the sense of awe, of the consciousness of being part of the cosmos, that is, of all existence, incapable of looking into the eyes of a fellow animal—whatever the species—and of seeing himself in it, he was thereby prevented from recognizing the dangers of the unintended consequences of his acts and omissions, unable to understand with his entire embodied cognition (not just with his solipsistic mind) that he is *merely* stardust: like everything else. What could Beard teach anyone that could affect genuinely their lives and the lives of the creatures around them? How could his encyclopedic knowledge, his refined erudition, enhance his primate empathic powers so that he could become a valuable planetary citizen, to the benefit of others?

Maybe these questions could find some answers in the future, not only through research and theoretical work on Big History, but also through the *praxis* inspired by it. As we suggest here, there is little ground for claiming neither "neutrality" nor "distancing" when it refers to the ethical stance of a researcher toward the world around him or her. This is a matter of 'response-ability', as Donna Haraway says. The path is not entirely clear, and, as Big History establishes itself as an academic endeavor, its practitioners must be aware of the perils of taking some things for granted.

As the little imp who haunted Socrates—making him as controversial and iconoclastic as possible—there is also a Michael Beard lurking around the corner, but not to make big historians as inquisitive as they can be. Beard is there to lure big historians toward a false Apollonian nirvana made of law, order, straight lines, objectivity and unambiguity, represented by the idea of a "grand unifying theory of the past." When such a prospect is longed for, it makes it easier for one to pursue a detached way of being in the world *right at this moment* because, after all, the explanation for everything—and the cure for all evil—will be written in the same textbook. Every alternative path will end up absorbed—if they lead toward the light of consilience—or eliminated—if they insist on the darkness of particularity. There would be no alternative standpoint from where Big History could be evaluated. There will be no opportunity to learn from dissent. No *auriga* would whisper "*Memento Mori"* to Caesar's ears. In that case, why should we care about climate change, deforestation, animal exploitation, inequality, war, poverty, geopolitics—all of these small things happening under our noses—if "humankind" is racing toward a technoliberal Kurtzweilian turning point? Let's live our lives as usual, enjoy the pleasures of overconsumption, and indulge in apathy because our heroic task is to reveal the secrets of the cosmos *someday*. This should grant all the emotional and irrational

demands for an ethical stance toward scientists like us.

As it comes to age, Big History needs critical theory. This is not a revolutionary plea. The biohumanities advance nowadays as an applied field of knowledge with four objectives: "deepening our understanding of biology itself, engaging in constructive science criticism, creating alternative visions of biology, and achieving critical science communication" (Stotz and Griffiths 2008, 44). Big History will fall victim to its own success if it does not accept dissent and epistemological criticism as part of its *métier*. David Blanks has an interesting analogy to this need for critical theory:

> Imagine big history as a large house. There are rooms for physicists and geologists, chemists, biologists, social scientists, and yes, artists and musicians too. They live and work together and share a space which represents a grand narrative that combines areas of expertise. . . . But hidden inside the walls and under the floorboards of that house are the electrical and plumbing systems upon which they depend. The inhabitants take these for granted and none has been trained as an electrician or a plumber—which is fine until the power goes out or the hot water stops working. When this happens they will need to call in a specialist, someone who understands a building's internal working. This is when they will need a theorist (Blanks 2019, 234).

If we just add to Blanks' observation that the relationship between any field of knowledge with critical theory must be more a matter of preventive maintenance than of fixing what is broken (when it happens), we strongly disapprove of Richard Feynman's impressions. As he supposedly said in one of his worst "Michael Beard moments," "the philosophy of science is about as useful to scientists as ornithology is to birds." This phrase has something of the apocryphal about it. It is regularly quoted, but its origins are a little controversial. We are not, however, interested in discussing Feynman's personality. What we want is to raise awareness of the dangers Big History faces, and to do that, we must realize that "philosophy and history of science may be as valuable to science as conservation biology is to birds" (Stoltz and Griffiths 2008, 44).

Every kind of human knowledge needs to have its theories, methods, hypotheses and especially *aprioris,* scrutinized. They belong to the everyday of academic work and usually bring moral, ethical, aesthetical, epistemological and ideological content in a subliminal way. As these hidden assumptions are theoretical, they are previous to analytical work, and as such, they have the power to frame scientific conclusions. It may sound a little obvious, but scientific evidence—of any kind—will not speak for itself. All it can tell us depends on the questions we ask, and these questions are determined by our assumptions (Bloch 2001). "Meaning does not emerge from the empirical evidence all on its own. One cannot, as some big historians claim, remove oneself from the equation by taking academic distance from the subject. This is theoretically naïve" (Blanks 2019, 235).

Reclaiming the goal of achieving convergent modalities of knowledge must necessarily invoke plurality—we speak about forms, not *a* form: infinite diversity, in infinite combinations. The disciplinary approach toward science is to consider the methods, techniques, concepts, theories and objects of a given discipline as a world in itself. All mediations with the outer world (other disciplines) must be regulated, sanitized, or run the risk of producing contamination. Big historians, in their desire to achieve a "grand unifying theory of the past," are perhaps looking for a strange way to "disciplinarize" Big History. The expectation of achieving this may carry between the lines a vision of integral knowledge as a no-boundary universe. As such, there is no North or South, in or out. In these terms, and supposing that such a unified theory is feasible, Big History could encapsulate its own philosophy of science. If so, who will watch the watchmen? We are not questioning here whether or not a theory of everything is more fantastic than the alchemical *lapis philosophorum*; we are questioning the ethics and values behind the search. As Michael Beard says, "Let the philosophers of science delude themselves to the contrary, physics was free of human taint, it described a world that would still exist if

men and women and all their sorrows did not" (McEwan 2011, 11). He could also ask to all big historians: how distant from my world are you, consilience seekers? It is never enough to remember an old, worn epigram: "Whoever fights with monsters should see to it that he does not become one himself. And when you stare for a long time into an abyss, the abyss stares back into you" (Nietzsche [1886] 2002, 69).

