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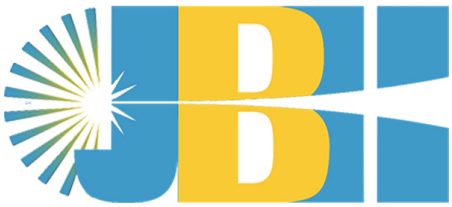

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From the Editor

Welcome to our fourth year. It may well prove to be a momentous one, as it has been in the past. 2020 will mark the 75th anniversary of the end of WWII, the 100th anniversary of the ratification of the Treaty of Versailles, the 100th anniversary of the Nineteenth Amendment, the 250th anniversary of the Boston Massacre, 400 years since the Mayflower sailed, 500 years since Magellan and his crew crossed from the Atlantic into the Pacific, and the 2500th anniversary of the Battle of Thermopylae. This reminds us that it is important to think about the past at various temporal scales—but it holds other lessons as well.

It reminds us, for one, that we are unable to mark anniversaries of events that occurred prior to the invention of writing. So what's missing from this list is as significant as what's included. It reminds us, too, that lists are culturally-constructed, and that from a big history perspective, much has been left out, both on a geographic scale, and also concerning subject-matter, which henceforth shall be known as the "scale of interdisciplinarity." Thus it behooves us to recall that 2020 also marks the 100th anniversary of the publication of *The Outline of History* by H. G. Wells and *The Age of Innocence* by Edith Wharton, 200 years since Hans Christian Ørsted discovered electromagnetism, 400 years since Francis Bacon published *Novum Organum*, and 800 years since the birth of Robert Grossteste, who many consider the father of the scientific method. It is also, I will have you know, the 400th anniversary of the end of the Wanli period (1573 -1620) of the Ming dynasty, the 1000th anniversary of the death of the Persian poet Abū al-Qāsim Firdawsī, 1250 years since the death of Tang dynasty poet Du Fu, and 2750 years since Piye succeeded his father, Kashta, as ruler of the Nubian kingdom of Napata.

This edition of the *Journal of Big History* cuts across time, distance, size and discipline in a manner befitting our mission. Daniel Barreiros, Bioethics and Applied Ethics Center, Universidade Federal do Rio de Janeiro (UFRJ), and Daniel Vainfas, PhD Student at the Institute of Economics (UFRJ), examine temporal scales as they apply to the history and theory of warfare. Specifically, they use the science of ethology to reevaluate the idea that war is a continuation of politics by other means and the belief in a universal "warrior culture." It is an excellent example of how research can be undertaken in big history, in this case, to completely overturn models of warfare that have been all but canonized. Another Brazilian scholar, Tatiana de Freitas Massuno, Postdoctoral Fellow, Philosophy Department, Pontifícia Universidade Católica do Rio de Janeiro (PUC- Rio), deploys literature to have at questions of genetic engineering, transhumanism, ecological awareness, and what she calls the "good Anthropocene" in the novel *Oryx and Crake* (2003) by Margaret Atwood. We are happy to be able to publish as well a Portuguese translation of this article that Dr. Massuno has prepared for us.

Marilyn Ahearn, Sustainability, Environment and the Arts in Education (SEAE) Research Cluster, Southern Cross University, Australia, offers this edition's research on the pedagogy of big history. Her article is based upon a workshop that Dr. Hearn presented at the 2018 International Big History Association (IBHA) conference at Villanova. Her focus is the impact of a 17-week big history program on 8-9 year old students and their teacher. From the Environmental Science Division of the Argonne National Laboratory (University of Chicago, Lemont, Illinois), David J. LePoire, in work supported by the U.S. Department of Energy, shows us how size scales ranging from the atomic nucleus to the universe can be estimated with only a few fundamental physics constants. It is stunning to learn that nine of the fundamental distances that we discuss in big history relate to one another by the same factor of 150,000. Our final essay has been written by IBHA Board Member Barry Wood, University of Houston, who brings geology, biology, and paleontology to bear on the four -billion-year story of the making of India.

David R. Blanks

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Articles

Book Reviews

Clausewitz, Keegan, and the Big History of Warfare

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Abstract

As a social phenomenon, is war subordinate to politics, as Carl von Clausewitz argued in the early nineteenth century, or, instead, is it the product of an instinctive 'warrior culture', common to all peoples and times and beyond politics, as John Keegan suggested in the late twentieth? Should we emphasize 'essential historical elements in the search for a temporal continuum in warfare? In this article, we stress the relevance of the 'perennity of war' thesis, and the impropriety of a dichotomy between political rationality vs. instinct. The results of the clash between these two strands of thought about the origins of warfare face limitations due to the absence of a temporal 'play of scales', so that short-term approaches emerge as incompatible with macro-historical views. We suggest that a deep understanding of the phenomenon of warfare must consider the interaction and the feedback between processes at different time scales.

Introduction

If war (in general) is the "father of all things" as said by Heraclitus, the Wars of the French Revolution were the parents of the modern theory of coalitional violence. Carl von Clausewitz, the man behind the most notorious incursion of the Enlightenment in the rational explanation of war, served in the Prussian army during the Rhine Campaigns of 1793-1794, went through defeat and humiliation at the hands of the French army in Jena (1806), fought alongside the Russians in Borodino (1812) after Prussia's surrender, and paved the way for the Sixth Coalition that would bring down the Grande Armée and its allies in 1814. His wartime reflections and experiences gave birth to a treatise on modern warfare published posthumously in 1832, named Vom Kriege (On War), that influenced world leaders like Bismarck, Moltke, Lenin, Eisenhower, and Mao Zedong among others. On War became the cornerstone of military strategic thinking in the twentieth century and is still praised as one of the most important works on the subject. Of all topics addressed by Clausewitz, the idea that warfare is a rational endeavor caught the attention of many critics, especially after the carnage of two world wars. Naturally, Clausewitz was not trying to sugarcoat the nature of his métier, and in spite of the fact that he spent most of his military career away from the frontline, he was very aware of the fact that real combat is engulfed in a storm of emotions, instincts, and somatization. So, what On War teaches is that coalitional violence is chaotic and dreadful but is nevertheless a rational instrument in the hands of human collectives (modern states, in this case) in their dispute over scarce resources. When conflict resolution fails, Clausewitz says, a state is able to employ organized violence as a technique, as social engineering, a means to obtain desired ends. From the viewpoint of the strategist, war is just like chess, and that is the way it should be if it is to be conducted in a "civilized" and "rational" manner (different from the "savages" overwhelmed by the lack of organization and primitive motives and methods). In the Clausewitzian tradition, war is a continuation of politics, and that is the point where a long debate begins.

John Keegan, a British military historian who never faced live rounds—actually, he was considered unfit for duty in the armed forces due to a medical condition in 1952—was brave enough to dig deeper into the nature of warfare. He dismisses all "well-behaved" and historically shallow concepts of organized violence in favor of a framework that shows the

lines of continuation between warfare among non-state and state actors. Evoking the idea of a "warrior culture" ubiquitous to all mankind, Keegan emphasizes the social function of warfare in terms of group cohesion, coordination, and identity and stratification, rather than the instrumental aspects so dear to the Clausewitzians. A conceptual debate was formed around these positions, but the aim of this article is not to take sides. Instead, our purpose is to suggest that this debate is tainted by its inability to grasp with the "play of scales" as conceived by David Christian (2005, 2018); if we "scale up" our look into human experience employing critical insights obtained from primatological, ethological, and archaeological studies, we can find enough common ground between Keeganian and Clausewitizian traditions.

In *A History of Warfare* (1994), Keegan argues that warfare should not be understood as a continuation of politics, as stated in the Clausewitzian tradition, but rather as a cultural phenomenon, a product of the collective practices adopted by a particular group or society. Thinking of warfare as a cultural product would open the possibility, according to Keegan, of escaping the artificial restrictions imposed by Clausewitz that bound warfare to human rational mind and particularly to state rationality. In this way, to formulate a theory of warfare that would explain its existence throughout the history of humankind would be possible. Although the concept of culture is broader than the concept of politics and although Keegan's assertion gives us a wider understanding of warfare, it is still necessary to consider the ideas of Clausewitz about what constitutes the political phenomenon and contrast them with the definition given by Keegan since the controversy between these two authors is substantial enough to demand caution in the use of their concepts.

Keegan's concept of culture is interchangeable with a loose concept of human nature. He claims that the major cause of warfare is "warrior culture" and recognizes its universality among societies (Keegan 1994); in other words, there seems to be more than enough space for us to identify a possible overlap between that object (culture) and an innate behavioral framework in *Homo sapiens*.

> Warfare is almost as old as man himself, and reaches into the most secret places of the human heart, places where self dissolves rational purpose, where pride reigns, where emotion is paramount, where instinct is king. (Keegan 1994, 3)

Keegan's assertion is quite interesting as it situates warfare as a phenomenon present in the very beginning of human natural history and, therefore, as a structural component of the social history of all human groups since Paleolithic times. In doing so, Keegan must determine a main cause for warfare that must also be transcendent in time; this procedure puts his ideas on a collision course with the Clausewitzian tradition, which places politics (and warfare, by definition) in the list of phenomena determined by human "rationality." By stating that "instinct is king" and invoking its biological dimension, Keegan conceives culture as something beyond or even opposed to politics (in its state and formal dimensions). Nevertheless, Keegan does not insist upon bringing up the concept of instinct in its plain colors, opting for a more generic element, easier accepted by his interlocutors: something like a "human warrior culture" with local tones but a universal hue (Keegan 1994, xvi), in opposition to a supposed misuse of the Clausewitzian "war as politics" assertion. Keegan suggests that Clausewitz's original statement tends to be inaccurately translated. Better than affirming that warfare is the continuation of politics by other means would be saying that warfare is the continuation of political interactions with the *participation* of other means (Keegan 1994, 3). Consequentially, a duality emerges in a Keeganian reading of Clausewitz: on the one hand, politics, and on the other, the so called 'other means'; the undefined second element in the dyad definitely paves the way for theoretical exploration.

Warfare, therefore, is not a monolithic phenomenon since it carries a fundamental opposition in its core; if, in broad terms, this opposition is formed by a well-defined element (politics) and a somewhat amorphous element (the "other means"), it happens to transcend its very object (warfare), enabling us to bring into the debate the general ontological structure of the human psyche. This structure also consists in an opposition between elements with different levels of definability (conscious vs. unconscious mind), and we are convinced that it is not a mere product of analogy. In short, warfare appears as a holistic phenomenon, integrating not only the dimensions of conscious decision and rational action as a means to an end but also of the complex interaction between culture, society, and deep psychology.

That Keegan tries to break the duality that lies in his theoretical and interpretative framework by replacing the causes of warfare with a general notion of culture is true. The 'military culture', in particular, would be that privileged environment in which the "tribal spell" would happen and where the contingencies of civilization would be dissolved in a so-called 'ancestral urgency' (Herberg-Rothe 2001, 183-184). The most interesting aspect in this formulation is in the fact that it comes to us as essentially misleading in its definitional roots.

Keegan defends the primacy of "culture" from an analytical and theoretical standpoint where the very notion of culture should be dissolved. Instinctive urgency ("where instinct is king") and the "tribal spell" are not specific cultural elements; actually, they refer to a set of ancient psychic mobilizations present in all human groups. The "culture of the warriors," which is the key element of Keegan's argument, is not properly cultural; on the contrary, it is clearly a pre-cultural element, which must precede the symbolic, representational, idiosyncratic and historical dimensions. In his eagerness to overcome the notion

of warfare as policy, Keegan not only ends up entering the minefield of the "natural" explanation of the collective and organized intersocietal violence but also offers an understanding of "politics" in Clausewitz that flirts intensely with contradictions.

Keegan's understanding of "politics" in Clausewitz's work is quite controversial because it tends to equate "politics" with "policy," the latter referring to a rational construction, an adequacy of means to ends, particularly the improvement of human wellbeing. On the other hand, Clausewitz used the German term *Politik* with a two-fold meaning, invoking simultaneously the notion of policy and of politics. "Politics" in this sense involves a degree of conflict and non-rationality that is absent from Keegan's construction. Warfare, then, can be violent, barbaric, and cruel and still be "political" to the extent that it deals with divergences between distinct political groups (Bassford 1994, 326-327). Certainly the conversation between Clausewitz and Keegan is disturbed by the simple reason that they both name distinct processes (in whole or in part) the same. In spite of that, two important notions seem to survive this struggle: (1) that the universal character of the warrior culture feedbacks with (Keegan would say, "determines") politics as a social organizational phenomenon, as Bassford (1994, 333) suggests; and (2) that, in Keegan's work, the warrior culture as a concept refers to a phenomenon that does not behave as a manifestation of the social and intellectual history, but rather as an aspect of human cognitive dynamics that informs every kind of culture.

C. S. Gray takes the theme of human nature to criticize Keegan and defend Clausewitz, bringing up the idea of the "common thread of the human factor" (Gray 1999, 164). That common thread would represent a problematic and controversial "proclivity to combat" and a "will to fight" (Gray 1999, 176, 181). If it is true that something like a "human nature" exists, sustained across the evolutionary time in spite of technical and cultural changes, then we could be able to formulate questions beyond short-term transformations. The fundamental problem would be to recognize what *nature* is in order to formulate the theory with the best possible result. Clausewitz's hypothesis of "structuring rationality", i.e., the notion that every war has or must have a political purpose (Gray 1999, 169), is not enough though it seems to be true in its own way. The strength of the structuring rationality hypothesis lies in the notion that politics (in all its dimensions) is steady enough to function as a catalyst to the congregation of individuals with different and (most of the time) colliding agendas, leading to the cooperation necessary to make warfare possible. In essence, politics, as behavior, is related to major structuring myths in the core of our social and cultural life as *H. sapiens*:

> Any large-scale human cooperation—whether a modern state, a medieval church, an ancient city or an archaic tribe—is rooted in common myths that exist only in people's collective imagination (. . .). States are rooted in common national myths (. . .). Yet none of these things exists outside the stories that people invent and tell one another (Harari 2015, 36).

The existence of different myths is such a problem that a complete theory must investigate the birth of myths and macro-narratives rather than the social consequences of a particular narrative. To accomplish this, we have to venture into the Big History of human evolution to de-authorize unilateral readings of Clausewitz and of Keegan. A Big History of warfare that seeks to recognize the dialectical interaction between phenomena occurring at different timescales, from the *événementielle* to the evolutionary, would consider pointless the opposition between the instinctive "warrior culture" and the "rational enterprise." Rather, the conceptual dyad formed by the "instinctual" and the "rational" aspects of warfare behavior sheds light on the very nature of the mind of *H. sapiens*.

Keegan's belief that warfare belongs to a set of social phenomena endowed with a certain universality finds macro-historical support, albeit not without controversy. If some contemporary hunter-gatherer societies that do not undertake intersocietal coalitional violence exist, it is not uncommon to identify in their past (when this is ethnologically possible) evidence of engagement in conflicts with neighboring groups or with regular military forces, which ultimately resulted in demographic, political, and economic fragility (so that much of the hunter-gatherer pacifism can be associated with "defeated societies") (Keeley 1996, 31-32). All other societies display some sort of military cultural practices that interact dialectically with religious, ideological, mythological, and political representations. Thus, the existence of something like "warrior tendencies" in a transcivilizational level seems plausible. Nevertheless, as we shall see, the notion that intersocietal violence is the result of some innate psychological impulse dedicated exclusively to this purpose (i.e., lethal action against other social groups) is based on very fragile evolutionary foundations, often associated with discussions about human nature that are tributary to the western political philosophy of the 17th and 18th centuries (Hobbes vs. Rousseau, especially). In the same tune, Keegan's proposition that the "warrior culture" is the ultimate reason why warfare exists does not lead us farther from the clash between *doves* and *hawks* since Keegan suggests that intersocietal coalitional violence is the product of some "active principle" of human cognition, whose nature and function are to promote conflict.

Prosocial cognition: construction of the ingroup

The cognitive foundations of intersocietal coalition violence belong not to any active ethological complex in favor of warfare but to the failure of the dedicated and highly specialized modular social intelligence, built by

natural selection in a very long evolutionary history that traces back to the last common ancestor between chimpanzees and modern humans six million years in the past. Intersocietal coalitional violence, i.e., the result of processes and phenomena related to the organization of social sub-units dedicated to the exercise of power over other groups, based on the imposition (or threat) of lethal action, is quite rare in primatological terms. Among extant great apes, only modern humans and common chimpanzees have a behavioral portfolio consistent with the practice of warfare. We have no reason to reject the hypothesis that all the species that descended from the last common ancestor of *Homo* and *Pan* also engaged in intersocietal coalitional violence, even though our ability to trace evidence of this type of practice in the fossil record is restricted by taphonomic reasons and by the dubiousness in the identification of osteological markers of lethal violence

We have no evidence of warfare—in a broad sense—in any other primate lineages, extant or extinct, and in this respect, we should not be surprised. Organized lethal aggression toward other social groups emerged as a functional byproduct of the specific form assumed by socioethological structures emerged six million years in the past among species split from the LCA social structure that, in its more specific aspects, was another very rare condition in the primatological universe.

Two were the most likely conditions of sociability among the many species of great apes by the time of the LCA speciation. The first, older and more common, consisted of permanent kin-related female matrilineal collectives, accompanied by unstable and uncooperative non-kin groups of males (migrant individuals in volatile groups). The second one also relied on kin-related female cooperation, but associated with the exercise of strict dominance in male-male relations, with the formation of harems (with vast inequality in the distribution of copulatory opportunities among males). To think of social organization on a macro-historical scale and beyond modern human societies requires taking into account the challenges represented by the energetic needs of females in eutherian and mammal species. Females suffer a great amount of ethological pressure for accessing food resources with the highest possible nutritional value, since the costs of lactation and of a relatively long intrauterine pregnancy are far from negligible. From this evolutionary standpoint, we understand the formation (behaviorally innate) of permanent kin-related female matrilineal collectives, based on cooperative relations aimed at guaranteeing mutual energy needs in the genetic community (Foley 2003, 220; Nordhausen and Oliveira Filho 2015, 36).

Territoriality is shaped by the foraging strategies of female collectives, so males follow female groups and compete for reproductive opportunities among themselves, with intense interpersonal agonistic behavior. In species that ethologically form one-male groups, an alpha-male will strive to deny copulatory opportunities to his rivals through violence and intimidation; these primate societies are more prone to agonism and show higher levels of sexual dimorphism (morphological and behavioral differences between males and females, including body mass, temperament and behavior, canine morphology, and muscle mass) and fewer opportunities for male cooperation. In cognitive terms, intricate forms of social intelligence, with innate modules dedicated to conflict management, manifest among many of these species in both of the situations. Nevertheless, given that social relations in male groups are mostly transient, fight-or-flight behavior is highly functional and relevant so that retreat and migration to other groups can be a sufficient strategy for a male eventually confronted by an overwhelming force (Foley 2003, 223-224; Wrangham and Peterson 1996, 131).

An ecological change in habitats occupied by certain species of great apes may have led some populations to large scale migrations and others to a slow adaptation to the new context. The gradual savannization of East Africa and part of Central Africa advanced along the Cenozoic and met a critical point in the Late Miocene for most of the great apes around eight to six million years in the past. For the species that resisted in these savannized habitats, heterogeneity in the distribution of natural resources and the decrease in its average nutritional value began to take its toll, requiring adaptive responses. The rarefaction of resources in the territory would have jeopardized the strategy of kin-related female cooperation; the dispersion of resources and the lower energy value stored in each patch of bushland or woods would have led these kin-related groups to be threatened by internal competition, rendering most of the win-win strategies replicated ethologically up to that point ineffective. Avoiding internal competition would mean, to these female apes, spreading through the landscape, driving cooperative behavior to sub-optimal levels of efficiency. In this evolutionary context, kin-related matrilineal sociability is disfavored, and female migration to other groups as they reach sexual maturity becomes a pattern of behavior gradually fixed by natural selection in these species. This means, for females, that disputing resources that are more distant as possible from one's maternal genetic community renders more reproductive gains (in the evolutionary long run) than staying in natal groups. For males, this ethological change in female behavior could have led to the emergence of patrilineal kin -related cooperation, an exotic type of sociability (Aureli et al. 2008, 629-630; Foley 2008, 230).

Male patrilineal collectives, in association with non-kin female groups, would potentially create a problem: how the access to reproductive opportunities could be regulated and how a win-win strategy could be sustained in order to keep permanent cooperation behavior among males in the genetic community. As we have seen, the most common ethological strategies in other contexts were either the intensification of interper-

sonal male conflict with high lethality risks or the migration to other groups. Patrilineal male cooperation denies these two strategies since the former jeopardizes a more balanced distribution of gains in terms of evolutionary fitness, and the latter dissolves male stable sociability itself. Of course, there is no reason to disregard the fact that climatic aggravation and its impacts on African ecosystems could have made, hypothetically (other factors excluded), permanent societies of great apes in the arid zones unlikely. However, gregariousness and cooperation are evolutionary assets that, once conquered, have the tendency to survive even major evolutionary bottlenecks (Shultz, Opie and Atkinson 2011, 222; Wrangham and Peterson 1996, 128; 186).

Speaking of environmental pressure, for the great apes, savannization resulted in the fragmentation of resources (and females) across the territory, making one-male social groups quite difficult to maintain, if not impossible to exist. Broadly speaking, surveillance by an alpha male in order to hinder the incursion of rival males had become unlikely, and the evolutionary opportunity was open for the cooperation between kin-related males in the control of the territory and its resources. These coalitions act to prevent access to the group females by any *outsider* male. For cooperation to work, so that the dispute between individual reproductive agendas does not produce fractures in the kin collective, a specialized and ethological social intelligence emerges, exclusively devoted to process social information, in order to operate a dynamic hierarchy of status. This socio-cognitive domain should operate the norms and forms of dispute for higher ranks and produce prosocial limits that buffer against lethal outcomes in internal conflict.

Social intelligence, differently from general intelligence, is not based on the application of simple and standardized learning rules, generating cumulative and modified content based on interaction with the environment, but on trial and error. Social cognition has the following characteristics: (1) an increased dedication and speed of processing information that allow for the prediction of the status rank actually possessed by others through the analysis of sensorial cues and through the recall of past interactions; (2) the formulation of hypotheses about the behavior of conspecifics in a given social interaction, involving or not the observer; and (3) the designing of strategies for climbing status ranks or preserving a current rank, employing alliances and coalitions with conspecifics dedicated to the same objective. Social cognition forms, thus, an innate political ethology, present in common chimpanzees and also in the evolutionary lineage of *H. sapiens* (Aureli et al. 2008, 632; Mithen 2002, 129-131; Wrangham and Peterson 1996, 128, 186).

The ethological rite in the struggle for status among common chimpanzees in a social group follows some elementary principles, identified and thus interpreted from the observation of these primates in their natural environment (Mithen 2002; Wrangham and Peterson 1996):

The prospect of a stable dominance maintained basically through force, as occurs with gorillas, is discarded so that status relations are organized into fluid networks of power with unstable alliances between males and between females (more intense among the first); the rise and fall in hierarchy indicate that social mobility is a very important ethological aspect in the species split from the LCA, six million years in the past.

The rise and fall in the status pyramid, although part of a win-win strategy in the long run (as a prosocial mechanism that helps to prevent the dissolution of the society), in the short run results in a zero-sum game in which the gain of one is the loss of another.

Males will confront other males in an intricate dynamic of coalition formation, involving the intimidation of adversaries and their allies, and the conquest of crescent support from the group members. This growing support is expressed by the longer social time spent by a contestant with his supporters (involving grooming and other forms of recreation and/or strengthening of social bonds). In this case, the ascension of a competitor brings non-linear status gains to all members of his coalition;

The "ritualistic" dimension (*lato sensu*, devoid of the symbolic nature present in the culture of modern humans) is a crucial aspect of disputes of status because it provides rapid sensorial information to the social cognitive mechanisms. The cycles of dispute involve precisely the violation of expected social behaviors that, when in practice, indicate the recognition of the status of a third party. A common chimpanzee bends down before a higher rank conspecific, permits being touched on the shoulder, etc., as forms of status signaling. Denying these 'courtesies' on a regular basis means conflict.

Status disputes indirectly involve most of the group, and their cycles are concluded through the establishment of a "consensus", insofar as the majority of the members of the social group converge in support of a certain competitor and his allies. From this point, gains and losses are recognized, submission/dominance signaling in form of gesticulations and vocalizations are performed, and life goes on until a new contest begins.

Outgroups and coalitional violence

The prosocial ethology in chimpanzees (and presumably in the LCA) is not fail-safe. Fluid but effective limits persist in the average volume of social information that can be processed cumulatively. Thus, although composed of dedicated and specialized mental modules, social cognitive activity has a significant correlation with the neocortical volume, and both have as proxy the time spent in grooming and other forms of recreation necessary for the renewal of social bonds and for the reaffirmation of hierarchies. This means that when the number of relationships to be pro-

cessed exceeds a certain limit (variable according to encephalization, in each species), the volume of sensory information to be detected and analyzed, as well as the number of possible combinations of relationships involving two or more individuals, surpasses the power of mental processing, making cooperation and coordination less viable. In this context, the identification of the status rank of a growing number of conspecifics becomes increasingly vague, which makes the operation of prosocial mechanisms less effective. Thus, by virtue of demography or environmental factors, the operation of the prosocial ethology may be impaired, leading to the intensification of internal conflict between individual agendas; in these situations, permanent group fission tends to be the answer, leading the operation of social cognition back to manageable levels (Aiello and Dunbar 1993, 184-185; Aureli et al. 2008, 637; Ferguson and Beaver 2009, 291).

What about intersocietal relations? No prosocial ethological restraints present as capable of preventing lethal violence from being imposed on individuals about whom little or no social information is available. The unloading of excessive social information, enabled by group fission, results in framing the "foreign" as an entity external to the hierarchy pyramid and, therefore, as someone not eligible to be included in prosocial mechanisms; intersocietal relations are thus restricted to violent contacts. The logic underneath the "wars" among common chimpanzees lies in the physical elimination of "opposing" males, in the disarticulation of neighboring communities, and in the abduction of their females. This is attempted during many raids into the foraging territory belonging to neighboring groups, promoted by male raiding parties, eventually accompanied by a few nulliparous females (Roscoe 2007, 485-486; Wrangham and Peterson 1996, 6-7, 162-165).

From the process of mobilization of a raiding party to the return to their home territory, some themes are relevant:

Mobilization is triggered by a high-ranking male through vocalizations and bodily displays with strong somatic and sensorial content. Once successful, mobilization results in the formation of temporary parties organized with the sole purpose of inflicting lethal violence to the "enemy." It is not a defensive action, or the result of any need of patrolling the territory boundaries.

During the advance toward the neighboring territory, the sensorial attention for the presence of "enemy" chimpanzees is intense. The perception of features on the landscape that suggest the proximity with the border between the two territories reduces the number of vocalizations emitted and widens the attention even more. If a vocalization is responded by an enemy chimpanzee, signs of anxiety in the raiding party become visible, and prosocial ethology enters the scene: the group members most often perform gestures and specific actions, which are employed to calm and renew mutual trust under normal conditions (touches and hugs as examples).

The strategy of violence between groups of common chimpanzees seeks to exploit asymmetry of power to the maximum. An attack on an isolated opponent is the main objective; in the ecological niches explored by these primates, and probably also by our common ancestor (savannah, open woodland, or bushland), the rarefaction of resources in the territory leads to frequent dispersion in their already deconcentrated social macrogroups, creating opportunity for the engagement of a lone opponent. During a raid, if a decisive numerical advantage is not identified, the attacking group retreats. In case of contact with more than one "enemy" and if the conditions of numerical asymmetry are still favorable, the aggressors will seek to isolate their opponents to prevent them from cooperating in their defense.

There are no observed acts of non-lethal violence and intimidation performed by an aggressive coalition against male members of an *outgroup*. Lethality seems to be always sought, and there are records of ethological demonstrations of intriguing content, such as the emasculation of dying opponents and the sharing of body parts and the blood of dead "enemies." The association between intersocietal violence and cannibalism is of particular interest, since common chimpanzees exhibit different somatic displays and vocalizations when dealing with *ingroup* and *outgroup* individuals: in the first case, all ritualistic and lethality prevention mechanisms are in place, while in the second case, raiders show body language and make vocalizations normally related to hunting activities (chimpanzees often feed on small vertebrates and even on smaller monkeys like the red colobus, *Piliocolobus badius*). Therefore, "foreigner" chimpanzees are behaviorally treated as prey. The re-signification of the enemy's nature is called "dechimpizing", clearly analogous to "dehumanization" processes (Roscoe 2007; Mithen 2002).

Raids may also be associated with attempts to coerce females from neighboring groups through intimidation and non-lethal violence so that they desert and join the aggressor's side. In case of success, the first offspring born of newly incorporated females are almost always victims of infanticide by adult males. This type of behavior is not uncommon among social mammals and has the effect of minimizing the impact of paternity uncertainty on a polygynandric mating system: since there is no sexual exclusivity among common chimpanzees,

infanticide in these cases operates as a guarantee that the offspring does not belong to males unrelated to the *ingroup*. This is an important factor (the absence of marked inequality in reproductive opportunities) that makes engaging in intersocietal violence a potentially rewarding strategy for all males involved.

The balance of power is an ethologically relevant strategy for the prevention of intersocietal violence among common chimpanzees. This is because lethal aggression, although not a rare ethological phenomenon among mammals, occurs more frequently at interpersonal levels, in asymmetric conditions, and between adults and infants (Roscoe 2007, 485-486; Wrangham and Peterson 1996, 6-7, 162-165). Lethal aggression among adults is a high-risk behavior, with the potential for killing aggressors and/or victims. What makes intersocietal violence possible in the way it occurs among chimpanzees is precisely the presence of an advanced social cognition, acting to produce intense male cooperation and coordination. The coalitional strategy has the potential for breaking the balance of power, for delivering lethal violence against the enemy with minimal risks to the aggressors, and for maximizing individual returns resulting from the expansion of foraging territory (as a consequence of the demographic decline of neighboring groups), and from the abduction of females in a polygynandrous mating system.

Warfare and the modern human mind: between Clausewitz and Keegan

Of course, all this relates to our closest evolutionary relatives, with whom we share almost 99% of the genes. In this context, anyone could quite rightly claim that human societies function in another framework, that modern humans are rational and conscious, and that they are cultural animals; thus, wars between human societies should illustrate a phenomenon of another kind, incurring another dynamic and logic. In fact, human evolution lead us through other paths; in spite of this, the evolutionary dynamics should never be confused with the drawing board of the Creator, in which drawings are erased to give space to others, traced from scratch; the evolutionary process is a *collage* that takes place over millennia, with overlapping images, some visible, others almost imperceptible, but still present. The human mind, though distinct as a result of its metarepresentational and transdominial format, carries in its ontology and phylogeny all the evolutionary content of the deep past, substantially situated in the opacity of the collective unconscious (Stevens 2002).

In modern humans, specialized intelligences of high performance and energetic cost operate together, with their algorithms, innate and learned contents circulating freely, generating knowledge of a creative and transversal nature. As a result of this transdominiality, for modern humans a forest can contain a universe of naturalistic information regarding foraging (for the resources it contains), but, at the same time, a forest represents a socially constructed space (the "dwelling of the ancestors," for example); for modern humans, a forest can be imbued with sentience, can talk and listen, so it must be respected as a social being. By this transversality between naturalistic and social intelligences, it is highly likely that the food resources provided by a forest can also be a "gift" of the ancestors, satisfying not only energetic needs but also renewing social bonds through symbolical and mythical representations. Automobile enthusiasts in modern industrial societies know that their cars are much more than a tool, a product of technology and capitalism; a vehicle can be treated as a social entity, an object of trust and affection, and can send powerful social messages about its owner. I believe that only a few SUV owners in the capitalist world consider of more importance the technical aspect that gives the thing a name – 'utility' – than the strident social message it sends to economy car drivers; although this message is also "useful" in its own way.

The articulation between cognitive domains with strong presence of innate algorithms is made by a master domain, the metarepresentation module, which gains this name by producing simultaneous images of the same object in different specialized intelligences. Moreover, it is in the module of metarepresentation that holistic representations about knowledge are expressed—in the form of something like a "consciousness of the consciousness." Evidence suggests that chimpanzees are aware of themselves and aware of others only in the realm of social relations but nowhere else. Chimpanzees do not use tools (which they produce) to convey social messages and help in their status disputes, nor do they seem to be able to use their social algorithms in their relationship with the natural world (Mithen 2002, 139). Human capacity to employ consciously or unconsciously deep-rooted ethological algorithms in tasks for which they were not evolved—a capacity for a "creative confusion"—can make the aftermath of the clash between Keegan's "warrior culture" and Clausewitz's "rationality of war" less trivial than it may seem.

We will insist here on the inexistence of a real opposition between these two propositions and on the fact that they emerge at different instances of the complex phenomenology of social cognition. In the first place, the question does not seem to involve a problem of rationality vs. irrationality. If the war for Clausewitz is fundamentally rational because it is a means to an end, the results of the intersocietal coalitional violence in *Pan troglodytes* also have a solid rational dimension; as a means to an end, warfare contributes to the expansion of the foraging territory of a social group and to increase the number of sexual opportunities for all males (albeit unevenly) as a result of the polygynandric mating system. It is evident that wars between modern human societies, and especially interstate conflicts, often involve different purposes. We do not need, for any reason, to postulate that modern wars, being

impacted by the constant presence of "ancestral impulses," have to result in the expansion of male reproductive fitness and in the expansion of a society's "vital space." This is not the way these "ancestral impulses" comes to us. The ethological algorithms that echo in the metarepresentational mind and the symbols produced by it are not the cause of war, either among humans or among chimpanzees. These algorithms are ultimately one of the means to make warfare happen, even though they arise as an indispensable condition.

What modern humans do, in the mobilization and in the strategy of war, is to resort consciously or unconsciously to the ethology contained in deep layers of specialized intelligences, to combine them with hundreds of other pieces of knowledge, and to change the values of the variables in the algorithms so that they serve the expected 'rational means' that some cultural, institutional, or political context demands. In other words, we must consider that, in the minds of women and men in modern war offices, the prospecting of geopolitical scenarios and the setting up of strategies—rational actions, by definition—become credible and trustworthy only by resorting to deep ethological complexes that make some courses of action familiar and self-explanatory to the detriment of others. So, in every pursuit of a rational goal involving strategy, evolutionary algorithms are frankly present; their echoes in the metarepresentational mind reduce, at the cognitive level, the degree of estrangement and uncertainty about decisions that, at the limit, can involve the lives of hundreds of thousands of people. In preparation for modern warfare, indoctrination and training of the combatants (as well as the mobilization of public opinion) involve a large dose of massive and programmed activation of unconscious ethological complexes through the use of cultural and symbolic categories that reinforce the construction of imagined *ingroups* ('homeland', 'nation', 'class' , 'brothers in arms', and the like). The Hobbesian *warre* involves also the use of cultural contents capable of triggering dehumanizing behavior through the use of concepts that outlines the enemy *outgroup* ('barbarian', 'immoral', 'impure', 'pagan', 'imperialist', 'communist', among others).

War among modern humans, if reduced to its innate behavioral components, would result in an irrational phenomenon: the potential gains in reproductive fitness brought by intersocietal violence, fixed by natural selection since the LCA, do not appear as the result of engagement in modern warfare. In this way, if the expansion of the male evolutionary fitness is supposedly the purpose for which men (and women!) march toward the battlefield and something that makes strategists a living, modern warfare would be an irrational phenomenon since, in theory, it fails to contribute to this goal either in victory or in defeat. The rationality of interstate warfare is a product of transdominiality and metarepresentation; it is a means for purposes that are transversal to the economic, political, and cultural realms, using strategic or incidental activation of ethological complexes on the collective unconscious. These complexes, selected over millions of years of the natural history of the Primates order, are employed by modern humans as instruments for understanding, significance, mobilization, and acceptance of lethal intersocietal violence, devoted to objectives most distinct from ancestral ones.

Pride, emotion, and instinct, the affective triumvirate of warfare in Keeganian terms, produces a false contradiction with rational purpose. This provocation against Clausewitzian principles seems to slip between two distinct dyads: rationality x irrationality, by one side, consciousness x unconsciousness, by the other. The so -called "irrational dimensions" in Keegan should be so because of the eventual inadequacy of warfare in achieving certain goals, and it does not appear that intersocietal coalitional violence has been constituted as a mere set of frivolities, distempers, or periodic tragedies. If there is a conflict between categories, it happens not in the circumstances of an "unconscious-rational" dyad but in an "unconscious-conscious" one although the notion of conflict does not fit the complex dialectical game between these two instances of the metarepresentational mind. "Irrational" belongs to behavior and courses of action seeking or resulting in sub-optimal consequences. Those that result in optimal outcomes are rational by definition, regardless of their conscious or unconscious origins. In this way, the "warrior culture" can be a mechanism for the discharge of primal impulses without ceasing to be a means to an end.

Final considerations

Keegan is captured by the contradiction between his intuitions about a "human condition" directed toward warfare and his theoretical need to define it as "culture". Considering the mechanisms of intersocietal violence we have described, a "warrior instinct" seems devoid of evidence; in spite of this, Keegan contributes decisively in bringing the *longue durée* to the debate, something that paves the way to the interaction between the collective unconscious with evolutionary origins (Jung 2015) and particular cultural systems. We can overcome this conceptual confusion by unfolding the "warrior culture" in two separate and interlocked aspects: (a) one that requires a deep comprehension of warfare, requiring our attention to "ancestral psychic mobilizations" based on ethological projections (the observance and the violation of prosocial complexes) over the metarepresentational mind; or (b) another one that evaluates genuine "warrior cultures" in their condition of conscious and unconscious practices specific to particular societies. The "warrior culture" in Keegan is definitely not what it seems, and we believe that Clausewitzian rationality is not what it seems either if it is considered as synonym of "consciousness." Keegan resorts to a universal dimension, and thus ends up postulating his object of analysis as something pre-cultural and innate, ubiquitous to all societies.

Such universality places the "warrior culture" in the ethological realm, but, as we have seen, the existence of a warfare ethology is very unlikely; no unconscious complexes dedicated to bringing lethal violence to *outsiders* are identified. Ethologically speaking, intersocietal violence seems to be the result of the exhaustion of social cognition with the eventual inability to recognize the rank and status of an increasing number of individuals. For these "unidentified" conspecifics, prosocial mechanisms are off limits, which means that further contacts may be mediated by hunting ethological complexes—the behavioral basis for intersocietal violence.

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The Wish to Stop Time: Margaret Atwood's *Oryx and Crake*

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Abstract: What if humans continue to pursue "more and better"? What if we continue living within our safe anthropocentric boundaries? What if we ignore the question of when too much is too much? Margaret Atwood's "speculative fiction" presents no new worlds, as Atwood's world resembles our own; her novels present, on the other hand, what-if realities. By extrapolating trends, *Oryx and Crake* poses the afore-mentioned questions within Modernity's framework. Atwood's novel revisits key concepts such as time and subjectivity and brings progression to a halt. What may the wish to stop time, our human condition, result in, after all? Modernity and its concepts are under scrutiny in a novel in which climate change and nature seem to have been surpassed. The present paper aims, therefore, at investigating what this "us without a world" story, which becomes a "world without us" one, can tell us about the pursuits of Modernity and their repercussions: that is, ecological awareness and the good Anthropocene.