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Endnotes

[1]Notice the inversion here: it is not culture that is free from the taint of nature, as modern thought understands it, but the opposite: according to Beard, it is nature that is free from human taint, as though immune to human actions.

[2]"The boot room" episode and McEwan's experience on Cape Farewell's expedition were presented in McEwan 2005.

[3]Marxism recognizes that human agency is dialectically linked with long-term phenomena, which means that the synthesis of the interaction between contingency and structure imposes restrictions to the "human" side, at least. As the well-known passage says,

[4]"[Humans] make their own history, but they do not make it as they please; they do not make it under self-selected circumstances, but under circumstances existing already, given and transmitted from the past" (Marx 1977, 203).

BH678: Big History in the Italian Middle Schools: A Manifesto against the Fragmentation of Knowledge

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ABSTRACT

With the *Big History Italia BH678 Project* I have introduced the Big History approach in the Italian middle schools, proposing an interpretation of the history of the universe as a way of creating a complex fusion among the sciences and a symbolic path for personal and spiritual growth. Starting from a deep love for complexity, I have written a novel, *Storia interiore dell'Universo* (now in print for the Italian market), that brings Big History into a poetic and psychedelic landscape. If you want to know the universe, probably, sometimes your body, your brain, your matter are enough; but if you desire to learn from the universe and you work in education, you should consider the whole *Homo sapiens*, as I believe our species learns only through feeling. Each Big History threshold is an opportunity to feel the echo of some keywords that contribute to developing our Inner Big History, taking off from apparently outer island-moments scattered across spacetime.

Lacking an invitation, education must invite itself to the table of the branches of knowledge, a fascinating research laboratory aimed at interpreting contemporaneity. Here voices harmonize. There is no arrogance in formulating hypotheses because this type of education searches for objective results in the ultimate investigation, that of increasing the quality of life of our species, acting on the reality of the present in order to help us be happy with that of the future. There, seated, vibrant, are the voices of a desire to be an expression created by change. Education listens, aware of being able to learn from the whispers of each different cultural perspective.

Assuming we agree that the nature of reality is a system of complex systems, the proposed BH678 format is configured as a theory of surgical reduction of the gap existing between the complex extra-scholastic reality and the alienating scholastic reality. The disturbing introduction of these categories appears necessary for only the love of horror as soon as you look closely at middle school. It often presents itself as a shattered and bureaucratically articulated sequence of fragmenting fragments and fragmenting institutions—a diabolical device capable of perfectly representing the opposite of a complex system,

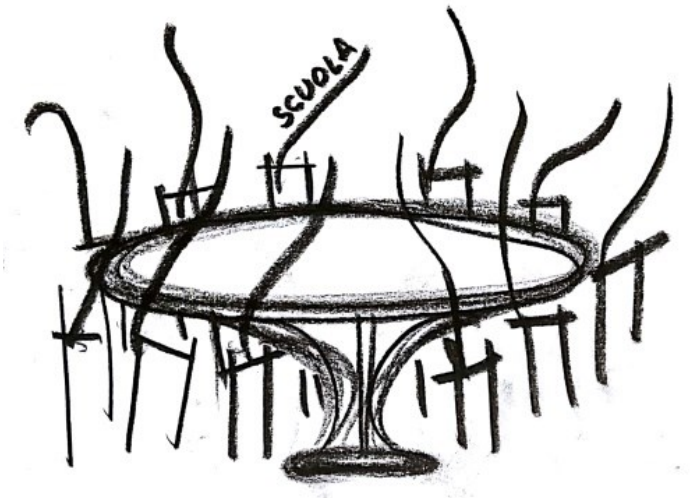

Figure 1 Education

the opposite of reality. Follow the rhythm, the repetition, the delineated form of the fragments of knowledge, fragments of time, fragments of space, fragments of the mind. At school we have fragmented entities for knowledge, fragmented entities in charge of time, fragmented entities for physical spaces and fragmented entities that act on the minds of its occupants—a complete service, served up in apparently reassuring packages that are sadly hermetically sealed. An educational offering of this kind would be perfect if our goal were to create students hemmed in by schizophrenia and serial fetishism, moving from one subject to the next. In fact, the unfortunate pupils, in order to survive and indeed to make a good impression in the eyes of the scholastic system, now must: construct an entirely different image of reality with respect to extra-scholastic complexity; constantly confuse the detail with the whole during each boxed lesson experience; and finally demonstrate the ability to repeat *N* times the manifestations of their love for each hermetic fragment, observing the seriality that the system expects. In this organization there are no structured moments in which to take notice of the existence of a global and complex tableau. It is not like this at the table of knowledge, and education realizes it. Despite this bleak practice, fortunately, reality imposes itself with its own complex, embracing nature, and therefore the artist-teachers cannot resign themselves to post-fragmentation.