Global warming might just as well continue what Freud called the great humiliation of the human. Being added to a list of humiliators, which includes, according to Timothy Morton, Copernicus, Darwin, Derrida, Marx, and Heidegger, just to name a few, global warming brings human displacement to a new level since it forces us to acknowledge that "*we are always inside an object*" (Morton 2013, 17). Global warming, as a hyperobject, as something that is massively "distributed in time and space relative to humans" (Morton 2013, 1), makes humans grapple with the painful realization that there is no *away*. Global warming is nonlocal; it is everywhere: in the bodies, oceans, forests, and buildings, yet nowhere to be found. It is viscous, as it clings itself to everything. In the time of hyperobjects we discover "ourselves on the inside of some big objects (bigger than us, that is): Earth, global warming, evolution" (Morton, 2013, 118). Our human scale is proven insufficient to rule it all. The split between nature and culture, subject and object, human and planetary history was just a fallacy. Human and nonhuman temporalities are more enmeshed than previously thought: "Now we must concede what seemed impossible to contemplate — humans as agents changing the course of the deep history of the Earth, or rather of the Earth's deep future, an event giving rise to what might be called "post-history." (Hamilton 2017, 13) Accepting human's geological agency, Timothy Clark would go on, "is to revise strongly notions of what is or is not historically significant" (Clark 2015, 52). Not only human history is historically significant, after all.

Margaret Atwood's world in *Oryx and Crake* is a human-altered environment in which a newly created race, the Crakers, and the narrator, Jimmy, a remnant of human race, survive the harsh conditions of an altered planet. Through Jimmy's faltering memory the story of the creation of this new race is told, along with the collapse of human race, its decimation by a lethal virus. Even though climate change as a reality exists since the beginning of the novel, all the scientific discoveries in the walled communities, the so-called compounds, seem to address this new reality: the Earth is getting warmer, nothing is changed in human behavior. Climate change does not play a role in Jimmy's life. If on the one hand, animals are becoming extinct; on the other hand, more animals are being bioengineered. If plants outside the compounds cannot survive the harsh reality of a warmer planet, inside, new plants, bioengineered ones, thrive and keep the temperature under control. Climate is under control within the walls of the compounds and life goes on as though nothing had happened. The compounds, therefore, as an attempt to go *away*, to escape the viscosity and nonlocality of global warming, may help shed some light on our modern constitution. This novel, obsessed with binaries as it is, the split between humanities and

sciences, is a speculative exercise on how modernity conceives knowledge and its consequences. But mostly on how the split—nature and culture, humanities and sciences, object and subject—may prevent us from addressing the reality of climate change. Accepting its reality means going beyond the split, beyond the sovereignty of the subject; it means, in a nutshell, rethinking our cherished modern concepts, such as time, progress, and subjectivity.

Snowman/Jimmy lets us know right from the beginning of Margaret Atwood's *Oryx and Crake* that it is zero hour. As he looks at his watch, out of habit, he is overtaken by a feeling of desperation: "A blank face is what it shows him: zero hour. It causes a jolt of terror to run through him, this absence of official time. Nobody nowhere knows what time it is" (Atwood 2003, 3). Zero hour, as though time had been suspended, as though all progression had come to a halt and Snowman, formerly Jimmy, was stuck in this limbo, stuck between a past he cannot regain, a past that keeps slipping through his fingers, and a present with no future: "He doesn't know which is worse, a past he can't regain or a present that will destroy him if he looks at it too clearly. Then there's the future. Sheer vertigo" (Atwood 2003, 147). When did it happen, anyway? Snowman keeps asking himself. "He must have been five, maybe six" (Atwood 2003, 15). Remember the bonfire, Snowman? Remember that once upon a time you were called Jimmy? That once you had a mother and a father and then a stepmother and a friend and lovers, so many lovers? Remember when it was? "Several years passed. They must have passed, thinks Snowman" (Atwood 2003, 59). At this zero hour, this empty space Snowman seems to inhabit, his experience of time is reduced to "must haves." He must have been six, several years must have passed, but who can be sure of when it all happened? "There are a lot of blank spaces in his stub of a brain, where memory used to be" (Atwood 2003, 4).

Snowman's present is constantly interrupted by his past's replays, by flashbacks he cannot turn off, by voices that come out of nowhere, by sentences on fridge magnets, by words out of context, and even though the reader is presented with at least two different storylines, Snowman's present and past; all sense of progression is denied. The novel comes full circle when it ends with the same idea with which it had begun: "Zero hour, Snowman thinks. Time to go" (Atwood 2003, 372). Zero hour, once again. Is it the beginning or the end? A beginning and an end? One and the same?

> Snowman's broken watch identifies the negation of time as a consequence of catastrophe in two different senses: first, the ending of the mechanical and social commodification of experience through the imposition of clock time and, second, an ending to history through the violent disruption of human memory and civilization. (Dodds 2015, 121)

There is no arguing against the sense of ending throughout the novel, against a post-apocalyptic last man experience that Snowman personifies. Until the very last minute, Snowman believes himself to be the only one alive: "Everything is so empty. Water, sand, sky, trees, fragments of past time. Nobody to hear him" (Atwood 2003, 11). Until the very last minute the narrative unfolds as a "world without us" experience, as Snowman, the last man alive after a virus destroys mankind, tries to survive by becoming a scavenger as he looks for and holds on to the last remnants of human experience. At the last minute, however, Snowman learns he is not alone; there are others, human beings, just like him, human beings still driven by the imagination Crake tried to destroy. The "world without us" narrative is about to become "us without a world" when it comes to an end: Time to go, Snowman announces. Time to go where? The lack of closure it presents seems to add just another layer to the ambiguities present in the novel as a whole. "End or beginning?" I ask.

Atwood's recovery of the zero-hour expression at the end, her insistence on the stillness of the chronological time, in spite of the different stories presented in the novel, points to a puzzle to be solved: What is the relevance of time, or the framing of time, for the different levels of experience in *Oryx and Crake*? Since time is one of the guiding principles of our modern experience, our new experience as moderns, the novel as a whole, as "speculative fiction," keeps Modernity under scrutiny.

Hegel was, according to Habermas, the philosopher who inaugurated the discourse of Modernity. Hegel perceives Modernity's need for self-certification since the models of the past would not be enough to grasp what modernity entails. Modernity's criteria should, therefore, be extracted from itself. It should be certified by its own norms, owing nothing to the pre-modern view of the world. Modernity's self-certification would be taken by Hegel as the guidepost of his philosophical concerns. Its guiding principle, subjectivity, guarantees Modernity's superiority (when compared to the pre-modern world) and is illuminated by the ideas of "freedom" and "reflection" (Habermas 2002, 25). The subjective freedom of the individual permeates modern culture and gains full expression, according to Hegel, in romantic art due to its absolute interiority. Subjectivity, however, is not restricted to the arts and, as a principle, organizes religious life, the State, and society as a whole.

Certain historical events were, nonetheless, crucial to the establishment of subjectivity, namely: the Reformation, the Enlightenment and the French Revolution. The Reformation led to the reflectiveness of the faith, inasmuch as tradition lost its authority to the sovereignty of the individual. The Declaration of the Rights of Man and Citizen and the

Napoleonic Code, by focusing on the freedom of the will as the substantial foundation of the State, similarly, made the historical right lose its importance—as rights and ethics were no longer imposed from the outside, as God's commandments, but founded on man's will.

The expression "subjectivity" could have four different connotations, Habermas goes on: individualism—infinitely particular singularity; the right to criticism—that which is acknowledged by everyone should prove itself legitimate; autonomy of action —the possibility of answering for what we do; idealist philosophy—philosophy should ascertain that it knows what it is (Habermas 2002, 121). Modernity, therefore, by breaking away from the pre-modern world's parameters, by being established by means of "freedom" and "reflection," entailed a rupture in time. The term Modernity is not free from controversy, however.

For Marshall Berman, the history of Modernity has three different stages. The first one, when people start to experience modern life without being aware of what has hit them, begins in the sixteenth century and continues to the end of the eighteenth century. The second stage began in 1790, when a sense of living in a revolutionary time provoked profound changes. In its third stage, the twentieth century, Modernity loses its capacity to make sense of things, an era that has lost touch with its roots. (Berman 2007, 25-26).

Kumar, however, does not understand the seventeenth century as the beginning of Modernity. Except for Descartes, who, in *Discourse on the Method,* rejects older modes of thinking in order to establish a new way of thinking based on human reason, developing, this way, a new method to search for truth; as a whole, the accomplishments of the moderns were related to the idea of decadence (Kumar 1997, 89). For progress and growth, mankind had to pay a price, that is, moral and spiritual decadence.

Throughout the seventeenth century persists the return of an apocalyptic thought that limits the interest in the present. The present becomes a moment of preparation and waiting for a future that will be the result of a divine intervention. Human action plays no role in it. Only in the second half of the eighteenth century would this perception of time and history gradually give way to a new concept of Modernity (Kumar 1997, 91). In order for the idea of Modernity to be fully developed, there was the need to exorcize the apocalyptic view of the world, a condition that was fulfilled through only the secularization of Christian time in the eighteenth century. Modernity was no longer a degenerate copy of the ancient times; quite the contrary, it begins to mean an opening of pathways, a rupture with the past, an opening up to a time of unprecedented progress (Kumar 1997, 91). The moderns are, thus, those who live in a whole new world and should rely on themselves to discover new ways of acting and thinking. The "new" is a value, or "time's irreversible arrow," in Latour's terms (1993, 10).

The human condition, Crake would counter argue, is the "wish to stop time" (Atwood 2003, 292). In the face of death, human beings, as opposed to other species, will procreate as a last attempt to cheat death, to live on, to reach for immortality—to stop time as though reversing the arrow that points to the grand finale of us all: death. Crake's sentence seems at first a simple response to Jimmy's question: "What pays for all this?" (Atwood 2003, 292), but what follows this ironic, detached, cynical response, is Crake's disclosure of the BlyssPluss pill, whose justification is "we're running out of space-time" (Atwood 2003, 295). There is little time, not enough time, before the whole species is doomed, hence "grief in the face of inevitable death" (Atwood 2003, 292). The BlyssPluss pill would provide mankind, at least the remnants, with a chance for a better future. Its benefits, protection against sexually transmitted diseases, unlimited supply of libido, and a prolonged youth, would be its selling points; what would not be advertised, however, were its birth control effects. Crake's interest does not reside in its benefits, though. The benefits would only attract the buyers, guarantee that it would reach a larger number of the population by appealing to the so-called human nature: "The tide of human desire, the desire for more and for better, would overwhelm them. It would take control and drive events, as it had in every large change throughout history" (Atwood 2003, 292). "More and better," Crake says, is the guiding force behind the impulse for newness, for an improved experience of sex. The pill would, this way, revolutionize human interaction by appealing to their need for newness, for what seems to drive human beings. The search for "more and better," the same one that had led to the scarcity of space-time, would, this time, buy mankind more time, reverse time's irreversible arrow, provide a better chance for human beings. In the face of the impending death, mankind's extinction, Crake attempts to stop time.

Lara Dodds, in *Death and the 'Paradice within' in Paradise Lost and Margaret Atwood's Oryx and Crake*, places *Oryx and Crake* within a science fiction tradition that responds to Milton's *Paradise Lost*. In Atwood's novel, Crake's plan aims at reversing the myth of the Fall, according to Dodds. The new race of men would inhabit a new Eden, where the consciousness of death would be inexistent. After eating the fruit from the tree of knowledge of good and evil, Adam and Eve become aware of their mortality. All of a sudden, they realize they are ashamed of their nude bodies. They are made aware of the corporeal components that make them who they are: bodies that rot, bodies that die. Conversely, the bioengineered race that Crake envisions has no consciousness of

death. The physical aspect of death still exists, though, since their bodies are programmed to die. "The children of Crake," however, do not know they will eventually die and are kept in this state of innocence, in a bioengineered Eden in a post-apocalyptic world. Crake wishes to stop time, then, by reversing mankind's state to that before the consciousness of death, before mankind was determined by the flux of time: "To be subject to death, as Adam and Eve are following the Fall, is to be subject to the gap between the duration of one's life and the shape of time. It is in this sense that human history can be said to begin with the Fall [. . .]" (Dodds 2015, 128). Stopping time, in Crake's terms, could have at least two meanings. Firstly, it could mean the illusion of immortality. Not knowing about the existence of death means not suffering in anticipation, which would result in not acknowledging the passing of time. Secondly, it could prolong the existence of this newly created race. Fewer individuals who were more adaptable to the climate change and the hazards posed by an altered environment would probably pose fewer threats to the environment, guaranteeing both the permanence of the species and the world. Stopping the time, however, would be possible only by modifying the "human nature" through the stages of his plan. First the pills, as Crake points out, "The BlyssPluss Pill was designed to take a set of givens, namely the nature of human nature, and steer these givens in a more beneficial direction than the ones hitherto taken" (Atwood 2003, 293). The pill that would end up killing basically all human race, except for a couple of individuals, would do so by "manipulating" the so-called nature, by making nature work in favor of a previously designed plan. After massive extinction, a newly improved race would take over. The Paradice Project is its name. By altering the ancient primate brain, destructive features such as racism, hierarchy, territoriality, and torments due to sexuality would be eliminated, and these perfected beings would repopulate the world in their eco-friendly way. There is a catch, though, as Crake warns Jimmy:

> *Watch out for art*, Crake used to say. *As soon as they start doing art, we're in trouble*. Symbolic thinking of any kind would signal downfall, in Crake's view. Next they'd be inventing idols, and funerals, and grave goods, and the afterlife, and sin, and Linear B, and kings, and then slavery and war. (Atwood 2003, 361)

Crake's concerns seem to resonate with that of Raphael's in Milton's *Paradise Lost*. "But apte the Mind or Fancie is to roave / Uncheckt, and of her roaving is no end" (Milton 1952, 236), Raphael warns Adam. Beware of the imagination; soon enough you will be thinking of worlds invisible; you will be imagining things remote from your daily life; soon enough you will be transgressing, I ask, is that so? Curiously, Lucifer, right after being expelled from Heaven for not abiding by a decree that, logically, offended the principles by which all the angels had lived until then—equality and freedom—, realizes that no matter where he is, Heaven or Hell, one thing remains inalterable: "A mind not to be chang'd by Place or Time" (Milton 1952, 99). His resistance, therefore, against a tyrannical decree is his own mind. Much better to be free in Hell than to serve in Heaven since: "[t]he mind is its own place, and in itself / Can make a Heaven of Hell, a Hell of Heaven" (Milton 1952, 99). "A Heaven of Hell, a Hell of Heaven," says Lucifer, highlighting, this way, the mind's reflective power. The reflection is made visible by means of an inversion of the word order. The physical (visible) presentation of the verse matches its content meaning; there is no disjunction between signified and signifier, as both point to the idea of reflection. Reflection, mirror, speculation—what does the mind do? The mind speculates and, by doing so, changes the reality of all the things around. Heaven can be hell and hell can be heaven, as long as the mind wishes it to be so. The possibilities are endless, warns Raphael. Without limits, boundaries, limitations, the roaving has no end. Men can imagine, Crake would go on, that there is a life after death, that there is a soul, that the soul leaves the body when we die, that our soul lives on in another dimension, that poetry could reach immortality, that there is a God and there is a Nature: "I don't believe in Nature either," said Crake. "Or not with a capital N" (Atwood 2003, 260). What does it mean to believe in nature with n as opposed to nature with N? What changes when you think of Nature as a subject or as an object?

It means that for Crake the concept of Nature had been surpassed, that we would be living in a post-nature world. Christophe Bonneuil, in *The Geological Turn: Narratives of the Anthropocene*, understands that the term post-nature may have different meanings. Modernity's discourse has always been that of human race freeing itself from natural determinism. Reflection (consciousness) enabled mankind to gain more and more freedom with the passing of time. Progress was hence the combination of reflection and freedom. More consciousness meant more freedom and subjective freedom; according to Hegel, it permeated the modern times. The separation between culture and nature is, nonetheless, questioned whenever the concept of the Anthropocene is brought into discussion. Conceiving the entire species as a geological force that altered the Earth means that both realms—human and planetary—are more enmeshed that previously thought. What is more, the different

temporalities—planetary and human—are not separated, after all. Climate change, the acidification of the oceans, earthquakes and tsunamis, the scarcity of "space-time," as Crake mentions, play a role in human history. There is no human history without its natural counterpart. Nature is not a backdrop to human history, then, since nature and culture were never really separated. The so-called Great Divide was nothing but a fallacy, in Latour's terms, as we have never been modern. Nature with a capital N is just a romantic construct, Crake would say. The acceptance of this post-nature idea would, on the one hand, instill humility in our dealings with the planet, since the human exceptionalism paradigm would be discredited; on the other hand, it would lead to what is called "the good Anthropocene":

> [T]here will no longer be an environment that is external (read: hostile) to humankind. Not so much because man will be transfigured by technology, as Singularitarians dream, but because the old Nature will be recodified (or rather re-axiomatized) by the capitalist machine as merely a matter of managing resources, of environmental governance—everything according to so-called "best practice." The anthropic dream of the Moderns would thus be finally materialized: a post-environmentalism in which man will find himself contextualized and sustained only by himself, surrounded by the immense accumulation of commodities, energized by his shiny new and super-safe nuclear centrals (with cold-fusion reactors, if possible), and relaxed by large and pleasant ecological leisure areas, populated of course by a carefully curated, genetically enhanced flora. (Danowski and Viveiros de Castro 2017, 49)

Oryx and Crake's two main storylines, Snowman's present and past, take place in different moments of the good Anthropocene. Jimmy's life, in the compounds, in Martha Graham, is surrounded by technology, bioengineered foods and even pets; a life behind the walls of the compounds where everything is orderly and controlled, where surveillance is the norm and people cannot come and go as they wish. Living in the compounds is similar to living in a bubble, artificially protected from the harsh environmental change all around. No wonder do climate change and catastrophes take the form of as a matter of fact comments, almost as footnotes, rushed descriptions that seem dislocated from the main action:

> Still, as time went on and the coastal aquifers turned salty and the northern permafrost melted and the vast tundra bubbled with methane, and the drought in the midcontinental plains regions went on and on, and the Asian steppes turned to sand dunes, and meat became harder to come by, some people had their doubts. (Atwood 2003, 24)

According to Adam Trexler, climate change

> is little more than a footnote to the novel's concerns. Atwood describes a world where hierarchical, corporate capitalism and biotechnologies allow the unprecedented exploitation of human bodies. The world population is decimated by a virus engineered in the center of the corporate machine, and a new race of posthumans is positioned to live more sustainably. (Trexler 2015, 196)

Climate change is not a concern in the novel. It is, though, the context in which new technologies emerge. It is the context that propels more and more scientific advances. The search for "more and better" that endowed mankind with geological agency continues to be the impulse behind the walls of the compounds. Science responds to environmental change and the new demands imposed by an altered environment. Climate change is, then, a concern in the novel. How does one live in an altered world, the novel asks itself. For which humans do climate change and environmental disasters beg? How can anyone guarantee the permanence of the human in this post-nature epoch? The novel is, therefore, about human agency in the face of environmental collapse: human stewardship, living in the good Anthropocene. When the first attempt seems to fail, when there is still scarcity of "space-time" in spite of it all, Crake puts his plan into action: a new race, a perfected race, a bioengineered race. Crake wishes to stop time, to restart the world, to go back to the basics.

Climate change is beyond the gates of the compounds. In these walled spaces, where science and money are combined, any sea level alteration, scarcity of meat, animal extinction and increase in the global temperature are being mitigated by new biotechnologies and technologies that allow for comfortable living spaces. Climate change is, as a reality, almost surpassed, a thing in the past, being brought up when the past is evoked: "[. . .] like the beach house her family had owned when she was little, the one that got washed away with the rest of the beaches and quite a few of the eastern coastal cities when the sea-level rose so quickly, and then there was that huge tidal wave, from the Canary Islands volcano" (Atwood 2003, 63). The compounds are, thus, a post-nature, post-climate change world. The compounds are as well, not only a reality, spaces of status and power, but also the great metaphor for a novel obsessed with boundaries, walls, limits, and binaries.

> The Compounds encapsulate corporate "yes" culture in a spatial metaphor of bringing together into one place all those who have "opted in," who have internalized the goals, truth, and ethics of the company as their own, and excluding or expelling everything that is threatening to this homeostasis. (Crooke 2006,

69)

Since the beginning of the novel we are told that there are two categories of people: numbers or word people. Crake fits the numbers person profile, whereas Jimmy falls under the word person category. The duality permeates the novel, being recurrently brought up, and helps understand both characters' successes and failures. Their scientific or rhetoric-linguistic abilities are key factors determining not only the colleges they attend and the job offers they receive but also where they live. In a techno-scientific society, where nature has been surpassed and climate change is in a once-upon-a-time framework, being science-oriented, or a numbers person, in Atwood's words, is really profitable. Since the compounds are science-driven spaces, the best scientists have the best paying jobs and live in the best compounds. The search for "more and better" leads to different house moves and determines how contingent relationships are: "Kids came and went, desks filled and emptied, friendship was always contingent" (Atwood 2003, 71). Underlying all this scientific talk, however, is the true catalyst of societal changes: money.

Scientific and research interests do not exist in themselves, though. The novel does not present a science for science's sake tale; quite the contrary, scientific interests are circumstantial, more based on demands than investigative nature. Science is just a commodity, a pretty lucrative one, I must add.

The split between numbers people and word people, or in broad terms, between science and the humanities, can be understood as Stephen Dunning does, as a means to extrapolate the fields division and warn against its consequences. *Oryx and Crake* would, thus, be a cautionary tale about the dangers of conceiving scientific knowledge without taking human concerns into consideration. The human concerns should mediate scientific knowledge, should put the brakes on the ambition for "more and better" as the ambition for more money.

Crake's character embodies the clear split between the different fields of knowledge: "His clothes were dark in tone, devoid of logos and visuals and written commentary—a no-name look." (Atwood 2003, 72) Even through his choice of clothes, Crake displays his lack of affinity with words. Crake's "laconic" look may be read as a metaphor for his behavior toward the world. Clothes are supposed to be clothes and nothing more and should serve the purpose of covering his body. Everything exist for a reason, according to Crake: "Crake is a biological determinist, believing also in a logical biology, a biologic of sense. Art, for instance, exists for a purely biological function" (Crooke 2006, 77). Art, as well as words, serves a purpose and that is all.

Even though Jimmy is the classic example of a word person, both friends are much more alike than expected. Being a word person or a numbers person does not mean being complete opposites, it means, nonetheless, occupying different walled spaces: "There had been something willed about it though, his ignorance. Or not willed, exactly: structured. He'd grown up in walled spaces, and then he had become one. He had shut things out." (Atwood 2003, 184) Jimmy shuts things out, as well as Crake does, as well as the compounds do. There are different levels, therefore, of shutting things out, in the novel. As mentioned before, through the characters, the spaces, lines, stories, the novel unfolds its obsession with boundaries, limits, limitations. "Watch out for art," Crake says, establishing another boundary for his post-humans, "the children of Crake". But why art, Crake, I ask?

Throughout the novel, Snowman struggles with language. There is a sense that language is slipping away from him, that little by little, he is forgetting words, meanings. "Hang on to the words," he tells himself. "The odd words, the old words, the rare ones. Valence. Norn. Serendipity. Pibroch. Lubricious. When they're gone out of his head, these words, they'll be gone, everywhere, forever. As though they had never been" (Atwood 2003, 68). Why the old words, Snowman?

Since Snowman believes he is to be the last of his kind alive, some words may only exist in his mind. They are the remnants of a past type of living, of a past type of human—rare words, old words, like himself, a rare human being so different from the perfected beauty of "the children of Crake." When he is gone, human life as it is, as well as human language, may disappear forever. Crake's perfected human beings still use language to communicate but do not know malice, "but these people didn't go in for fancy language: they hadn't been taught evasion, euphemism, lily-gilding. In speech they were plain and blunt" (Atwood 2003, 348). Their use of language was much more practical, daily, and literal. Why would they need to resort to a concept such as serendipity, so far removed from their daily concerns, so distant from their new reality? Snowman's language refers to a long gone type of experience: "I used to be erudite," he says out loud. Erudite. A hopeless word. What are all those things he once thought he knew, and where have they gone? (Atwood 2003, 148). Outside the compounds, however, beyond the walled world, the walled experiences, the closed-in world of well-established knowledge, beyond the sovereignty of the subject, what was previously known does not suffice to account for this new world. Words fade, lose their solidity, and become, all of a sudden, insufficient; all of a sudden, wisdom is turned to folly, as Raphael imagined it would. Once the boundary is transgressed, knowledge, words, concepts become slippery, contingent, empty.

Another dimension to Snowman's concerns exists, however. After the world surrounding him changes, he tries to hold on to what is still familiar, as though trying to compensate for the loss of control. He had always been a word person, someone who found his way around the science-driven world by using his linguistic skill. Publicity was his way around. Publicity, nonetheless, entails a specific relationship to the words: "Reading a poem introduces some wiggle room between ideas and ways of having them. Propaganda closes this space down" (Morton 2018, 30). The words would hence be at Jimmy's disposal. Jimmy's attitude,

reaching out and grabbing the words, making them mean what he wanted them to, mastering the words, resembles Crake's attitude toward the world. Numbers people or word people seem much more alike than expected. As Timothy Morton warns us, "It's not what you think but *how you think* that starts World War III" (Morton 2018, 33). It's not what you think—scientific or human concerns—but how you think. In *Oryx and Crake*, science serves a purpose as well as the words do. It is thus the apotheosis of the subject-object dualism, the demise of a world where anything that could was objectified—commodification, plain and simple. When the walls between the perfect, engineered human world and the world around cracks, when humans lose control over a world that can no longer be programmed, predicted, words falter. Is the experience unimaginable? Does it surpass our too human abilities to conceive the world? Was wisdom turned to folly?

Just the human wish to stop time, as Crake warns us, but whose time, I ask? Crake's Paradice Project and his attempt to deny the post-humans, the newly created race, the consciousness of death is an almost too literal way to reverse the fall of men. The newly created race would be kept in this eternal innocence, leading a more eco-friendly mode of living. It is also an attempt to start again with a clean slate.

"Everything emits time, not just humans" (Morton 2018, 77). So whose time should be stopped, I ask? All experience of time, Crake would say. In no circumstances do non-humans enter into Crake's equation. Their temporalities are never acknowledged. Even when environmental disasters hit the globe, modifying life as it was, the non-human world continues to be shut out. Mankind finds a way to banish the non-humans, to deny their temporalities, to stop the time. The compounds, therefore, are a means to avoid any ecological awareness: "Ecological awareness is shaking our faith in the anthropocentric idea that there is one scale to rule them all—the human one" (Morton 2018, 22). The human scale continues to rule it all until the scarcity of "space-time" is such that denial is not a possibility anymore. Space and time, two *a priori* conditions of human sensibility prove themselves to be conditioned after all. "This is one of the ways, and not the least important, in which it can be said that our world has ceased to be Kantian" (Danowski and Viveiros De Castro 2017, 9). Men were proven unable to rise above the phenomenal order or causality. They were not the lawgivers of nature, after all, but phenomenologically bound to and conditioned by the human and non-human world: "You aren't outside the biosphere looking in. You are glued to the biosphere phenomenologically" (Morton 2018, 41). The boundaries were, this way, not enough. They are more porous than anticipated. Crake, nevertheless, instead of accepting the porosity of the boundaries, instead of acknowledging the non-human world, decides to put an end to human life as it was, to go back to the beginning, but with a twist. This clean slate is, however, still conditioned: "*Watch out for art*," Crake used to say. "*As soon as they start doing art, we're in trouble*. Symbolic thinking of any kind would signal downfall, in Crake's view" (Atwood 2003, 361).

Art determined whether the project was successful or a failure. Imagination's rove has no end, Raphael warned Adam it knows no boundaries, we can infer. Imagination brings visibility to the invisible realm; it establishes connections that are not apparent. Raphael equates fancy with the mind, as though both were one and the same, as though they shared similar characteristics. Fancy's rove had no end, as well as the mind's. Lucifer would agree: the mind is its own place; it had the power to alter space and time; it had the power to be a place of resistance. For Lucifer, the mind became a symbol of freedom. How does he free himself from the divine decree and all its constraints? Through his mind. Lucifer became a subject then:

> He is a "subject" in our contemporary theoretical sense (the "humanist subject"), and certainly his troubled "I" is prominent in the poem. But he is a "subject" also in the more literal, root sense of the term (sub iectus, thrown under): he discovers at the moment of his rebellion just what it means to be subject to God. Subjection is the origin of his subjectivity. (Forsyth 2003, 150)

His search for freedom, for the unconditioned, is the origin of his subjectivity. So, the new race, "the children of Crake," could stand a chance only if subjectivity would not emerge—if the principle behind the idea of Modernity, as Hegel states, did not guide the progress of mankind? The problem is not what you think, Timothy Morton would argue, but how you think.

Snowman learns that the Crakers, in spite of Crake's efforts to eliminate any symbolic thinking, the G-spot in the brain as he calls, are curious about their origins, are eager to create narratives: "They're up to something though, something Crake didn't anticipate: they're conversing with the invisible, they're developing reverence" (Atwood 2003, 157); singing and dreaming were not the only things humans were hard-wired for. Symbolic thinking seems to be part of human nature. Human's demise again? Zero-hour, Snowman lets us know.

What if subjectivity allowed for a new experience, one in which walled spaces were not a reality and shutting things out were not the norm? What if we did not let anything go, anything pass, as Isabelle Stengers suggests we do (Stengers 2015, 143)? What if we took full responsibility for the reality of our abstractions? What if we loved our monsters?

"*Watch out for art,"* Crake says. There is no denying that symbolic, abstract thinking allows for appropriation, for eliminating any other scale rather than the human one; yet isn't

there another side to it? The aesthetic experience entails solidarity to what is non-human, Timothy Morton would reply, caring for something that is not another human being. What is more, beauty is indifferent to the subject. The aesthetic experience might just as well, due to its weirdness (Morton 2018, 65), provide us with the hint of the uncanny necessary to overthrow the sovereignty of the subject: "this feeling of openness, this uncanny sensation of finding ourselves somewhere and not recognizing it, is exactly a glimpse of living less definitively, in a world comprised almost entirely not of ourselves" (Morton 2018, 26). Living less definitively might be the key, then?

"It's Zero-hour," Snowman says. It's time to go.

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O desejo de parar o tempo: *Oryx e Crake* de Margaret Atwood

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Resumo: E se os humanos continuarem em sua busca por "mais e melhor"? E se continuarmos vivendo dentro de nossos limites antropocêntricos? E se ignorarmos a pergunta de em que ponto muito é muito? A "ficção especulativa" de Margaret Atwood não apresenta novos mundos, já que o mundo de Atwood se assemelha ao nosso; seus romances apresentam, no entanto, "e se" realidades. Ao extrapolar tendências, Oryx e Crake retira as questões acima mencionadas do contexto da Modernidade. O romance de Atwood revisita conceitos-chave tais como tempo e subjetividade e faz a progressão parar. No que nosso desejo de parar o tempo, nossa condição humana, pode resultar, no fim das contas? A Modernidade e seus conceitos estão sob escrutínio em um romance no qual a mudança climática e a natureza parecem ter sido superadas. O presente artigo busca, assim, investigar o que essa estória de um "nós sem um mundo" que se torna numa estória de um "mundo sem nós" pode nos dizer sobre as buscas da Modernidade e suas repercussões: ou seja, a consciência ecológica e o bom Antropoceno.

Hora zero, Snowman/Jimmy nos alerta logo no início de *Oryx e Crake* de Margaret Atwood. Ao olhar seu relógio, por hábito, nos diz, ele é tomado por um sentimento de desespero: "A blank face is what it shows him: zero hour. It causes him a jolt of terror to run through him, this absence of official time. Nobody nowhere knows what time it is" (Atwood 2003, 3). Hora zero, como se o tempo estivesse suspenso, como se toda a progressão houvesse parado e Snowman, antigo Jimmy, estivesse preso nesse limbo, preso entre um passado que não pode retomar, um passado que continuasse a escorregar por entre os dedos e um presente sem futuro: "He doesn't know which is worse, a past he can't regain or a present that will destroy him if he looks at it too clearly. Then there's the future. Sheer vertigo" (Atwood 2003, 147). Quando aconteceu mesmo, Snowman se pergunta. "He must have been five, maybe six" (Atwood 2003, 15). Lembra da fogueira, Snowman? Lembra que você já se chamou Jimmy? Que você já teve uma mãe e um pai e depois uma madrasta e um amigo e amantes, tantas amantes? Lembra quando foi? "Several years passed. They must have passed, thinks Snowman" (Atwood 2003, 59). Nessa hora, nesse espaço vazio que Snowman parece habitar, sua experiência do tempo é reduzida ao "deve ter sido." Ele deve ter tido seis anos, muitos anos devem ter passado, mas quem pode ter certeza de quando tudo aconteceu? "There are a lot of blank spaces in his stub of a brain, where memory used to be" (Atwood 2003, 4).

O presente de Snowman é constantemente interrompido pela repetição do seu passado, flashbacks que ele não consegue desligar, por vozes que aparecem do nada, por frases de imãs de geladeira, por palavras fora de contexto, e apesar de o leitor ser apresentado a pelo menos duas narrativas, o presente e passado de Snowman, qualquer senso de progressão é negado. O romance faz uma viagem redonda quando termina com a mesma ideia que lhe deu início: "Zero hour, Snowman thinks. Time to go" (Atwood 2003, 372). Hora zero, mais uma vez. Mas é um início ou um final? Início e final? Um e o mesmo?

> Snowman's broken watch identifies the negation of time as a consequence of catastrophe in two different senses: first, the ending of the mechanical and social commodification of experience through the imposition of clock time and, second, an ending to history through the violent disruption of human memory and civilization. (Dodds 2015, 121)

Não há como negar o sentimento de fim ao longo do romance, a experiência pós-apocalíptica do último

homem que Snowman personifica. Até o último momento, Snowman acredita ser o único homem vivo: "Everything is so empty. Water, sand, sky, trees, fragments of past time. Nobody to hear him" (Atwood 2003, 11). Até o último momento a narrativa se desenvolve enquanto uma experiência de um "mundo sem nós," quando Snowman, o último homem vivo após um vírus destruir a humanidade, tenta sobreviver ao se tornar um catador de restos, procurando e se atendo aos últimos resquícios da experiência humana. No último momento, entretanto, Snowman descobre que não está sozinho, que há outros, seres humanos, tais como ele, humanos ainda movidos pela imaginação que Crake tentou destruir. A narrativa de um "mundo sem nós" está prestes a se transformar em "nós sem um mundo" quando termina: Hora de ir, Snowman anuncia. Hora de ir para onde? A falta de fechamento, finalização, apenas adiciona outra camada às ambiguidades do romance como todo. Fim ou início, pergunto?

A recuperação da expressão hora zero no final, a insistência de Atwood na imobilidade do tempo cronológico, apesar das diferentes estórias do romance, aponta a uma problemática a ser perseguida: a relevância do tempo ou do enquadramento do tempo para os diferentes níveis de experiência em *Oryx e Crake*. Ademais, como o tempo é um dos princípios norteadores de nossa experiência moderna, nossa nova experiência moderna, o romance como um todo, enquanto "ficção especulativa", coloca a Modernidade sob escrutínio.

Hegel foi, de acordo com Habermas, o filósofo que inaugurou o discurso da Modernidade. Hegel apontou para a necessidade de autocertificação da Modernidade, uma vez que os modelos antigos não seriam mais capazes de entender o que a Modernidade representaria. Os seus critérios (da Modernidade) deveriam, assim, ser extraídos de si. Seria, dessa forma, certificada por suas próprias normas, não mais devendo, assim, à visão de mundo pré-moderna. A autocertificação da Modernidade seria tomada por Hegel enquanto norteadora de todas as suas preocupações filosóficas. Seu princípio central, a subjetividade, garantiria a superioridade moderna (quando comparada ao mundo pré-moderno) e seria iluminada pelas ideias de "liberdade" e "reflexão" (Habermas 2002, 25). A liberdade subjetiva do sujeito permeia a cultura moderna e ganha total expressão, de acordo com Hegel, na arte romântica devido a sua absoluta interioridade. A subjetividade, no entanto, não estaria restrita às artes e, enquanto princípio, organizaria a vida religiosa, o estado e a sociedade como um todo.

Certos eventos históricos foram, entretanto, cruciais para o estabelecimento da subjetividade, a saber: a Reforma, o Iluminismo e a Revolução Francesa. A Reforma levou à refletividade da fé, já que a tradição perdera sua autoridade para a soberania do individual. A Declaração dos direitos do Homem e do Cidadão e o Código Napoleônico, ao focarem na liberdade da vontade como o fundamento substancial do Estado, similarmente, fizeram o direito histórico perder seu valor—uma vez que direitos e ética não seriam mais impostos de fora, enquanto mandamentos de Deus, mas fundamentados na vontade humana.

A expressão subjetividade poderia ter quatro conotações, Habermas continua: individualismo—singularidade infinitamente particular; o direito à crítica—aquilo que é reconhecido por todos deve se mostrar legítimo; autonomia da ação—a possibilidade de responder pelo que fazemos; filosofia idealista—a filosofia deveria assegurar de que sabe o que é (Habermas 2002, 121). A Modernidade, dessa maneira, ao quebrar com os parâmetros pré-modernos, ao ser estabelecida a partir da "liberdade" e da "reflexão," implicaria uma ruptura no tempo. O termo Modernidade não é aceito sem controvérsias, entretanto.

Para Marshall Berman a história da Modernidade possuiria três estágios distintos. O primeiro, quando as pessoas começam a experimentar a vida moderna sem ter ainda consciência do que as atingiu, iria do século dezesseis ao dezessete. O segundo estágio começariam em 1790, quando há a sensação de se viver em uma época revolucionária que provoca mudanças profundas. No seu terceiro estágio, o século vinte, a Modernidade perde a capacidade de dar sentido às coisas, uma época moderna que perdeu o contato com suas raízes (Berman 2007, 25-26). Kumar, por outro lado, não entende ser o século dezessete o início da Modernidade. Exceto por Descartes que, no *Discurso sobre o Método*, rejeita os modos antigos de pensamento para estabelecer um novo modo baseada na razão humana, desenvolvendo, assim, um novo método para buscar a verdade; de um modo geral, as conquistas modernas eram relacionadas à ideia de decadência (Kumar 1997, 89). Pelo progresso e crescimento, a humanidade tinha que pagar um preço: a decadência moral e espiritual.

Ao longo do século dezessete há o retorno de um pensamento apocalíptico que limitava o interesse no presente. O presente se torna um momento de preparação e espera por um futuro que era resultado da intervenção divina. A ação humana tinha pouca relevância. Somente na segunda metade do século dezoito a percepção do tempo e da história gradualmente cederia a um novo conceito de Modernidade (Kumar 1997, 91). Para que a ideia de Modernidade pudesse se desenvolver completamente havia a necessidade de exorcizar a visão apocalíptica do mundo, condição preenchida somente através da secularização do tempo cristão no século dezoito. A Modernidade não

era mais cópia degenerada dos tempos antigos, muito pelo contrário, começa a significar uma abertura de caminhos, ruptura com o passado, uma abertura a um tempo de progresso sem precedentes (Kumar 1997, 91). Os modernos são, dessa forma, aqueles que vivem em um novo mundo e deveriam confiar em si próprios para descobrir novos modos de agir e pensar. O novo enquanto valor, ou "time's irreversible arrow" (Latour 1993, 10), nos termos de Latour.