In the commitment to fight fragmentation, the BH678 format has been identified as a tool that operates on three levels: a physical level, a mental level, and a curricular didactic level. These levels are nothing but different variations on the concept of architecture, and it is possible to consider the first two levels as preliminary to the curricular didactic plan that the present work intends to deepen. However, our idle talk becomes inspiring when it takes care of the common denominator of the three levels of the anti-fragmentation intervention. The minds of many teachers, school buildings and the school curriculum are characterized by the cumbersome presence of walls, divisions, and fragmented entities. Despite some excellent ministerial suggestions, the three architectural levels in question reflect the fearful attitude that has brought up generations of students in the privation of complexity, and that appears happy to preserve itself within the defined traditional regulations. BH678 proposes, instead as a visionary of the lowest common denominator, a model inspired by a ring surrounding a group of towers—no, skyscrapers, students reaching toward the sky.

The primary requirement is to create and preserve an empty space in the center of the mind, of the buildings, of the curriculum. The hole in the center of the ring is redeeming; it is the space in which the possibility of seeing all the skyscraper students climb toward the infinite becomes a reality. Oh yes, they all stretch upward, but each in their own way. Perhaps, this is what fascinates the *skyscraper-Homo sapiens*, the personalization

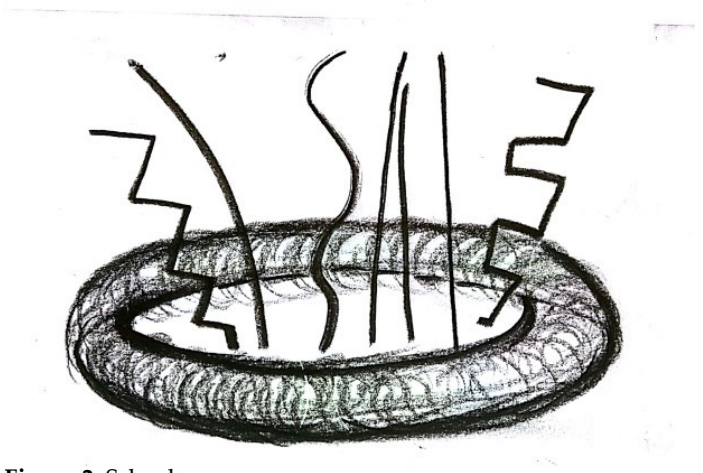

Figure 2. School

of the ascent. Many of these buildings have forgotten the very idea of open space, or maybe they have never experienced it. Many teachers' minds have forgotten the all-consuming pleasure of being fully rounded cultural beings, or perhaps they have never enjoyed the pleasure of themselves outside the disciplinary boundaries. At the table, however, this sensation is felt in the branches. Only in the empty space do the students experience the possibility of being autonomous actors of their own path of growth and education. Freedom of choice in the organized empty space, creative responsibility. Familiarity with the artistic, experimental work of research. Delusions in the minds of many fragmented school heads and teachers. The essence of metamorphosis needed

for middle school. I have removed partition walls, created open spaces, transparent gathering places in which to bring together the fragments of teachers' minds. The physical and mental reality are only one thing, and only by passing from the walls of the classrooms to the emptiness of the corridors and the recovered spaces is the slavery of comfortable fragmented entities removed from the teachers, and they are brought into the space of the breath of creation.

Here it is, ethereal, the substratum of a good learning environment: a complex and fascinating entity, but incomplete if designed for only students. BH678 is designed for *Homo sapiens*, not for students. The first to be immersed, overturned and deconstructed by the learning environment must be the teachers, who, enjoying the emptiness, will experience such exaltation that they will radiate excitement as an example for their students. There is nothing here in the middle, there are only we humans of different ages who share the pleasure of thinking about Totality in an ever more precise and humanizing way. If the teacher does not experience the emotional moment of the creative act of thinking every day at school, no student will begin to think. At the table, the awareness of being there is perceptible, of being there to paint the traits that define what it is to be human. Education listens. How to define a learning environment of this kind? Brian Eno coined the term *scenius,* a collective equivalent of genius. It refers to a research community in which you can think and in which you can feel the pleasure of having thought. The school changes from just a place to a beautiful inner landscape, to the extent that it makes possible the act of thinking, and this can be achieved only by placing emptiness in the architectural center. All you need is a blueprint for thought.

The third architectural level on which BH678 acts is the curricular, didactic one. The empty space requires an allure, a blueprint for thought. Look at the Farnsworth House, designed by Ludwig Mies van der Rohe; here is our guide for thought. Beams and pillars are the Languages: L1 grammar, then L2 and L3, and Mathematical Language (including technical drawing). The large glass walls are a unique *cultural corpus* called BIG HISTORY. The languages represent a gym for the development of knowledge and skills, while Big History is configured as the big stage on which knowledge and skills are transformed into competencies by entering a complex global tableau. Big History is an approach to knowledge that embraces the entire universal history in one single

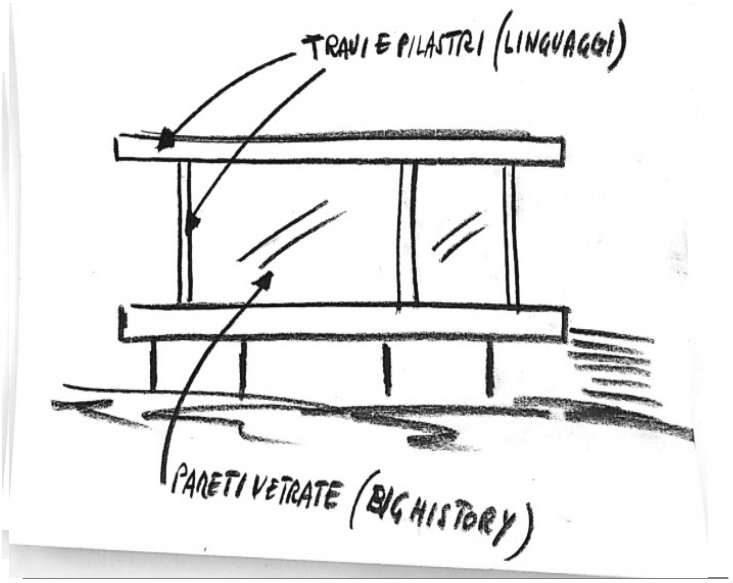

Figure 3. Thought

course, from the beginning of the universe's expansion to the future. The course follows the increase in the global complexity of the universe itself and rotates progressively through the various disciplines, which act as tools, narrating voices in order to tell parts of this long, united story. The path covers approximately 13.8 billion years, and this forces the cultural explorer to identify some threshold moments in which to create stages to reflect on distinct portions of the story. The thresholds were chosen because they coincide with a significant increase in the general complexity. The course, created by Professor David Christian, envisages ten threshold and is typically proposed in schools and universities as an independent discipline, in addition to the existing curriculum or integrated into it.

BH678 proposes, instead, for the first time, a Big History format tailored to the Italian middle school. In this case we are not talking about adding a subject matter, but about reformulating, reformatting the entire didactic curriculum on the basis of Big History, creating the empty space necessary to allow interaction and collaboration between the fragments of knowledge that are

represented by the various disciplines already present in the school. In the BH678 version of Big History, the following disciplines will be involved: philosophy, the sciences, geography, history, L1 literature, classics, L2 and L3 languages with CLIL (Content and Language Integrated Learning) activities, technology, art, music, religion or an alternate subject. In light of the specificity of the needs of middle school students, BH678 adds to the classic Big History path three original preparatory thresholds, necessary for the progressive introduction of some intersecting themes, such as the encounter between reality, diversity and complexity. The articulation of the course, therefore, differs from tradition by providing in total the following thirteen thresholds in Table 1.

The nomenclature of the thresholds appears at first glance aligned with a purely scientific trajectory. In order to follow successfully the vision of BH678 as a framework for a renewed interdisciplinary educational curriculum in complexity, an interesting operation of respectful hybridization and vaporization of the nature of the thresholds has become necessary. From each threshold, key words have been extracted, capable of blurring the outlines of spaces for dialogue accessible to all the disciplines. These key words, common and consistent with the scientific story, yet permeable, were then re-inflected within each subject, which created ad hoc activities from them. From this is derived an outline structure for the curriculum that presents the *thresholds as a chain of large pools of mysteries* in which to immerse the students.

Around each threshold is proposed a *cloud of activities defined as thought exercises*, proposed by the different disciplinary areas, but referable to and inspired by the same threshold key words. Each pool is surrounded by its own cloud of thought exercises, and such clouds are infinitely implementable by the teaching community. An interesting feature of the clouds is that they allow for educational outings, events, and trips consistent with the complexity thresholds to be included among the activities. The system therefore calls for an entire plan of excursions that are favorable to Big History. When students enter the pool of mysteries represented by the threshold, they tackle common themes but study them from the different points of view offered by the various disciplines. The result is a total immersion in the true complex nature of a theme, savoring the

THRESHOLD	OUTER MOMENT	INNER KEYWORD
00A	Encounter with Reality	From Signs to Symbols
00B	Diversity	Names
00C	Complexity	Mistery
01	Origin of the universe (space, time, matter and energy	Darkness
02	Origin of stars and galaxies	Light
03	Origin of the new chemical elements	Colours
04	Origin of the Sun and the solar system	Shapes
05	Origin and evolution of life	Information and Soul
06	Human origin and evolution	Human spirit
07	Domestication (of animals and plants), cities, states, agricultural civilizations and their evolution	Voices of the human spirit (from Neolithic to Middle Ages)
08	Expansion and connection: towards modernity	Voices of the human spirit (Modern Age)
09	Acceleration and Anthropocene	Voices of the human spirit (Contemporary Age)
10	The future	Renewed human spirit

Table 1 Thresholds

organic uniqueness of the human ability to gather connections, which is obscured by the linear thought that is traditionally taught. Turning to metaphorical and symbolic interpretation practices as well, the holistic approach to the thresholds creates the conditions for a definitive inclusive essence of the BH678 curriculum. Consistent with what is expressed about the importance of a *scenius* centered on *Homo sapiens*, the results of inclusiveness strike both teachers and students.