Mas a condição humana, Crake contra-argumentaria é o "wish to stop time" (Atwood 2003, 292). Frente à morte, os seres humanos, ao contrário de outras espécies, irão procriar, como última tentativa de driblar a morte, de continuar a viver, de buscar a imortalidade. Parar o tempo, como se pudesse reverter a seta que aponta para o grande final de todos nós: a morte. A frase de Crake parece a princípio uma resposta à pergunta de Jimmy: "what pays for all this?" (Atwood 2003, 292) mas o que segue à resposta cínica, irônica, desapegada é a apresentação da pílula BlyssPluss, cuja justificação residiria no fato de "we're running out of space-time" (Atwood 2003, 295). Há pouco tempo, não há tempo suficiente, antes que toda a espécie esteja condenada, "Grief in the face of inevitable death" (Atwood 2003, 292). A pílula BlyssPluss daria à humanidade, aos remanescentes pelo menos, a chance de um futuro melhor. Seus benefícios, proteção contra doenças sexualmente transmissíveis, fornecimento ilimitado de libido e juventude prolongada, seriam seus atrativos comerciais; seus efeitos contraceptivos, entretanto, não seriam divulgados. O interesse de Crake não residiria em seus benefícios. Os benefícios apenas atrairiam os compradores, garantiriam que a pílula atingiria uma parcela maior da população ao apelar à assim chamada natureza humana: "The tide of human desire, the desire for more and for better, would overwhelm them. It would take control and drive events, as it had in every large change throughout history" (Atwood 2003, 292). "Mais e melhor," diz Crake, a força por trás do impulso por novidade, por uma experiência sexual aprimorada. A pílula iria, dessa maneira, revolucionar as interações humanas ao apelar à necessidade por novidade, àquilo que parece impulsionar os seres humanos. A busca por "mais e melhor," a mesma que havia levado à escassez de espaço-tempo, faria, agora, a humanidade ganhar tempo, ao reverter a seta irreversível do tempo, garantindo uma melhor chance aos humanos. Face à iminente morte, a extinção humana, Crake tenta parar o tempo.

Lara Dodds, em "Death and the 'Paradice within' in *Paradise Lost* and Margaret Atwood's *Oryx and Crake,*" posiciona *Oryx e Crake* dentro de uma tradição da ficção científica que responde ao *Paraíso Perdido* de Milton. No romance de Atwood, o plano de Crake busca reverter o mito da queda, conforme Dodds. A nova raça de homens habitaria um novo éden, onde a consciência da morte seria inexistente. Após comer o fruto da árvore do conhecimento do bem e do mal, Adão e Eva ganham consciência de sua mortalidade. Repentinamente, percebem que sentem vergonha de seus corpos nus. Tornam-se conscientes dos componentes corpóreos que fazem o que são – corpos que apodrecem, corpos que morrem. Conversamente, a raça bioconstruída que Crake vislumbra não possui consciência da morte. O aspecto físico da morte ainda existe, já que seus corpos são programados a morrer. "As crianças de Crake", todavia, não sabem que vão eventualmente morrer e são mantidas nesse estado de inocência, em um éden bioconstruído, em um mundo pós-apocalíptico. Crake deseja parar o tempo, então, ao retornar a humanidade ao estado anterior à consciência da morte, antes de a humanidade ser determinada pelo fluxo do tempo: "To be subject to death, as Adam and Eve are following the Fall, is to be subject to the gap between the duration of one's life and the shape of time. It is in this sense that human history can be said to begin with the Fall (. . .)" (Dodds 2015, 128). Parar o tempo, nos termos de Crake, poderia ter dois sentidos. Primeiramente, poderia significar a ilusão da imortalidade. Não ter consciência da morte implicaria não sofrer em antecipação, o que poderia resultar na não percepção da passagem do tempo. Em segundo lugar, poderia prolongar a existência dessa nova raça recém-criada. Menos indivíduos mais adaptáveis à mudança climática e aos perigos de um meio-ambiente alterado provavelmente causariam menos danos ao meio-ambiente, garantindo tanto a permanência da espécie e a do mundo. Parar o tempo, contudo, somente seria possível ao modificar a "natureza humana" através dos estágios do seu plano. Primeiro as pílulas como Crake explica, "The BlyssPluss Pill was designed to take a set of givens, namely the nature of human nature, and steer these givens in a more beneficial direction than the ones hitherto taken" (Atwood 2003, 293). A pílula que mataria basicamente toda a raça humana, exceto por alguns indivíduos, assim o faria ao "manipular" a assim chamada natureza, ao fazer a natureza trabalhar a favor de um plano previamente concebido. E após a extinção massiva, uma nova raça aprimorada dominaria. Paradice Project era seu nome. Ao alterar o antigo cérebro primata, características destrutivas tais como racismo, hierarquia, territorialidade e tormentos derivados da sexualidade seriam eliminados e esses seres aperfeiçoados repovoariam o mundo no seu modo ecologicamente amigável. Havia um porém, no entanto, Crake alerta

Jimmy:

> *Watch out for art*, Crake used to say. *As soon as they start doing art, we're in trouble*. Symbolic thinking of any kind would signal downfall, in Crake's view. Next they'd be inventing idols, and funerals, and grave goods, and the afterlife, and sin, and Linear B, and kings, and then slavery and war. (Atwood 2003, 361)

As preocupações de Crake estão em sintonia com as preocupações de Raphael em *Paraíso Perdido* de Milton. "But apte the Mind or Fancie is to roave / Uncheckt, and of her roaving is no end" (Milton 1952, 236), Raphael alerta Adão. Cuidado com a imaginação, em breve estará pesando em mundos invisíveis, imaginando coisas remotas, distantes da vida diária, em breve estará transgredindo, pergunto? É isso? Curiosamente, Lúcifer, logo após ser expulso do Paraíso por não concordar com um decreto que logicamente ofenderia os princípios pelos quais os anjos haviam vivido até então – igualdade e liberdade—percebe que não importa onde estivesse, Paraíso ou Inferno, algo se mantém inalterado: "A mind not to be chang'd by Place or Time" (Milton 1952, 99). Sua resistência ao decreto tirânico seria sua própria mente. Muito melhor ser livre no Inferno que servir no Paraíso, já que, "The mind is its own place, and in itself / Can make a Heaven of Hell, a Hell of Heaven" (Milton 1952, 99) "a Heaven of Hell, a Hell of Heaven", diz Lúcifer, enfatizando, dessa forma, o poder reflexivo da mente. A reflexão se torna visível pela inversão das palavras. A apresentação física (visível) do verso se alinha ao seu conteúdo, não havendo disjunção entre significante e significado, uma vez que ambos apontam para a ideia de reflexão. Reflexão, espelho, especulação. O que a mente faz? A mente especula, e ao fazê-lo altera a realidade do seu entorno. Paraíso pode ser Inferno e Inferno, Paraíso basta a mente querer. E as possibilidades são inúmeras, adverte Raphael. Sem limites, fronteiras, limitações, o voo não tem fim. Os homens imaginam, Crake continuaria, que existe uma vida após a morte, que há uma alma, que a alma deixa o corpo quando morremos, que nossas almas vivem em outra dimensão, que a poesia poderia alcançar a imortalidade, que há um Deus e uma Natureza: "'I don't believe in Nature either', said Crake. 'Or not with a capital N'" (Atwood 2003, 260). E o que significaria acreditar em uma natureza com n ao invés de uma natureza com N? O que muda ao pensar na Natureza enquanto sujeito ou enquanto objeto?

Significa que para Crake o conceito de Natureza havia sido superado, que estaríamos vivendo em um mundo pós-natureza. Christophe Bonneuil, em *The Geological Turn: Narratives of the Anthropocene*, entende que o termo pós-natureza pode adquirir diferentes sentidos. O discurso da Modernidade sempre atrelou sentido à libertação humana do determinismo natural. A reflexão (consciência) permitiu à humanidade ganhar mais e mais liberdade com o passar do tempo. Mais consciência significava mais liberdade e a liberdade subjetiva, conforme Hegel, permearia os tempos modernos. A separação entre cultura e natureza é, todavia, questionada quando o conceito de Antropoceno é trazido à discussão. Conceber a espécie humana enquanto uma força geológica que altera a Terra significa que ambos domínios—humano e planetário—estão mais enredados que previamente pensado. Ademais, as diferentes temporalidades—planetária e humana—não estão separadas, no fim das contas. A mudança climática, a acidificação dos oceanos, os terremotos e tsunamis, a escassez de "tempo-espaço" como Crake menciona, têm um papel na história humana. Não há história humana sem o seu contraponto natural. A natureza não é mero cenário para a história humana, uma vez que cultura e natureza nunca estiveram separadas. A assim chamada Grande Divisão não fora nada além de uma falácia, nos termos de Latour, uma vez que nunca fomos modernos. Natureza com N maiúsculo fora apenas uma construção romântica, Crake diria. A aceitação da ideia de pós-natureza se, de um lado, incutiria humildade em nosso trato com o planeta, já que o paradigma de excepcionalismo humano seria desacreditado; por outro lado, poderia levar ao chamado "bom Antropoceno:"

> [T]here will no longer be an environment that is external (read: hostile) to humankind. Not so much because man will be transfigured by technology, as Singularitarians dream, but because the old Nature will be recodified (or rather re-axiomatized) by the capitalist machine as merely a matter of managing resources, of environmental governance—everything according to so-called "best practice." The anthropic dream of the Moderns would thus be finally materialized: a post-environmentalism in which man will find himself contextualized and sustained only by himself, surrounded by the immense accumulation of commodities, energized by his shiny new and super-safe nuclear centrals (with cold-fusion reactors, if possible), and relaxed by large and pleasant ecological leisure areas, populated of course by a carefully curated, genetically enhanced flora. (Danowski and Viveiros de Castro 2017, 49)

As duas principais estórias de *Oryx e Crake*, o passado e o presente de Snowman, acontecem em diferentes momentos do bom Antropoceno. A vida de Jimmy, nos complexos, em Martha Graham, era cercada por tecnologia, por comidas

e até animais de estimação bioconstruídos; uma vida atrás dos muros dos complexos onde tudo era controlado e ordenado, onde a vigilância era a norma e as pessoas não podiam ir e vir como queriam. Viver nos complexos era viver em uma bolha, artificialmente protegido da dura mudança ambiental em volta. Não é de se admirar que a mudança climática e as catástrofes tomem a forma de comentários um tanto a propósito, quase como notas de rodapé, descrições apressadas que parecem deslocadas da ação principal:

> Still, as time went on and the coastal aquifers turned salty and the northern permafrost melted and the vast tundra bubbled with methane, and the drought in the midcontinental plains regions went on and on, and the Asian steppes turned to sand dunes, and meat became harder to come by, some people had their doubts. (Atwood 2003, 24)

De acordo com Adam Trexler, a mudança climática

> is little more than a footnote to the novel's concerns. Atwood describes a world where hierarchical, corporate capitalism and biotechnologies allow the unprecedented exploitation of human bodies. The world population is decimated by a virus engineered in the center of the corporate machine, and a new race of posthumans is positioned to live more sustainably. (Trexler 2015, 196)

A mudança climática não é uma questão no romance. É, entretanto, o contexto a partir do qual novas tecnologias emergem. É o contexto que impulsiona mais e mais avanços científicos. A busca por "mais e melhor" que dotou a humanidade de agência geológica continua a ser o impulso atrás dos muros dos complexos. A ciência responde à mudança ambiental e às novas demandas impostas por um meio ambiente alterado. A mudança climática é, então, uma questão do romance. Como viver em mundo alterado, o romance se pergunta? Por que tipo de humanos a mudança climática e os desastres ambientais pedem? Como garantir a permanência humana em uma época pós-humana? O romance é, então, sobre a agência humana face ao colapse ambiental: sobre o gerenciamento humano, sobre viver no bom Antropoceno. E quando a primeira tentativa parece falhar, quando há ainda escassez de "espaço-tempo" apesar de tudo, Crake coloca o seu plano em ação: uma nova raça, uma raça aperfeiçoada, uma raça bioconstruída. Crake quer parar o tempo, reiniciá-lo, voltar ao início.

A mudança climática está para além dos portões dos complexos. Nesses espaços murados, onde ciência e dinheiro se combinavam, qualquer mudança no nível do mar, escassez de carne, extinção animal e aumento na temperatura global eram mitigados por novas tecnologias e biotecnologias que forneceriam espaços confortáveis para se viver. A mudança climática estava, enquanto realidade, basicamente superada, algo do passado, trazida quando o passado era evocado: "[. . .] like the beach house her family had owned when she was little, the one that got washed away with the rest of the beaches and quite a few of the eastern coastal cities when the sea-level rose so quickly, and then there was that huge tidal wave, from the Canary Islands volcano" (Atwood 2003, 63). Os complexos eram, assim, o mundo pós-natureza e pós-mudança climática. Os complexos eram também, não somente uma realidade, espaços de status e poder, mas também a grande metáfora para um romance obcecado com fronteiras, muros, limites, binarismos:

> The Compounds encapsulate corporate "yes" culture in a spatial metaphor of bringing together into one place all those who have "opted in," who have internalized the goals, truth, and ethics of the company as their own, and excluding or expelling everything that is threatening to this homeostasis. (Crooke 2006, 69)

Desde o início sabemos que há duas categorias de pessoas: a dos números e a das palavras. Crake se enquadra no perfil das pessoas "dos números", enquanto Jimmy cai na categoria "das palavras." A dualidade permeia o romance, sendo recorrentemente mencionada e ajuda a entender os sucessos e fracassos de ambos. Suas habilidades científicas ou retórico-linguísticas eram fatores determinantes não apenas nas universidades em que eram aceitos e nas ofertas de emprego que recebiam, como também onde viviam. Numa sociedade técnico-científica, onde a natureza havia sido superada e a mudança climática era coisa do passado, ter orientação científica, ou ser uma pessoa "dos números", nas palavras de Atwood, era realmente rentável. Como os complexos era espaços movidos pela ciência, os melhores cientistas tinham os melhores empregos e viviam nos melhores complexos. A busca por "mais e melhor" levava a diferentes mudanças de casa e determinava quão contingente as relações eram: "Kids came and went, desks filled and emptied, friendship was always contingent" (Atwood, 2003, 71). Por trás de toda cientificidade, no entanto, estava o grande catalista da mudança social: dinheiro.

Interesses científicos e de pesquisa não existiam em si próprios, entretanto. O romance não apresenta um conto da ciência enquanto um fim em si próprio; muito pelo contrário, interesses científicos eram circunstanciais, mais baseados na demanda que na natureza investigativa. A ciência era apenas uma commodity, e uma bem lucrativa, é necessário acrescentar.

A divisão entre pessoas "dos números" e "das palavras," ou em

termos gerais, entre ciência e humanidades, pode ser entendida como Stephen Dunning compreendeu enquanto uma forma de extrapolar a divisão dos campos de estudos e alertar contra as suas consequências. *Oryx e Crake* seria, assim, um conto preventivo sobre os perigos de se conceber o conhecimento cientifico sem levar em consideração as preocupações humanas. As questões humanas deveriam mediar o conhecimento científico, deveriam frear a ambição por "mais e melhor." A ambição por mais dinheiro?

Crake representa a divisão clara entre os diferentes campos de saber: "His clothes were dark in tone, devoid of logos and visuals and written commentary—a no-name look" (Atwood 2003, 72). Até em sua escolha de roupas Crake revela sua falta de afinidade com as palavras. O visual lacônico de Crake pode ser lido como uma metáfora para o seu comportamento com o mundo. As roupas deveriam ser roupas e nada mais, deveriam apenas servir para cobrir seu corpo. Tudo existia por uma razão, conforme Crake: "Crake is a biological determinist, believing also in a logical biology, a biologic of sense. Art, for instance, exists for a purely biological function" (Crooke 2006, 77). A arte servia um propósito, assim como as palavras, apenas isso.

Apesar de Jimmy ser o exemplo clássico de uma pessoa "das palavras," ambos amigos era mais parecidos do que era de se esperar. Ser uma pessoa "dos números" ou "das palavras" não implicava serem opostos, significava, contudo, ocupar diferentes espaços murados: "There had been something willed about it though, his ignorance. Or not willed, exactly: structured. He'd grown up in walled spaces, and then he had become one. He had shut things out" (Atwood 2003, 184). Jimmy expulsava, calava as coisas, assim como Crake, ou até mesmo os complexos. Há diferentes níveis, assim, de expulsão de coisas no romance. Conforme mencionado, através dos personagens, espaços, linhas, estórias, o romance mostra a sua obsessão com fronteiras, limites, limitações. *Cuidado com a arte*, diz Crake, estabelecendo outro limite para os pós-humanos, "As crianças de Crake." Mas por que a arte, Crake, pergunto?

Ao longo do romance, Snowman luta com a linguagem. Há o sentimento de que a linguagem está escapando de si, de pouco em pouco. Ele esquece as palavras, seus sentidos: "Hang on to the words," he tells himself. The odd words, the old words, the rare ones. Valence. Norn. Serendipity. Pibroch. Lubricious. When they're gone out of his head, these words, they'll be gone, everywhere, forever. As if they had never been" (Atwood 2003, 68). Mas por que as palavras antigas, Snowman?

Como Snowman acredita ser o ultimo homem vivo, algumas palavras existem apenas em sua mente. São os resquícios de um modo de vida passado, de um tipo de humano antigo. Palavras raras, antigas, assim como ele, um raro ser humano, tão diferente da beleza aperfeiçoada das "crianças de Crake." Assim que morrer, a vida humana como tal desaparecerá para sempre, e o mesmo se diz da linguagem. Os humanos aperfeiçoados de Crake ainda usam a linguagem para se comunicar mas não conheciam a malícia: "but these people didn't go in for fancy language: they hadn't been taught evasion, euphemism, lily-gilding. In speech they were plain and blunt" (Atwood 2003, 348). Seu uso da língua era mais prático, diário, literal. Por que teriam que recorrer a um conceito tal como acaso, tão distante de suas preocupações diárias, tão distante de sua nova realidade? A linguagem de Snowman referia a um tipo de experiência passada: "I used to be erudite," he says out loud. Erudite. A hopeless word. What are all those things he once thought he knew, and where have they gone? (Atwood 2003, 148). Fora dos complexos, entretanto, além do mundo murado, das experiências muradas, do mundo fechado do conhecimento estabelecido, além da soberania do sujeito, o saber sabido não dava conta desse novo mundo. As palavras esvanecem, perdem sua solidez, tornam-se, de uma hora para outra, insuficientes; de repente, a sabedoria se transforma em tolice, tal como Raphael imaginara. Assim que a fronteira é ultrapassada, o conhecimento, as palavras, os conceitos, tornam-se escorregadios, contingentes, vazios.

Há outra dimensão para as questões de Snowman. Após o mundo ao seu redor se alterar, ele tenta ainda se ater ao familiar, como se tentasse compensar a perda de controle. Ele sempre fora uma pessoa "das palavras," alguém que achou seu espaço no mundo científico através de sua habilidade linguística. A publicidade fora a sua saída. A publicidade, entretanto, implicava uma relação específica com as palavras: "Reading a poem introduces some wiggle room between ideas and ways of having them. Propaganda closes this space down" (Morton 2018, 30). As palavras, assim, estariam à disposição de Jimmy. A atitude de Jimmy, segurando as palavras, fazendo-as significar o que queria, mandando nelas (nas palavras), assemelha-se à atitude de Crake com relação ao mundo. Pessoas de números ou de palavras são mais parecidas que esperado. E conforme Timothy Morton nos alerta, "It's not what you think but *how you think* that starts World War III" (Morton 2018, 33). Não o que se pensa—questões científicas ou humanas—mas como se pensa. Em *Oryx e Crake*, a ciência cumpria um propósito, assim como as palavras. É, então, a apoteose do dualismo sujeito-objeto, o desaparecimento de um mundo onde tudo que podia era objetivado. Comodificação pura e simples. E quando os muros entre o mundo humano perfeitamente construído e o mundo em volta racha, quando os humanos perdem o controle de um mundo que não pode mais ser programado, previsto, as palavras falham. È a experiência inimaginável? Supera as nossas habilidades humanas de compreensão? Virou a sabedoria tolice?