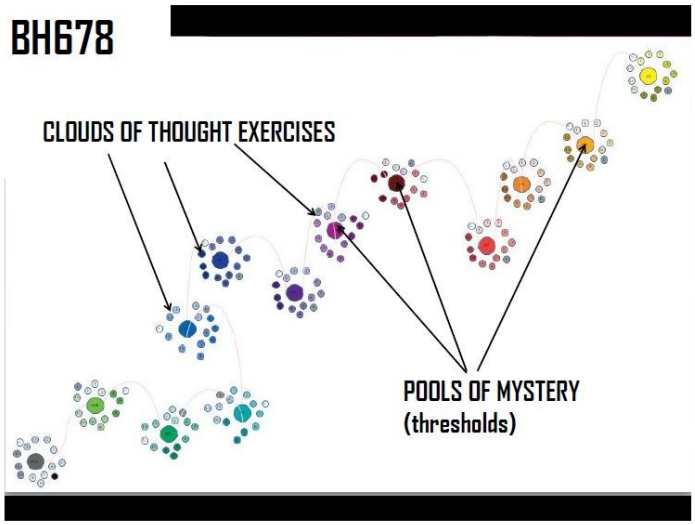

Figure 4 BH678

Teachers are guaranteed the opportunity to create freely thought exercises and to choose which activities to offer their students from the various formations of clouds. On the other hand, students are offered the opportunity to follow their own inclinations, deepening the themes of each threshold through a modular quantity relative to the number of exercises coming from different disciplinary fields. In order to guide the teachers in the construction of thought exercises consistent with the thresholds, an activity sheet and a suggested lecture has been prepared, which serve as an introduction to each threshold of the educational path, while awaiting the composition of a textbook dedicated to BH678.

Following the BH678 path, outlined by the pools of mysteries, we realize that the topics dealt with are usually part of the normal list of contents provided for by the National Guidelines. The BH678 ecosystem eliminates redundancies, and thanks to a collective and holistic assembly, finally manages to put into dialogue the brushstrokes of knowledge, which otherwise would be destined to remain prisoners of their nature of slavery to fragmentation.

Welcome, *skyscraper-Homo sapiens*. Without your boundless vital desire, nothing of BH678 would be possible. So sit at this table, and let's breathe together. I've been waiting for you.

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STEPHEN T. SATKIEWICZ: A History of Energy/Energy in History

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BOOK REVIEW

Smil, Vaclav. 2017. *Energy and Civilization: A History*. Cambridge, MA: The MIT Press.

What is energy? We know Albert Einstein's famous equation E = mc2, but is that all there is to energy? What about the resources that power our modern world such as coal, oil, natural gas, nuclear power, wind, and the sun? It is hardly surprising that concerns about energy, the economic and environmental effects of our use of fossil fuels, the search for sustainable alternatives, and calls for a "Green New Deal" should figure so prominently in contemporary global dialogue. The emergence of the notion of the Anthropocene is born of such concerns, and part and parcel of the big history movement, and it is in these tumultuous circumstances that Vaclav Smil has produced in *Energy and Civilization*, a thorough reworking of his groundbreaking 1993 study, *Energy in World History*, a tour de force of historical scholarship that both describes the close interrelationship between human cultures and their use of energy and provides a useful blueprint for better understanding where our civilization may be heading in the near future.

Smil begins by looking at energy and social complexity (Chapter 1). This is followed by overviews of the various phases of the social evolution of energy: the prehistoric era (Chapter 2), agricultural civilizations (Chapter 3), and early industrialization (Chapter 5), followed by "Fossil-Fueled Civilization" (Chapter 6), and concluding with his take on "Energy in World History" (Chapter 7) that looks at grand patterns, long-term trends, costs, and, significantly, the limits of energy explanations.

Most of the technical work is at the beginning of the book, where Smil discusses in detail energy flows, stores, controls, concepts, measures, and complexities. Here he explains what energy is, what it does, and how it is related to social structures. From there it is a more traditional historical narrative covering the entirety of human history from the Paleolithic era to the present; nonetheless, the author provides sufficient detail throughout in this competent and compelling world history, which should come as no surprise because Smil, Distinguished Professor Emeritus at the University of Manitoba, has published forty books and nearly five hundred papers on a wide variety of interdisciplinary topics in not only the field of energy but also in environmental studies, population change, food production, nutrition, technical innovation, risk assessment, and public policy.

His chapter on traditional farming cultures is one of the most compelling, covering an immense span of time from the Neolithic through ancient civilizations, to the Middle Ages, and then into early industrialization in the latter half of the eighteenth century. In the process, Smil provides considerable comparative analysis of different regions around the world such as ancient Egypt, China, Mesoamerica, Europe, and North America. Such subject matter could fill several volumes, but Smil is able to provide an informative and pithy summary of this vast amount of data that puts it into a useful world history framework, but also a useful big history

one considering the fact that energy flow is so central to the big history story (see especially Eric Chaisson, *Cosmic Evolution: The Rise of Complexity in Nature* (2001) and Fred Spier, *Big History and the Future of Humanity* (2010).

Smil emphasizes that early industrialization was a gradual process but goes on to show that the dependency of modern civilizations on finite fossil fuels at the rate we are using them is unsustainable in the long run. He underlines the severity of the challenge facing humanity, noting that two extreme positions are not viable: 1) a simple rejection of modernity and modern technology (long the dream of romantics and luddites) as well as 2) continuing as before. Noting the high costs of modern civilization is not an indictment of modernity altogether, for even Smil acknowledges that modern civilization has produced many positive qualities, such as "inventiveness, technical advances, gains in the standard of living, expanded information, and instantaneous communication" even though these have also unmistakably been accompanied by "deteriorating environmental quality and worrisome income inequality" (295).

This is the unfortunate paradox of modernity, and again, this book is not a call for turning back the clock and attempting to return to an idealized past period. Rather, Smil is looking for a proper critical assessment of the negative effects of modern civilization to allow for an arena to ponder viable solutions. One of the strengths of Smil's work is that when addressing such questions, he avoids providing simplistic and reductionist analyses or solutions. This is a complex issue and thus requires complex thinking. Smil stresses that there are never easy answers to the challenges facing humanity while at the same time remaining hopeful for the future (417).

The last chapter is the most insightful as the author outlines his overall perspective on the role of energy in human history. There is often the tendency in works such as this to reduce complex historical processes to a single factor, in this case energy, but Smil avoids this and openly critiques such an attempt to explain history without also referring to "non-energy" factors as well (385). Civilizations cannot be defined on purely materialist foundations. Although such factors are, naturally, crucial to our understanding, Smil examines the limits of one-cause analyses, stressing that *how* civilizations choose to use their energy is as important as *what* types of energy resources they use.

An argument can be made that the manner in which civilizations choose different means of using energy resources is mostly related to intangible "mental structures"—religion being the most common example (but not necessarily restricted to that). Smil does not explore this relationship in much depth, but in fairness he does provide ample references to scholars who have tackled the issue in a book that contains over seventy pages of densely packed notes.

It can be said that Smil touches upon so much in this one volume that, unfortunately, he himself cannot delve too deeply into any one topic in greater depth. Nevertheless, this is an important subject for debate not just for historical purposes, but also in regard to current debates on how best to use energy resources is tackling the issue of how prevailing mental structures and paradigms shape how the issue is framed and addressed.

With a wide scope of area to cover in one volume, some mistakes are, of course, inevitable. For example, when summarizing the developments of weapons during World War II, Smil writes that the T-42 was the critical Soviet tank design during the conflict (371), but while the T-42 was a prototype during the 1930s, it was never put into production nor witnessed combat. Rather, it was the T-34 that was the premiere Soviet tank design of the war. Even so, this factual error is minor and does not detract from the strengths of Smil's overall argument.

Smil has gone into further depth in other writings about the interrelationship between energy and war, studies that will be useful to all scholars of modern warfare. In fact, this impressive, encyclopedic volume contains much that will interest scholars in a wide variety of fields as he covers issues related to technology, economics, social complexity, politics, and much more. This demonstrates the great accomplishment Smil has achieved by himself and speaks in general to a particular strength of the big history approach.

ALEX MODDEJONGE: Thirty Years of Big History

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BOOK REVIEW

Christian, D. 2019. *Origin Story: A Big History of Everything*. New York: Little, Brown and Company.

2019 was big year for Big History: it marked three decades since David Christian's inaugural course at Macquarie University. Arriving just in time for the anniversary is Christian's latest work, *Origin Story: A Big History of Everything*. Featuring a splashy endorsement from Bill Gates splashed on the cover, *Origin Story* accomplishes several goals simultaneously. Even reviewers who have criticized the book freely admit that the book amounts to "an impressive act of authorial chutzpah" that deserves admiration (Weiner). If nothing else, *Origin Story* also operates as an extremely effective "short course in modern science" for non-specialists (Wooton). Most obviously, it works as a revision and update of Christian's monumental monograph *Maps of Time: An Introduction to Big History (*2004). Christian inserts a wealth of new findings gleaned from the past fifteen years, specifically in the early chapters on cosmology and biology. For example, Christian notes Einstein's formulation that gravity generated waves of energy was finally validated by the Laser Interferometer Gravitational-Wave Observatory in 2015. He, likewise, cites a 2017 discovery from Northern Quebec, which suggests life might have appeared on Earth as early as 4.2 billion years ago.

This tantalizing possibility seems to have compelled Christian to reconfigure the Big History narrative slightly. In *Maps*, the Earth's geological processes are described prior to the appearance of life. However, the suggestion that life sprang up several hundred million years earlier than previously believed has pressed Christian to look at geology as potential *generator* of the first organisms. For this reason, he opts to depict geology as an adjunct to his chapters on biology rather than planet-formation. It is a subtle but important shift that helps develop the Big History narrative toward true cross-disciplinary integration—assuming it can be verified.

Beyond updating the narrative, *Origin Story* also works a distillation Big History for readers of popular non-fiction. Like a film script that successfully compresses characters and plot development, the shorter breadth of this volume allows Christian the opportunity to pare down the manuscript of *Maps* to a comparatively breezy 357 pages (including endnotes and index). Gone, too, are the many tables, timelines, and maps that populate the previous book. Out as well are Christian's detailed appendices on dating techniques and an examination of order vs. chaos. In their place is a two-page timeline, one page of statistics on human history, and a helpful glossary of Big History terms. As a work of simplicity, *Origin Story* also succeeds as an update on the late Cynthia Stokes Brown's *Big History: From the Big Bang to the Present* (2007) in terms of offering a comparatively straight-forward crash course on the subject for beginners.

On a conceptual basis, *Origin Story* continues Christian's use of the principle of *emergence* in complex structures as basic historical thresholds. These thresholds in turn serve as chapter breaks that separate the Big History narrative into ma-

nageable chunks. Christian identifies nine, starting with the Big Bang and ending with an as-yet-unrealized sustainable world order. In defining these thresholds, Christian also deploys his metaphor of scales, comparing phenomena at one scale to another. For instance, he points out that densely populated villages resembled the same "clumps of matter" out of which early stars were formed. At another point Christian describes how the Mesopotamian elite pumped wealth into new urban areas through a mix of persuasion and coercion of their peasant populations, "like the proton pumps that maintain an energy gradient across cell membranes…" (221). Later, he playfully describes Fritz Haber and Carl Bosch as "the first multicellular organisms to successfully fix atmospheric nitrogen" (264). One interesting comparison that Christian does not make is between human history and the overall history of life. He might have pointed out that only a tiny sliver of human history comprises the agrarian and industrial eras, just as only a small percentage of the history of life encompasses the era of multicellular, big life. Such a comparison would reinforce one of the general themes in *Origin Story*: that simple structures *endure* more successfully than complex structures.