Somente o desejo humano de parar o tempo, Crake nos alerta, mas que tempo, pergunto, de quem? Paradice Project de Crake e sua tentativa de negar aos pós-humanos, à

nova raça recém-criada, a consciência da morte é uma forma quase muito literal de reverter a queda do homem. A nova raça seria mantida nessa inocência eterna, vivendo uma vida mais ecológica. É também a tentativa de começar tudo novamente do zero.

Mas "Everything emits time, not just humans" (Morton 2018, 77). Então de que tempo se fala, pergunto? Toda a experiência do tempo, Crake diria. Em nenhum momento os não humanos entram na conta de Crake. Suas temporalidades nunca foram reconhecidas. E quando os desastres ambientais atingiram o globo, modificando a vida tal como era conhecida, o mundo não humano continuou a ser excluído. A humanidade achou um jeito de banir os não humanos, negar-lhes temporalidade, de parar o tempo. Os complexos, assim, funcionavam como uma forma de evitar a consciência ecológica: "Ecological awareness is shaking our faith in the anthropocentric idea that there is one scale to rule them all—the human one" (Morton 2018, 22). A medida humana continuou a ser a regra até que a escassez de espaço-tempo fora tanta que a negação não era mais possível. Espaço e tempo, as duas condições a priori da sensibilidade humana se mostraram condicionadas no fim das contas. "This is one of the ways, and not the least important, in which it can be said that our world has ceased to be Kantian" (Danowski and Viveiros de Castro 2017, 9). Os homens se revelaram incapazes de serem elevados para além da ordem fenomenológica e da causalidade. Eles não eram os legisladores da natureza, no fim das contas, mas estavam sim presos fenomenologicamente e condicionados tanto pelos mundos humano quanto não humano: "You aren't outside the biosphere looking in. You are glued to the biosphere phenomenologically" (Morton 2018, 41). As fronteiras não foram suficientes, pois. Eram mais porosas que o esperado. Crake, entretanto, ao invés de aceitar a porosidade das fronteiras, ao invés de reconhecer o mundo não humano, decidiu dar fim à vida humana tal como conhecida, voltar ao início, porém, com uma mudança. O começar do zero era ainda condicionado: "*Watch out for art*, Crake used to say. *As soon as they start doing art, we're in trouble*. Symbolic thinking of any kind would signal downfall, in Crake's view" (Atwood 2003, 361).

A arte determinava o sucesso ou o fracasso do projeto. O voo da imaginação não tem limites, Raphael alertou a Adão, não conhece fronteiras, podemos inferir. A imaginação traz visibilidade à dimensão invisível, estabelece conexões não aparentes. Raphael iguala a mente à imaginação, como se fossem as duas uma só, como se compartilhassem de características similares. O voo da imaginação não tinha limites, assim como não tinha o da mente. Lúcifer concordaria: a mente era seu próprio lugar, tinha o poder de alterar o espaço e o tempo, o poder de ser um espaço de resistência. Para Lúcifer, a mente se tornara símbolo de liberdade. Como se libertar do decreto divino? Através da mente. Lúcifer se tornara, assim, sujeito:

> He is a "subject" in our contemporary theoretical sense (the "humanist subject"), and certainly his troubled "I" is prominent in the poem. But he is a "subject" also in the more literal, root sense of the term (sub iectus, thrown under): he discovers at the moment of his rebellion just what it means to be subject to God. Subjection is the origin of his subjectivity. (Forsyth 2003, 150)

Sua busca pela liberdade, pelo incondicionado, é a origem de sua subjetividade. Então, a nova raça, "as crianças de Crake" poderia ter chance apenas se a subjetividade não emergisse? Se o princípio por trás da ideia da Modernidade, como Hegel afirma, não norteasse o progresso da humanidade? O problema não é o que se pensa, diria Timothy Morton, mas como se pensa.

Snowman descobre que os Crakers, apesar da tentativa de Crake de eliminar qualquer pensamento simbólico, o ponto G do cérebro como chamava, têm curiosidade de saber sobre suas origens, são ansiosos por criar narrativas: "They're up to something though, something Crake didn't anticipate: they're conversing with the invisible, they're developing reverence" (Atwood 2003, 157); cantar e sonhar não eram as únicas programações humanas. O pensamento simbólico parece ser parte da natureza humana. A queda humana novamente? Hora zero, Snowman nos avisa.

Mas, e se a subjetividade permitisse uma nova experiência? Uma na qual espaços murados não fossem a realidade e a exclusão não fosse a norma? E se não deixarmos nada passar, como Isabelle Stengers sugere que façamos (Stengers 2015, 143)? E se aceitássemos total responsabilidade pela realidade de nossas abstrações? E se amássemos nossos monstros?

Cuidado com a arte, Crake diz. Não há como negar que o pensamento abstrato, simbólico permite apropriação, ao eliminar qualquer escala que não seja a humana. Mas não haveria outro lado? A experiência estética implica solidariedade com o que não é humano, Timothy Morton responderia, cuidado por algo que não é um ser humano. Ademais, a beleza é indiferente ao sujeito. A experiência estética poderia, devido a sua estranheza (Morton 2018, 65), nos prover com um pouco de estranheza (familiaridade não-familiar) necessária para destronar a soberania do sujeito: "this feeling of openness, this uncanny sensation of finding ourselves somewhere and not recognizing it, is exactly a glimpse of living less definitively, in a world comprised almost entirely not of ourselves" (Morton 2018, 26). Viver menos definitivamente seria a chave, então?

"É hora zero," diz Snowman. É hora de ir.

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Little Learners, Big History, Bigger Future: How Big History Widened the Worldviews of 8-9 Year Olds

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Abstract

This article is based on a workshop I presented at the 2018 Big History International Conference in Philadelphia, where I addressed findings from my recently completed PhD thesis: *An Tairseach (threshold): An exploration of connecting the emerging scientific story of the universe to authentic Catholic primary school environmental education.* My research investigated the extent to which students' environmental values could be informed through integrating story, values, environmental education, personal cultural origins, and Big History into the primary school curriculum. The methodology focused on employing Big History as a vehicle to achieve a cohesive, wider worldview for young learners, empowering them to engage in transformative thinking for the future. Semi-structured interviews were conducted along with a 17-week Big History pedagogical program with 8-9 year old students and their teacher. Qualitative analysis of these interviews indicated that primary students[1] could successfully access a shared, evidence-based and flexible narrative. Five interdependent themes emerged: 'shared vocabulary and knowledge of Big History' were foundational in allowing students to engage in meaningful discussions, alongside their knowledge of their 'local cultural origin stories,' 'local school values,' 'transdisciplinary learning' and 'environmental values within socioecological learning.' The findings have wider implications for the Big History collective, providing evidence that Big History is accessible and relevant to primary students within a transdisciplinary based and critical inquiry-learning structure.

[1]Primary education is the term used in Australian schools to describe schooling for 5-11-year-old students. In this particular article the term more particularly pertains to middle primary years (8-10-year-old students).

Orientation

In keeping with the essence of the chronological 'story' of Big History, particular scenes from *Alice's Adventures in Wonderland* have resonated with me throughout my PhD journey.

> *In another moment down went Alice after* [*the rabbit*]*, never once considering how in the world she was to get out again. . . . The rabbit-hole went straight on like a tunnel for some way, and then dipped suddenly down, so suddenly that Alice had not a moment to think about stopping herself . . . .* (Carroll 1886, Prologue)

I invite you to share in my journey down the PhD rabbit hole.

Reviewing the storyline—Literature review

The literature reviewed needed to inform my query: if I adapted the Big History online project (2019) for 8-9 year old students in a Catholic school, would it inform them with an additional perspective to explore environmental education through the lens of our precious universe?

> *There were doors all round the hall, but they were all locked; . . . trying every door, she walked sadly down the middle, wondering how she was ever to get out . . . .*
>
> *Suddenly she came upon . . . a tiny golden key. . . .* [*S*]*he tried the little golden key in the lock, and to her great delight it fitted!* (Carroll 1886, Chapter 1)

My contemplation for my research involved how the cohesive universe story, as told in Big History, could inform values in environmental education from the perspectives of international and Australian environmental education documents, the positioning of the Catholic Church, and the mandatory Australian curriculum in Catholic primary environmental education.

Weaving aspects of the story: International, Australian, and Catholic environmental education values

When considering values as integral to my research, I referred to international documents that stress their significance. These include *The Belgrade Charter* (UNESCO-UNEP 1976), also sanctioned in the *Declaration of Thessaloniki* (UNESCO 1997), where it set ground-breaking future directions for the consideration of values in environmental education with the objective that individuals and groups be helped to acquire "social values and strong feelings for the environment" (2), as well as the *Tbilisi Declaration* (UNESCO-UNEP 1978, 1.3), and *Agenda 21* (United Nations 1992, 36.33), both of which echoed *The Belgrade Charter* as being indispensable to addressing environmental awareness in education. The commonality of terms in such documents informed my research forward.

Other key international environmental educational literature addresses the importance of framing knowledge, values and transdisciplinary approaches in policies (see UNESCO 2012; UNESCO Education sector 2012; UNESCO-UNEP 2008, 2012). United Nations (1987) advocated a transdisciplinary approach where "environ-mental education should be included in and should run throughout the other disciplines of the formal education curriculum at all levels" (1987, 96). This appropriates to recent calls from the International Catholic sector in Pope Francis' statement:

> *The fragmentation of knowledge and the isolation of bits of information can actually become a form of ignorance, unless they are integrated into a broader vision of reality. . . . We are part of nature, included in it and thus in constant interaction with it.* (Francis I 2015)

Australian education research likewise has addressed the importance of values in developing curriculum (Board of Studies 2010; Lovat, Dally, Clement, & Toomey 2011; Mitchell 2012). In promoting transdisciplinary learning, the current *Australian Curriculum* (ACARA 2019) embeds a sustainability cross-curriculum priority aimed at effecting a change in centring environmental education across the mainstream core subjects. That is highly significant for the study as one quarter of students attend Catholic schools in Australia, where the *Australian Curriculum* is mandatory. Not only does this place importance on transdisciplinary learning but also highlights that *The Melbourne Declaration on Educational Goals for Young Australians* (2008) is publicly acknowledged as the foundation of the Australian curriculum (see

ACARA, 2013; Board of Studies 2010; Hamston et al. 2010; Lovat et al. 2011; MCEETYA 2008; Mitchell 2012).

The emphasis on transdisciplinary learning is also in keeping with Big History's storyline that transverses multiple disciplines. In the words of Christian (2011),

> *It is one of the many odd features of modern society that despite having access to more hard information than any earlier society, those in modern educational systems…teach about (our) origins in disconnected fragments. We seem incapable of offering a unified account of how things came to be in the way they are.* (2)

The story thread weaves through my research to converge logic, faith, and values in both secular and Catholic writing (Benjamin 2009, 5). In a radio interview, David Suzuki (ABC Radio National 2016 at 39.00 mins.) articulated a similar inclusive view:

> *I've been an atheist all my life. . . Laudato Si (Francis I 2015) is a magnificent document and I regret that'we' (environmentalists) didn't write it first, but what he (Pope Francis 1) has done is take issues of social justice, hunger and poverty and the environment and he's never split them into silos—they're all together.*

The above document correlated with Suzuki's own vision for the future of the environment where a whole-systems approach embraces social justice, hunger, poverty, and the environment, rather than being viewed in the silos of our own limited cultural worldviews (Sterling, 2011). Snaza and Weaver (2015) request that education "call into question the entirety of the discipline structure" and cut across the divisions (disciplines) "all constructed around the human" (5). The impressions of Suzuki, Sterling, and Snaza, and Weaver add weight to the findings of this research, that anthropocentric thinking could be transcended by Big History to broader, transdisciplinary socioecological thinking, thus empowering students with a whole- systems worldview. Further, such thinking transcends and is inclusive of local cultural norms, which, in the setting of my research, involves Catholic education values.

Theoretical framing

> *Alice replied, rather shyly, "... I knew who I was when I got up this morning, but I think I must have been changed several times since then." (Carroll 1886, Chapter 5)*

Narrative, when viewed from an environmental education perspective, "*fundamentally* alters our relation to the world, our relation to others, and our relation to our humanity. . . . It intertwines the condition of the world with the condition of our humanity" (Rodriguez 2002, 6). The review of relevant literature changed the frame of my thesis story to both socioecological education, linking environmental values to Sterling's understanding of whole-systems thinking (2003, 2011, 2016), and curriculum theory (see Pinar 2012; Wraga & Hlebowitsh 2003). In underpinning transdisciplinary learning in socioecological education, students in this study were empowered to incorporate an understanding of the changing deep-time universe metanarrative, with the interconnected interrelationships of ecological, social, economic, and holistic perspectives of socioecological education (Berry & Swimme 1992; Bowers 1994; Catholic Earthcare Australia 2013, 2017; Johnson & Duberley 2000; Wallette & Edgren 2013).

Figure 1 below illustrates my framing, centered on values where Environmental and Religious Education informed and were informed by a broader transdisciplinary educational model of curriculum theory

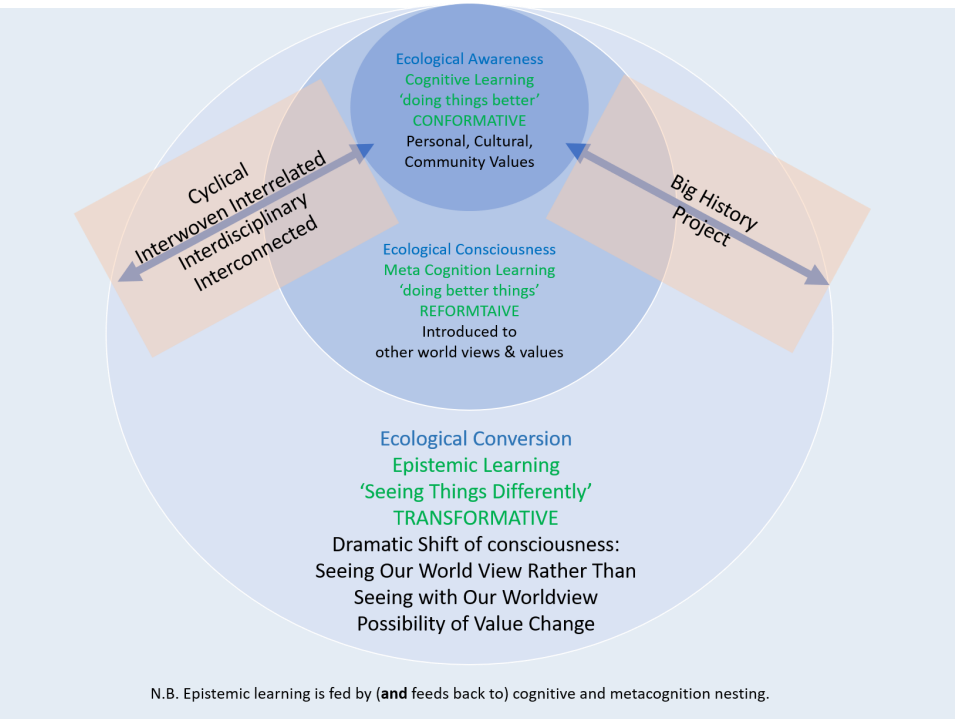

Figure 1. An Tairseach: A framework for transforming our story

and systems theory. In this framework the Big History unified account of the emerging story of the universe was adapted to incorporate whole-systems thinking (see Burford et al. 2013; Dahl 2012; Podger et al. 2010, 2013). Figure 1 incorporates my framing of opportunities for growth in learning. It merges both the Catholic environmental terminology (ecological awareness, ecological consciousness, and possibility for ecological conversion), alongside Sterling's theory (2011, 25) of conformative learning ('doing things better'), to reformative learning ('doing better things'), and the possibility of transformative learning ('seeing things differently').

Designing the story: Methodology and Method

> Humpty Dumpty advises Alice:
> *It would be just as well if you'd mention what you mean to do next, as I suppose you don't mean to stop here all the rest of your life. (Carroll 1872, Chapter 6)*

My next steps revolved around an action-based methodology, within whole systems thinking, to develop a qualitative, interpretative, and participatory research design. The action research took place within a child-framed ethnographic and cyclical framework. Figure 2 represents the nesting of my research methodology and methods, summarising my directions for the alignment of the chosen overarching theoretical model of values viewed from the perspectives of transdisciplinary and whole-systems thinking (see Lewis & Baudains 2007; Sterling 2003).

The setting was a third grade classroom of thirty students in a Catholic primary school. It involved fifteen eight to nine-year-old students and their teacher. The positive learning environment encouraged child-framed learning opportunities (see Spyrou 2011; Kellett 2010)

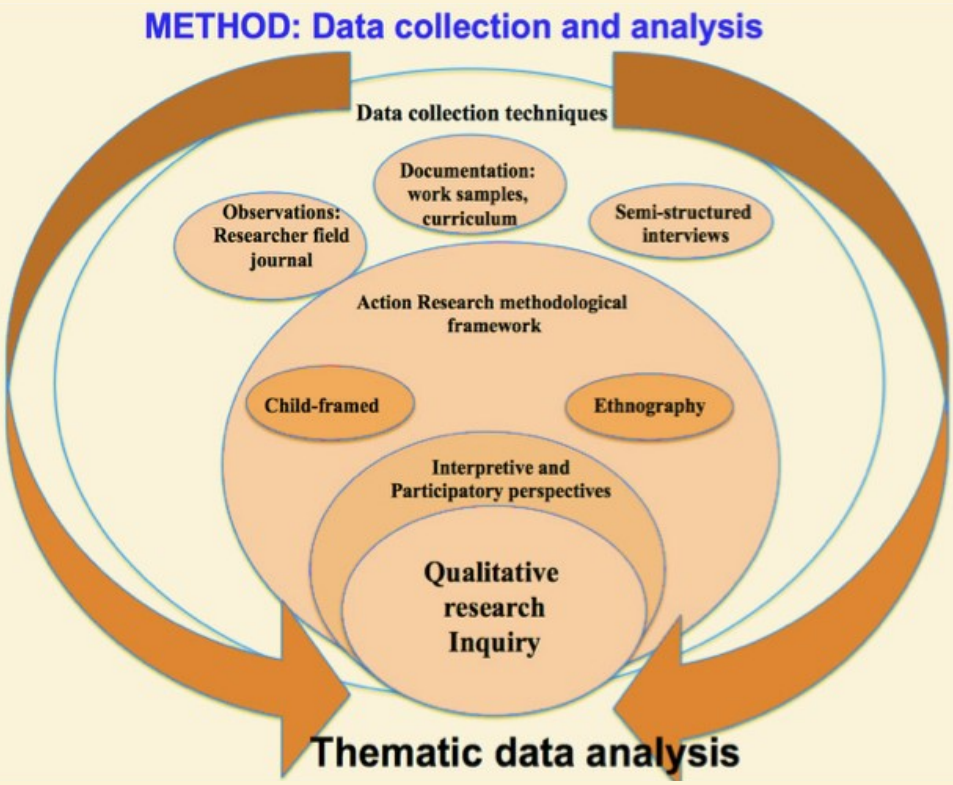

Figure 2.
Method: data collection and analysis.

based on a shared understanding with students that both the classroom teacher and I as researcher were lead-learners in the classroom.

The methods consisted of six semi-structured interviews of three to four students, conducted before, during, and after the implementation of a Big History pedagogical program. Data were principally gathered from the semi-structured interviews and were inclusive of evidence contained in student writing. Researcher journal observations added to the rich data collected during the visible learning pedagogical intervention (see Hattie, 2013).