Christian employs other literary devices worth noting, including the use of vivid tableaux to illustrate his themes. One is that of orbiting aliens as silent witnesses to the complex changes on planet Earth. Christian, making either a conscious or unconscious nod to the god-like extraterrestrials of *2001* or the Tralfamadorians of *Slaughterhouse Five*, uses these silent sentinels to speculate on the seeming randomness of many historical events—of which the appearance of humankind in the biosphere and its eventual domination over said biosphere is perhaps the most unexpected outcome of all.

Otherwise, Christian continues the Bill Bryson -method of sprinkling in scientific anecdotes to flavor some of the drier scientific discoveries that inform the pre-human narrative. Who can think about the discovery of cosmic microwave background radiation (CMBR) without remembering the pigeons roosting in the antenna at Bell Labs? Sadly, this motif does not carry over to the chapters on human history. To create a more coherent hyper-narrative, it might have been helpful to describe some of the schools of historical thought that he relied on to tell the story of agrarian and industrial civilizations. Without similar examples, the Big History narrative runs the risk of sounding like received knowledge rather than formulated wisdom. A bibliographic appendix the historiography would have been a useful addition.

Now for a few minor issues regarding conceptualization. As compressed as Christian has made Big History, he still spends an inordinate amount of time (an entire chapter!) on the origins of farming and another chapter on pre-modern agrarian civilizations. (*Maps* also contains a chapter devoted solely to the advent of agriculture.) A single chapter on both phenomena would have made the work even more concise, in the same way he integrated geology and biology. In his chapter on the future, Christian has likewise dropped the Rapa Nui as the this-island-earth metaphor used in *Maps*. Instead, he discusses the relative merits of the Good and Bad Anthropocene, and how to preserve the former while phasing out the destructive features of the latter. This section is more didactic and less vivid than the historical example of Easter Island. The reason Christian jettisoned it is likely due to historical controversy about the demographic collapse of the island's native inhabitants. The caravan metaphor used to describe individual humans' lives in introduction to *Maps* has also been replaced by a cavalcade in *Origin Story* but serves the same function.

Another rhetorical device that bears examination is Christian's tendency to anthropomorphize the aspects of the universe. *Heat energy*, for example, is described as a "drunken traffic cop" who "directs energy every which way and creates chaos" (42). For this reason, Big History terms like complexity and entropy are transformed into almost godlike entities imbued with human characteristics. While Christian the writer should be praised for making his history lively, the choice in writing style runs the risk of turning physical phenomena into cosmic entities in the minds of general readers.

At the same time, Christian chooses numerous descriptive nouns with dubious connotations, particularly when it comes to human activities and institutions. For instance, the first Sumerian city-state, Uruk, is referred to as a "monster" and the spread of farming across Eurasia as a "virus" (a debatable characterization since farming also emerged independently in many other areas of the world). Again, this is likely done to make the text more relatable and entertaining to casual readers. However, the choice of these *types* of words make it hard for said readers to come away from *Origin Story* without the view that farming, urbanization, and finally industrialization were all net *negatives* due to their effect on the biosphere and the quality of human life.

Perhaps, the most important matter is the *intent* of Big History as conceptualized by Christian. The quasi-religious theme of creation myths in *Maps* has been traded in for the quasi-storytelling theme of *Origins*. No doubt, this came as a result of criticism Christian received for the seemingly contradictory endeavor of rendering a scientific history in mythological terms. However, replacing creation myths with origin stories accomplishes almost nothing new conceptually because the two are essentially interchangeable in the way Christian describes them. Though Christian insists that "like all origin stories," Big History "will never lose a sense of mystery and awe," the scientific neutrality of *Origin Story* would seem to preclude this (Christian 10). *Eliminating* the mystery and eschatology—themselves remnants of the premodern, pre-Enlightenment human conceptions of reality—should be the *entire* point of the Big History project. On a purely psychological level, *Origin Story* aims at mitigating "the sense of disorientation, division, and directionlessness . . . everywhere in today's world" (8). Christian thus sets up Big History as the answer to modern humanity's malaise and ennui. Even if there is a gap to be filled, is that the purpose of Big History or simply a by-product of it?

Historian David Wooten, whom Christian cites in his text, has criticized *Origin Story* on slightly different grounds. While Wooten concedes that humans' desire an origin story, he believes Christian "makes a basic error" in the way he uses the concept. "We crave origin stories because we want to know that our existence has meaning. But the story Mr. Christian tells us is one that shows our existence to be without any meaning at all" (Wooton). Another reviewer has reinforced this critique, noting that the power of creation myths is that they "supply meaning in an otherwise meaningless universe, even if they fall short on facts" (Weiner). What these critics seem to be ignoring is that the implied meaning inherent in complexity theory does elevate the human experience. This is what is suggested by Christian's assertion that the Big History project represents the universe "slowly opening an eye after a long sleep" (5). While this is yet another anthropomorphic description, this time it is thoroughly appropriate. If the eye is opening, it is because of humankind. In other words, humanity *is* the eye.