Analysis of Data

"Alice asked, 'Would you tell me, please, which way I ought to go from here?'" "'That depends a good deal on where you want to get to,' said the Cat." (Carroll 1872, Chapter 6) My research question and data analysis directed me toward five themes that were not seen as linear but rather fed into and informed each other, as represented in an adaptation of Sterling's nesting framework (2003, 2011, 2016) in Figure 3 below.

Nesting the Findings

I present the following findings through my own reflective interpretations of the analysis, alongside the authenticity of class teacher and students' voices as my co-researchers.

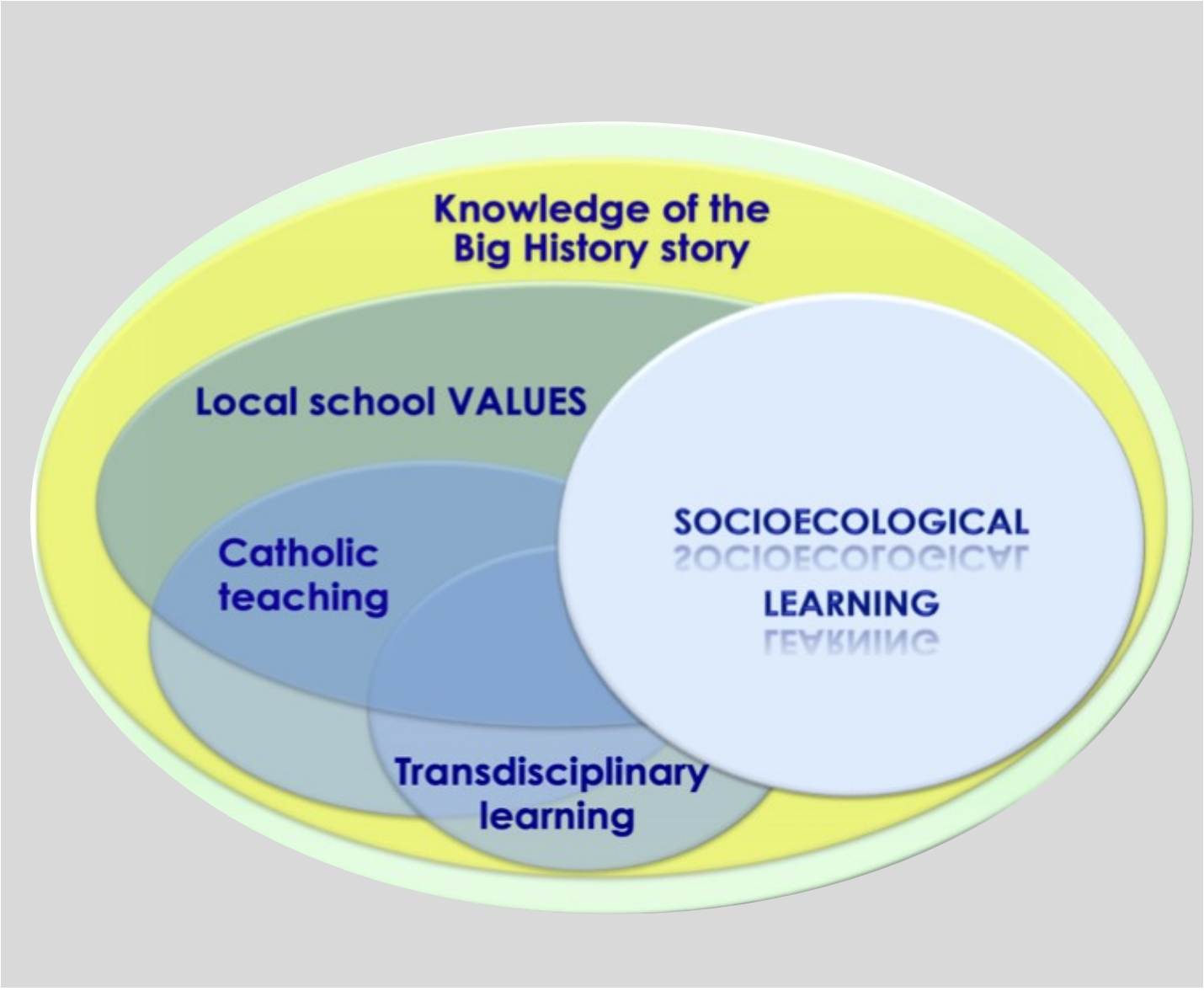

Figure 3.
Extending the storyline: nesting themes

THEME 1. KNOWLEDGE:

The extent the emerging story of the universe, taught through the vehicle of Big History, contributed to informing students' critical knowledge

Justification for the emphasis on teaching explicit knowledge and vocabulary of Big History became evident as students' learning in the pedagogical intervention progressed. The following two interview excerpts were recorded before students' Big History learning. As can be noted, students voiced a variation in the depth of knowledge and vocabulary, but both interview extracts display the lack of a cohesive understanding of the universe timeline.

Researcher:	*Do you think you know everything there is about the universe?*
Mia:	*I reckon a bit more.*
Aaron:	*A bit more.*
Indi:	*I know all about it.*
	(Pre-pedagogical interviews, 29-30 June 2016)
Aidan:	*The universe has a lot of planets, all the planets, and it holds stars and no oxygen.*
Aidan:	*No gravity, no oxygen.*
Jack:	*Because gravity is oxygen, if there is no gravity, there is no oxygen.*
Aidan:	*Yup. That's definitely correct. I agree with him 100%.*
Jack:	*I think I know what the Big Bang is. I think it is when all the planets were together. I have seen on some commercial that they said all the planets were like one big planet and maybe the Big Bang was when they exploded into the planets.* (Pre-pedagogical interviews, 29-30 June 2016)

In comparison, the evidence in the following excerpt, from a post-pedagogical intervention interview, validates students' growth in knowledge and use of appropriate vocabulary while also enabling student initiated inquiry.

Aidan:	*DNA is in many things. It can be in my blood and when the zipper opens, sometimes it can't make the exact same DNA parts so it's slightly different, but they're not really different. That's how everyone looks different.*
Researcher:	*Are there any words you now know?*
Jack:	*Astronomy, astronomer, scientist, archaeologist, … origin story, history*
Aaron:	*Goldilocks conditions*
Researcher:	*What does that mean for Big History?*
Jack:	*Just right. . . . Thresholds [looking very pleased with his answer].*
	Claim testers . . . to learn about what to ask the experts and knowledge and evidence but in scientific language.
Aidan:	*Intuition, gut feeling*
Theo:	*Light years*
Jack:	*Authority*
	(Fourth pedagogical interview, 17 October 2016)

The latter excerpt shows the students accessing and confidently sharing their common learning. Aaron, in particular, previously had been reticent to join in with routine class discussions, but in this case, was empowered with his newly learnt Big History knowledge and vocabulary.

The critical importance of informing students' knowledge created a meaningful platform for informed, child-framed discussions in student interviews as revealed in the next excerpts.

Mia:	*It's* [*zipper is*] *an example where DNA just keeps on splitting and splitting and splitting . . .*
Researcher:	*What happens every time it splits?*
Mia:	*It makes more DNA.*
Aidan:	*DNA is in many things. It can be in my blood and when the zipper opens, sometimes it can't make the exact same DNA parts so it's slightly different, but they're not really different. That's how everyone looks different.*
	(Fourth pedagogical interview, 17 October 2016)
Researcher:	*Why is DNA part of our human story?*
Charlie:	*It's like collective learning … The scientist tells people and then they pass it on and pass it on and then pass it on.*
Georgia:	*I used to wonder about stuff. . . . Now I know everything that I wondered about. I wondered when the world was created: 13.8 billion years ago!*
Charlie:	*I didn't know that the stars gave elements to us . . .*
Georgia:	*I didn't even know there were elements.*
	(Fourth pedagogical interview, 17 October 2016)

As the teaching and learning program progressed, students used their knowledge base to express their understanding of the evolving universe story. The analysed data verified that students accessed increasingly complex knowledge and common vocabulary through successive Big History thresholds.

Molly:	*If we didn't have Threshold 1, we wouldn't have anything because the world has started up as one little tiny cell . . . and some elements and the gravity fused them together to make bigger elements.*
Gabby:	*As Molly said, if we didn't have Threshold 1, there wouldn't be Threshold 2, 3, 4, 5, 6, 7, 8, 9. There would be no gravity; there would be no space; there would be no time. Nothing would be fusing: no stars; it would just be all dark, and nothing.*
	(Post-pedagogical interviews, 15 November 2016)

The synthesis of that knowledge into a wider worldview opened the possibility of transformative environmental education learning. When comparing the following two excerpts, it is apparent by the second interview that Imogen's use of *'we'* has not only highlighted a growth in knowledge but also transformed her thinking of nature and humans as interrelated.

Excerpt 1:

Researcher:	*. . . Are humans animals then?*
Imogen:	*Yeah, no.*
Imogen:	*Animals belong with nature, so they're kind of nature and at the same time they're not. They kind of blend.*
Molly:	*In the middle, nature, not nature, in the middle of that.*
	(Pre-pedagogical interviews, 29-30 June 2016)

Excerpt 2:

Georgia:	*. . [W]e started off in the ocean.*
Imogen:	*Yes and bacteria. And cells . . . started off as one cell—that surprised me. We started off as like one cell like bacteria in the deep oceans. I thought we started out as like animals. I didn't know.*
	(Fourth pedagogical interview, 17 October 2016)

Jack likewise, in the last interview, used his Big History knowledge to explain his thinking about the future: "When you grow up, if there's a new Threshold, you can study it and you can maybe add new information to the other Thresholds."

The co-researcher teacher emphasised the progression of students' understanding through the teaching of Big History, where she noted they were, ". . . applying and using Big History . . . in their writing and responses throughout the Thresholds and in their journals, . . . they've got a much deeper understanding."

THEME 2. CATHOLIC BELIEF:

The extent that students transferred their prior knowledge of the Catholic teaching on God's Creation to inform their emerging knowledge of the story of the universe

The integration of children's newfound vocabulary into their understanding of the Catholic belief system was integral to embracing the local school culture within the wider worldview interpretation of the emerging Big History narrative.

The limited student perception recorded in pre-pedagogical interviews is in contrast to Catholic literature (Australian Catholic Social Justice Council (ACSJC) 2002; Francis I 2015; Sydney Catholic Education Office 2012), which calls for the embracing of the interrelationship of the environment and humans.

Researcher:	*. . . Do you know how the Earth began?*
Amy:	*No. Jesus created it.*
Jack:	*Yeah, because everything is made up from God.*
	(Pre-pedagogical interviews, 29-30 June 2016)

The ability of Big History to empower students with a richer worldview within their Catholic traditions was apparent when students' prior knowledge and appreciation of God's creation were interpreted within their new knowledge of Big History learning and environmental education values.

Indi:	*How did God get so much power? . . . How did he have such a good idea of building us? I learnt . . . how God created us and the steps that he used to create us. I think* [*Threshold one—the big bang*] *is important to humans so they know who created them . . . and they understand that God exists.*
	(First pedagogical interview 1 August 2016)

The growth in students' Catholic understanding of God as creator was evident in students' ability to correlate their known Catholic story and local school's values framework to the new learning context of the Big History story.

Imogen:	*I think Big History is a more amazing story* [*of God's creation*] *. . . . It says what was created, how it was created, all these big words like agriculture, dioxide ribonucleic acid, and all of that.*
Gabby:	*God's creation, it's not like it made itself. God made them, and it's like each of the Thresholds is each of the days. I'm saying that they're both like, both together. . . .*

It was reassuring to observe, as the excerpts demonstrate, that students were not disturbed by the scientific evidence that was presented; rather they readily correlated the evidence into a greater sense of awe and wonder at the grander and more complex unfolding of God's creation through the Big History story.

Gabby:	*When it was the beginning, it was just black, and there was nothing there except God. Then, everything started to get more complex, and then the stars came, and the planets came, and then they were all orbiting the sun, and then animals evolved.*
Emma:	[*The universe*] *is more complex. I've always been wondering how we were here; since I was really little, I've been wondering what will happen in the future. Will there be robots or something? How are we here? How were we made? Who is God?*
Researcher:	*And did Big History help answer that?*
Emma:	*Yes (other students agreed)*
	(Post-pedagogical interviews, 15 November 2016)

The co-researcher teacher commented on students' ready acceptance of the Big History narrative within their Catholic understanding of God's creation: that God is essential to the unfolding story.

THEME 3. VALUES:

The extent that environmental education values, particularly in the context of local school values, were interpreted by students through the lenses of Big History

The importance of analysing values at the local school level, as discussed by Somekh and Zeichner (2009) and Podger et al. (2013), was appropriate to apply to the child-framed methodological basis of my research. The students at the research school were immersed daily in the local values of their school: peace, respect, honesty, justice, empathy, compassion and tolerance. As evidenced in the following excerpt, they voluntarily connected those values to Big History learning, whilst also including the term 'sustainable' in their discussions within the context of student appropriate understanding.

Gabby: *I think sustainable is also part of our values, because sustainable . . . we have to be fair, justice, and it could be like . . . It's like* ***sustainable means like all of our*** **[*local school*]** ***values.***

Jack: *You might need* ***PRhOJECT LOVE—Love*** *because you need love to take care; you need to respect everyone's ways. (* **PRhOJECT LOVE** is an acronym for the local school values of the research school—***P****eace,* ***R****espect, h****O****nesty,* ***J****ustice,* ***E****mpathy,* ***C****ompassion,* ***T****olerance* ***LOVE.)***

Aidan: *I think all of the* [*local school*] *values because if you have all of them you have a stronger heart and you can help the environment. . . . You should only use what you need. I would like to make the world sustainable.*

(Post-pedagogical interviews, 15 November 2016)

The data represented the local school values as a pivotal point around which students centred their discussions because the values were already so deeply embedded in all classes' daily routines.

Gabby: *We need a sustainable future, and we need all the* [*local school*] *values. Big History helped me think about the future and people.*

Both co-researcher teacher's observations and my journal notes concurred with the advantage of students' previous knowledge of local school values and the ensuing enrichment of interpreting those values through the lens of the Big History universe story.

Co-researcher-teacher: *Now through the Big History programme,* [*students are*] *more articulate and they're more able to see* [*local school*] *values apply to the world and the universe . . . how something that happened so long ago is still something to respect and to value and to love . . . something that's going to happen in the future.*

The above comment validates Dahl's appeal (2012) to incorporate local vocabulary in articulating values, where the important learning of the children corroborates applying values to the past, present, and future from the perspective of the cohesive Big History learning story.

THEME 4. TRANSDISCIPLINARY LEARNING:

The extent of impacts on students' environmental education values

Transdisciplinary learning enriched students' understanding of environmental education values when nested in the emerging Big History narrative, their Catholic understanding of God's Creation, and local school values. In the following child-framed dialogue the children named the limits of learning subjects in 'silos' and highlighted their move away from an anthropocentric worldview.

Jack: [*We are learning Big History*] *new words . . . so we can speak more like scientists and astronomers*

Aidan: *You can learn lots more and it's part of different subjects—like religion, maths, history, science and all the other subjects that we know … because you can't just learn one subject because if you just learn one subject, when you do a test or when something comes to light that you need to do with other subjects, you won't know it and so you should know lots of subjects so then you'll be ready for life's challenges.*
(First pedagogical interview, 1 August 2016)

The students' conversation validates the significance of transdisciplinary skills in Big History learning, leading to the ability to articulate a wider worldview.

Students' broadening worldview away from anthropocentric thinking unfolded through the teaching of a universal story, language, and Big History learning framework. This became apparent as other students also articulated the need for the interconnection of subjects to enable a deep understanding across subject areas.

Molly: *I'm surprised that we have learnt all these difficult science things that a lot of us didn't really know at the beginning. . . .*

Gabby: *I'm wondering why we are learning, doing this—shouldn't we do it at Year 6 or university because it's really hard stuff to do and maybe we can't get it all—**but we can!***

(First pedagogical interview, 1 August 2016)

The co-researcher teacher, likewise, remarked on the learning across disciplines and the opportunities for children of varying academic abilities to engage in inquiry learning at their own level of understanding, where they were empowered to see themselves as co-learners with the teachers. This is in keeping with cyclical and reflective components of action research as "part of the joy is in the doing" (McNiff, 2002, p. 17; Mertler 2008, 25).

The nesting of diverse knowledge and transdisciplinary skills of the Big History course were powerful in allowing students to interconnect and to apply their understanding to the wonder of the universe's increasing complexity. The extent of the impacts on students' environmental education values was discernible in students' enriched observations, their use of their newly learnt knowledge from Big History and their known local school values and Catholic teaching.

THEME 5. SOCIOECOLOGICAL LEARNER:

The evidence for conformative, reformative, and transformative socioecological learning process

The fifth interrelated theme from my analysis, the socioecological learner, demonstrated the extent that students' values were informed within the conformative, reformative, and transformative socioecological learning process of the emerging Big History narrative, as illustrated previously in Figure 1. The data representation I collated as central to my research, revolved around the nesting of the first four themes within this final theme of the socioecological learner. I continued to view each theme not merely as linear, but as nested in and informing each other. Theo expresses it as "If you would know any [only one] subject then you won't be that smart to do anything in science or history or any subjects."

The lack of a wider worldview, in how we interact with society and the environment, as noted by Snaza and Weaver (2015), calls into question limited learning that is structured around the human. The evidence I collected is in keeping with the stance Big History Project promotes (2019), which empowers children to integrate a wide range of academic disciplines that aligns with socioecological learning (Gruenewald 2004; Hart 2012; Kyburz-Graber 2012).

The learning journey began as teacher initiated, but by the end of the intervention children had taken ownership as active learners with numerous references to themselves as 'big historians' during interviews and class activities. Aidan commented on the last day of school:

> *Oh, my Big History journal: Big History was my most favourite subject this year. It was awesome and my Mum is going to be amazed at what I have learnt when I show her this book. She's going to say, "Good job Aidan. You've learnt so much." I've already told her so much about Big History. I loved Big History. I learnt so much because I didn't know anything about how the world was created and how it was so complex.*

Aidan's comments are in keeping with the concept of the socioecological learner and the report of the Australian Education for Sustainability Alliance Project (2014), which calls for learning that embraces comprehension, complexity, uncertainty, and risk that can be applied to future sustainability. An empathetic deeper level of learning was expressed by Imogen and Gabby:

Imogen: *Imagine if you were nature, and people were building things on you, and cutting you down. How would you feel?*

Gabby: *I think we should treat the earth as what we want to be treated because if we treat the earth (how) we want to be treated then we can help the earth and all the animals because the earth is like a human being, it's like us except it doesn't walk. We want to keep the Earth safe so we have to treat the earth how we want to be treated as well.*

An overall finding from the analysis of this theme was that a cohesive deep time story empowered students to embrace past, present, and future within a shared language and critical inquiry evaluation techniques. They evaluated the implications of our

past, present, and future, moving away from anthropocentric thinking to critically examining the inclusiveness of all that is human and nonhuman in the universe. The following excerpt encapsulates the sense that socioecological learning can happen for any student. The insightful response below comes from a child who initially showed little awareness of the interconnectedness of human and non-human. His simple words echo the Delors Report's four pillars of learning (1996): learning to know, learning to do, learning to live together, and learning to be.

Aaron:	*Big History tells us about stuff that we can't see.*
Researcher:	*So do we need nature?*
Aaron:	*We need nature, but nature doesn't need us.*
Researcher:	*Did you understand why we need nature but nature doesn't need us?*
Aaron:	*Yeah, because if nature faults, we fault, and if it all collapsed, we collapse.*
	(Post-pedagogical interviews, 15 November 2016)

Aaron's observation is in keeping with Sterling's call (2003, 2008) that conformative and reformative learning, may lead to the possibility of transforming how we perceive whole systems and worldviews (also see Wattchow et al. 2014).