In the search for a meaning (or at least a moral order) Christian has latched on to the centrality of environmentalism. In Christian's narrative, humanity is important in as much as it acts as responsible custodians of the biosphere. How humanity acts in the short-term future in relation to the environment is referred to as "the quest." The quest is the meaning that can be derived from the universe opening its eye and only the scale of Big History can help "prepare us for the huge challenges and opportunities that all of us face at this pivotal movement in the history of planet earth" (10). The goal of the quest is to avoid an environmental crash since "there is no good place for humans in a ruined biosphere" (290). Christian describes the lofty goals set forth in the 2015 United Nations document "Transforming Our World" as the next step in this journey. Reaching back to the play of scales, the author hopes humanity will imitate the sun and "settle into a period of dynamic stability" (Christian 294). He notes, however, that such an outcome "will depend to some extent on how well and how persuasively people can describe the quest itself" (300). In other words, it depends upon how successful the Big History project is in seeping into the public psyche in order to influence policy designs.

The sustainability argument is augmented by quotes from figures of the Western intelligentsia

as diverse as John Stuart Mill and Robert Kennedy, both of whom made comments supporting what became fashionably known in the 1970s as "limits to growth." The pervasive thought patterns of that decade, including concerns of unchecked population growth and environmental degradation, have inextricably shaped Christian's worldview and inform his approach to Big History in the twenty-first century. The potential problem is that this may reduce Big History to a political talking point—one that appeals less to Lagos and Mumbai, and more to Davos and Berkeley. As Christian notes in his introduction, "Many of the pieces of our origin story fell into place during my lifetime" (4). This makes the Big History narrative a story as much about its author as about the universe itself.

In considering the future, Christian refers to the present global environmental situation as "the slow-motion time of a near accident." He also asserts that humanity is "now managing an entire biosphere, and we can do it well or badly" (289). As with the spiritual and psychological need for Big History, this assertion must be met with a dash of cynicism. While we are certainly influencing the biosphere more than any other organism, are humans exerting more power than, say, plate tectonics? Even if this were the case, there is a vast difference between influence and management. Then the larger question becomes whether the goal of humanity is to survive as a species or sustain the biosphere. Christian believes the two are inextricably intertwined. One might just as easily argue that a better quest could be a longer-range goal that allows humans to escape the confines of the biosphere via accelerated technological advances in transhumanism or space travel.

Christian's sustainability ethos is also characterized in his continuing romance with paleolithic human societies. In addition to recycling Marshall Sahlins' the original affluent society thesis concerning foragers, Christian depicts them as living in relative harmony with the natural world. However, this image is directly contradicted by practices such as big game hunting and firestick farming, both of which Christian details. Despite this, in his concluding chapter on the future, Christian states "What it means to live richly and dynamically in a less changeable world is preserved within the cultures of many modern indigenous communities whose people see themselves primarily as custodians of a world larger and older than themselves" (294). While this reinforces the cyclical appeal of Big History as something that reaches back into the deep past of the human imagination, to what extent can foraging societies really inform of a world of 7.8 billon people about sustainability?

Another contradiction comes in the introduction, where Christian argues that "[w]e should not make the mistake of assuming that complex things are necessarily better than simple things" (11). However, in the universe described by Big History, greater complexity is always going to be inherently more relevant and more interesting. Without increasing complexity there would be no historical development. Christian also asserts a potentially misplaced belief that "accelerating change" will lead inevitably to a "catastrophic explosion –the human equivalent, perhaps, of a supernova" (300). One could just as easily argue that the "goal" of humanity should be to increase complexity in the universe (contra entropy) rather than top it off. While it is true that the modern revolution has provided "a growing awareness that we humans share a common fate on our one home, planet Earth" (299), it is not inevitable that we shackle ourselves to such a fate. In any event, attempting to "manage" such a future seems unlikely, considering our past. Wooten takes this even further, concluding that Christian's project is "a futile enterprise. His origin story does not give meaning to our lives; and his environmentalism is based on incorrigible wishful thinking, on the belief that we can come to behave like a close-knit, well-intentioned, rational community—all history suggests that this will never happen" (Wooton).

Christian describes Big History as "the first origin story to embrace human societies and cultures from around the world" (x). Later he insists it "has been built not by a particular region or culture but by a global community of more than seven billion people, so it pools knowledge from all parts of the world" (9). However, these claims are

contradicted by the admission that Big History emerged from the "dynamic and potentially destabilizing tendencies of modern capitalism" (10). Big History is thus an outgrowth of what used to be referred to as Western Civ., and yet one of Christian's most powerful images is his imagined scene of ancient Australian aboriginals exchanging origin/creation stories around the campfire. This works as a stand-in for the potential unification of humanity itself through the unification of knowledge. This is a powerful and important message, particularly in the hyper-partisan atmosphere of today's world. Liberals and conservatives do not merely disagree on the issues: they disagree on the nature of reality itself. An apolitical, truly global Big History can have the potential to bridge this divide. If Big History is to grow, it *must*.

Ultimately, the Big History narrative still exhibits many gaps in what science can adequately explain about the roots of complex structures. As Weiner notes, *Origin Story* "contains plenty of mystery. . . on a cosmic scale." Perhaps there is still too much mystery. He asks, "Why does the universe contain any structure at all and not just a random flux of energy? Why did the agrarian revolution erupt almost simultaneously in places separated by thousands of miles?" (Weiner) The precise origins of life on Earth and collective learning in *Homo sapiens* remain unclear. Christian reasons that life is the natural outcome of complex chemical reactions and suggests viruses as a possible link, but this is only informed speculation. The reason the Big Bang occurred is even more inscrutable and perhaps unknowable. In order to try to offer an explanation, Christian ends *Origin Story* by alluding to the multiverse, a concept that at this point is still pseudo-scientific speculation. It would be easier to say "We don't know," but that would also be far less satisfying.

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