The final rich data feedback from both co-researcher teacher and students is affirmation for the rich and emerging Big History story that encourages socioecological learners to be informed, and in turn to interpret, local school environmental education values within a Catholic school setting.

The co-researcher teacher's observations are significant; as lead–learner she naturally incorporated the newly learnt Big History terminology and the local school values to express her opinion:

> [*Students developed*] *a very good understanding of—you just can't get some more oxygen; you can't get more helium or hydrogen. What happened in the beginning created what we have now, and if we don't care for it now, and if it's not just and fair, and if we don't respect the environment, then it's going to be gone for the people in the future. If we don't respect each other and respect the environment, then parts of the environment will disappear.*

She believes Big History gives children a more powerful voice to articulate the socioecological aspect of learning in their own child-appropriate language, that humans' relationship with the environment is fragile, and, as such, humans need to play our part for future sustainability.

Socioecological learning became increasingly evident throughout student interviews in their intertwining of deep-time knowledge through the lenses of local school values, their learnt Catholic traditions, and transdisciplinary skills and concepts aligned to the Big History Project.

Conclusion

I conclude with words of wisdom toward a bigger worldview future from Alice, students involved in the action research, Big History, and my research findings:

Firstly, the Queen's advice to Alice:

> *"I can't believe that!'* said Alice.
> *'Can't you?'* the Queen said in a pitying voice. *'Try again: draw a long breath, and shut your eyes.'*
> Alice laughed. *'There's no use trying,' she said: 'one can't believe impossible things.'*
> *'I daresay you haven't had much practice,'* said the Queen. *'When I was your age, I always did it for half-an-hour a day. Why, sometimes I've believed as many as six impossible things before breakfast.'* (Carroll 1872 Chapter 5)

Synthesising the five theme

Like Alice, I needed to take the Queen's advice to correlate the extensive findings from my data analysis. Among the most pertinent was the verification that environmental education is all the richer when teachers and students are empowered with a narrative that embraces a wider worldview, encompassing sociological learning. Most importantly the cohesive Big History story enables students to understand the interconnectedness of the evolution of human life within the history of the universe. This knowledge allows them to critique environmental actions being discussed, alongside an underlying joint responsibility to take care of the Earth and the understanding that everything AND everyone is interconnected from a rich values perspective.

Big History learning empowers students to reflect critically on and evaluate their worldviews from a child-framed perspective, which relates to my methods reference to Spyrou (2011) and Kellett (2010), who promote the place of children in education as critical reflective thinkers. The students' immersion in the cohesive story of Big History learning enables them to express confidence in their new, shared knowledge and to articulate a growing sensitivity to and awe of their own interconnection and interdependence as socioecological learners.
My research shows that 8-9 year old students easily transferred the emerging scientific story of the universe of the past and present to inform both their local school and environmental values for deeper future thinking. The following written student comments at the conclusion of the pedagogical intervention

school and environmental values for deeper future thinking. The following written student comments at the conclusion of the pedagogical intervention uphold my conclusion:

> *I can tell my family things they didn't know. . . . I'm a Big Historian now! :)* [sic]. *. . . It's fun and interesting! We need to know about evolution and elements because we need to know where we came from.*
>
> *I know all the thresholds now and some people can't learn Big History, so I am very grateful; and I think we should now teach everyone. . . . and we should use these thresholds to care for our future environment to make a better universe.*

Employing Big History as a teaching vehicle for the scientific universe story achieves a cohesive, wider worldview for primary-aged learners, empowering them to engage in transformative, socioecological thinking for the future. These significant findings have wider implications for systems-wide education and curricula development, providing evidence that Big History is accessible and relevant to primary-aged students where environmental education is not taught as a silo discipline but as a transdisciplinary-based and socioecological learning structure.

The child-framed pedagogical intervention empowered students with a common learning platform to connect the new knowledge they had gained from Big History within the lenses of their embedded Catholic traditions and local school values. Building on this substantial foundation the transdisciplinary and socioecological learning inspired students to critically reflect on their environmental values and query their previous assumptions of sustainability.

In light of the findings presented, there is clear evidence of students' sharing story and knowledge of the universe to inquire critically and evaluate their learning, not merely to promote a cause (see Scott 2009). The evidence presented is heartening at a crucial time when we need our students' learning to incorporate informed and shared values within a post-humanist environment for a better future for everyone and everything.

Limitations

A clear benefit of my research demonstrates that knowledge of a cohesive and interconnected history of our universe empowers primary-aged socioecological learners to inquire critically beyond anthropocentric models of learning and to embrace an emerging post-anthropocentric future.

The lack of a recognised, evidence-based, and systemic educational framework and affirmation of Big History as a valued learning framework in the primary school made it difficult for me to have my research acknowledged by both Catholic education and state education authorities. I approached many schools before my research was seen in the light of authentic and relevant education. The reticence of some schools was articulated as not wanting to counter the perceived, conservative beliefs of school communities. In the case of Catholic schooling, I produced official Catholic documentation to counteract that concern, particularly Pope Francis I's latest official document on caring for our Earth (Francis I 2015). In hindsight this may have been overcome by holding a pre-research whole-staff discussion to validate the educational worth of my project. No objections from parents arose to teaching the Big History course to the class before or during the intervention, which was a positive sign.

Recommendations for future research

> *Once more Alice found herself in the long hall and close to the little glass table. Taking the little golden key, she unlocked the door that led (back) into the garden.* (Carroll, 1886 Chapter 3)

The findings from my research are an initial validation that teaching Big History to primary-aged students empowers socioecological learning, informs known values, and invites the possibility of transforming student worldviews to an understanding of human and nonhuman interrelationships and interdependence.

As this is an initial study at a doctoral level into teaching the cohesive Big History story in primary education, the holistic and nested nature of the inquiry alludes to a breadth of future directions; however, I outline below the areas that I have identified as significant.

Implications from this research indicate that researchers and educators in teacher education and primary schooling need to be provided with educational models to empower them to use Big History effectively, in line with transdisciplinary learning that is already embedded in contemporary curricula. Future research requires further qualitative and quantitative studies into teaching the universe story that examine how success is managed and maintained throughout a student's primary schooling years, alongside the extent that children's environmental values are transient or long lasting. Macquarie University *Big History School* Project (2019) is worthy of ongoing postgraduate research as it promotes a supportive and holistic primary and secondary education curriculum. Such embedded support networks that are authentic to critical enquiry learning would ensure that the socioecological learner, not the Anthropocene, is at the heart of the teaching and learning.

Significantly, I address unfounded concerns that Catholic schools may not be mandated to teach within a Big History-based scientific model. Student responses from my research provide evidence that students were empowered to further their understanding of sustainability threaded throughout the curriculum. They learnt an enriched worldview of amazing awe and wonder of what God has created, alongside the values needed for a sustainable world.

My research has broken new ground into adding original, significant literature to environmental education research beyond Catholic education. Clear evidence exists that my study raises significant issues requiring innovative address by all primary schooling systems. Environmental education is significantly enriched when viewed from the perspective of a shared universe story, inclusive of transdisciplinary socioecological learning perspectives.

The emerging scientific story of the universe is a story of the past and present informing the future through socioecological learning where action requires love, understanding and, equally as important, cohesively taught critical

knowledge as emphasised in the following quotation:

> *It is essential to seek comprehensive solutions which consider the interactions within natural systems themselves and with social systems. . . . We lack an awareness of our common origin, of our mutual belonging, and of a future to be shared. A great cultural, spiritual and educational challenge stands before us, and it will demand that we set out on the long path of renewal.* (Francis I 2015, 139 - 202)

The words of Pope Francis summarise my new-found hopes stemming from this research: that Catholic primary school education systems, and education broadly, take up the challenge to evaluate critically the teaching of a cohesive and interconnected history of our universe.

Wider implications from this research open up opportunities for critical inquiry beyond anthropocentric models of learning. The evidence clearly indicates that the deep-time framework of Big History is accessible and relevant to primary-aged students. The research findings were significant in the context of child-framed deep learning pedagogy that informs environmental values for current and future learning. If educators are truly to comprehend the importance that values play in transdisciplinary, socio-ecological learning, then our universal deep-time story needs to be embedded at all levels of the education continuum, inclusive of primary-aged students. Figure 4 captures my post-anthropocentric vision, where **all** education encompasses our learning toward the many questions of our unknown future.

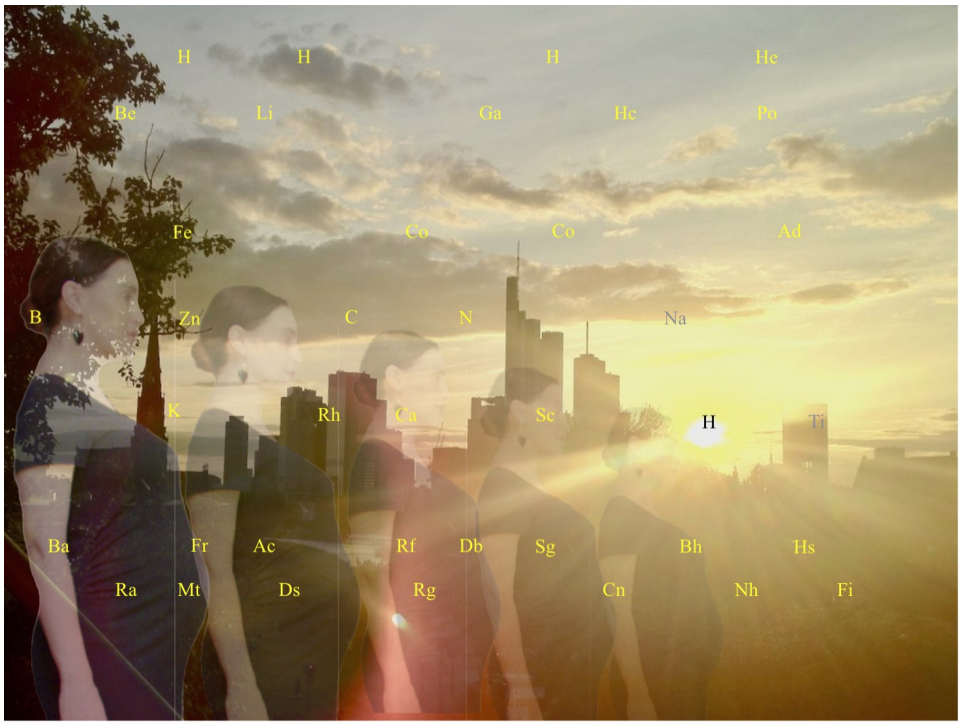

Figure 4. Deep Time Entanglements
Collaborative Deep Time entanglements, Image created by author and photographer (Ahearn, M. & Smith, L. 2019, with permission)

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Size Relationships of Big History Objects: From the Universe to the Atomic Nucleus

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Abstract: Big History involves a variety of sizes from the atomic nucleus to the size of the universe. How can we make sense of this? A popular video (Eames 1977) about the power of 10 took a "picture" for every factor of 10 in distance with over 40 "stops" from a nucleus (not even the smallest distance we can talk about) to the edge of the universe. Instead, we will explore just nine steps in distances of things we know about: the atomic nucleus, the atom, a bacterium, a human, the Earth, the distance to the sun, the distance to the closest star, the size of the galaxy, and the size of the universe. Quite amazingly, many of these distances can be estimated with only a few fundamental physics constants. Also, the ratio of the distances of the larger to the next smaller is about the same (with some exceptions): about 150,000. How can this factor of 150,000 be visualized? It is about the ratio of a commercial jet's height compared to your palm, or, using the American standard unit of a football field, the smaller distance would be about 1/32 of an inch.

Introduction

Besides the different time scales in Big History, quite a range also exists in sizes of objects involved in Big History. The time range includes the billions of years of the universe, stars, and planets; millions of years for species; thousands of years for historical processes; generations for humans and technology development; and seconds for DNA replication, thoughts, and computer calculations. The size scales cover the range of the universe as a whole to the atomic nucleus.

While one might think that there are so many physical phenomena involved in determining these sizes, any systematic discussion about this range would involve innumerous details and inputs from a range of fields. Instead, many in the late 1970s (e.g., Carr and Rees 1979; Press and Lightman 1983) explored these size relationships to uncover estimates that were based surprisingly on just a few constants and a few physical phenomena constraining the environments in which the objects would occur. Here those relationships are reviewed, and actual distances are compared: nine of the fundamental distances in Big History follow a pattern with a ratio of the sizes being about 150,000.

The path starts with the relationship between the atom and the size of the universe. Then intermediate sizes follow along with the smaller size of the proton.

Size of an Atom

The first distance to discuss is the size of an atom. While quantum mechanics may give details, the size can be estimated based on the need to balance the attraction between the charges of the electron and proton with the energy caused by the uncertainty principle. That is, as the negatively charged electron attempts to move closer to the positively charged proton, its velocity and momentum increase, but the product of uncertainty in distance and momentum remains constant (related to the Planck constant, P). This leads to a simple estimate of the size of an atom, which is denoted as 'a'. With the mass of the electron being m, and the charge of the electron C, then balancing the energy leads to the estimate of $(PC)^2/m$, which gives about 10^{-10} meters (about a tenth of a nanometer). For reference, DNA is about one nanometer wide and the transistors in your computer or smartphone are about fifteen nanometers wide.

Many of the remaining distances can then be expressed as the product of this fundamental distance and some powers of two unitless parameters, G and A. The first (G) is just the ratio of the electromagnetic and gravitational forces between two protons (any distance). This has a numerical value of about $5x10^{-39}$. The second (A) is called the electromagnetic fine structure constant ($C^2/(Pc)$, where c is the speed of light), which is numerically equal to about 1/137, or 0.0073. This is related to

the maximum charge of 137 protons in an atomic nucleus. (So far the highest charged nucleus has 118 protons and the highest natural nucleus is uranium with 92 protons.) The square of this parameter is the fraction of energy in the bound hydrogen atom compared to the mass-energy of the electron, mc^2. This energy can be estimated in a way similar to how the distance was derived in the paragraph above.

Size of the Universe

Now jump to consider the other end of the size spectrum, the size of the universe. To simplify matters, let B represent the ratio A/G, which is about $1.5x10^{36}$. Then, the size of the universe is about this many atomic distances ('a' from above), i.e., size of the universe (U) = Ba, which is about 15 billion light years, i.e., the distance light would travel from the beginning of the universe. However, since the universe has been expanding, the true size of the observable universe is about six times this distance. How is this simple formula derived, especially since the size of the universe changes with time (from a point in the Big Bang to the current size)? The derivation of this relationship requires an additional assumption that enough time had passed for the universe to generate enough carbon (and other elements) to make planets and life. Hence, this is really an estimate of the size of the universe when conditions are ready for life with many generations of stars.

Size of Galaxies

Making other assumptions (discussed below) about the conditions necessary for the formation of galaxies and planets leads to an estimated typical galaxy size of about A^2U. This shows that the size of galaxies relative to the universe is about the same fraction (0.005%) of the energy in the hydrogen atom compared to the electron mass-energy. This estimated galactic size is about four times larger than the size of the Milky Way (150,000 light-years), which is quite accurate, considering the simplicity of the estimate and the variability in galactic sizes.

The necessary assumptions consider the relative rates of cooling and gravitational condensation of a cloud of mostly hydrogen and helium gases that existed about a billion years after the Big Bang. As these clouds begin to condense because of gravity, this gravitational energy is converted to heat, which must be expelled from the clouds to maintain the condensation. If it is not expelled quickly enough, the pressure builds up and the gravitational force is canceled by the pressure. Much of the cooling is done through ionization of hydrogen, which is dependent on the energy of ionization that can be estimated from the size of the atom (as above). The largest mass at which this cooling mechanism works gives a galactic mass of about a trillion solar masses. Further discussion of this process and its relationships to other Big History eras can be found in a recent paper by Grinin and Grinin (2019).

Distance to Nearest Star

As these galaxies form from cloud collapse and merging of smaller galaxies, a net rotation of the stars around a common center can occur. The rotation tends to flatten out a galaxy just as a clump of pizza dough takes its shape as the baker throws it in the air with a good spin (similar to the way planets orbit around the sun in a disk). The mass of a typical star can be estimated based on the physics of nuclear reactions. This is done by balancing the thermal pressure from the nuclear fusion reactions in the star's core with the weight of the outer part of the star pushing in because of gravity. This estimation requires knowledge of very many fundamental aspects of physics including gravity, electromagnetism, both the strong and weak force, along with thermodynamics and quantum mechanics (as protons react through quantum "tunneling").

By knowing the mass of a typical star and galaxy, the number of stars can be estimated. Combining this with the disk size of the galaxy (as found above), an estimate for a typical distance between stars in a galaxy can be found. Note that in nature are many different types of galaxies and within each galaxy are different types of stellar environments such as the crowded central hub and the less dense spiral arms (like we are in) with fewer stars between the arms. This consideration of galactic size and number of stars can be used to find the average distance between stars, which is similar to the distance from the sun to its nearest star, Proxima Centauri, of 4.2 light years away.

Distance from Earth to Sun

The Earth is in the "Goldilocks" zone, better known as the habitable zone around the sun where the temperature is such that liquid water might form. While some supercomputers might be able to calculate some properties of water from first principles, it is unlikely that all the special and unique properties of this substance could easily be explained. The electrons around hydrogen and oxygen do their dance to create an unusual substance that floats when it freezes, can dissolve both salts and organic compounds, can easily evaporate, and can be moved around the world in clouds while occasionally condensing to water the planet.

The distance from the sun that this habitable zone incorporates depends mostly on the energy output from the sun. The paragraphs above mentioned that many aspects of physics were combined to estimate the mass of stars. With this mass, the rate of nuclear reactions in the core can be estimated and with that the energy output of typical stars. The energy per area falls off as the square of the distance from the sun. Some assumption needs to be made concerning how much energy would be absorbed by a planet while that remaining is reflected out into space. This absorption can be used to find the temperature by assuming that the planet comes into a balance between the energy being absorbed from the sun and the amount of energy being radiated back out into space at the planet's lower temperature. (This radiation is similar to the orange glow coming from a heated stove or toaster.) Knowing the mass and luminosity of a star leads to an estimate of a planet's temperature. This estimated distance is again close to the actual

distance from the sun to Earth of 150 million kilometers.

Size of a Habitable Planet

Rocky planets are large enough that gravity tends to pull the rocky material into near spherical shapes. Gravity also helps hold atmospheres. The gases in the atmosphere might escape if gravity is too weak since the molecules move at fast speeds. The estimated rocky planet's radius that can hold an atmosphere at temperatures comfortable for life comes to about 4,000 km, which is about 60% of the Earth's radius but within 15% of the size of Mars.

To grasp an idea of the magnitude of the gravity needed, the average speed of a typical atmospheric molecule, N_2, can be easily found (about 500 m/s), whereas the speed of anything (rockets or molecules) to escape the Earth's gravity is about 11 km/s, that is, about twenty-two times the average velocity of molecules.

However, many other factors should be considered. For example, Mars currently has about 1% of the Earth's atmospheric pressure at its surface, and it is still losing it. On the other hand, Venus has a mass and a radius more similar to Earth but contains an atmosphere with a pressure nearly one hundred times larger. The atmospheres of Venus and Mars might have been more similar to the Earth long ago (Way 2019).

Size of a Human

Since we are looking for only an *estimate* for the size of a human, we will consider in general how big animals can grow on land. Many criteria, such as heat management, might be considered, but a significant aspect is that animals would not survive long if they were easily severely injured when they fell. Even at our size it is relatively common to break a bone or sprain a muscle, but a fall is usually not fatal until the height is about fifteen meters, i.e., about ten times a human's size. A key factor in this estimate is the strength of the material that might break compared to the planet's gravity. Some material properties can be estimated with slightly less simple models than considered earlier, while the gravity is based on a planet that can maintain its atmosphere (as above). Considering material of lengthy polymers gives an estimated size close to human -sized scale.

Size of a Cell

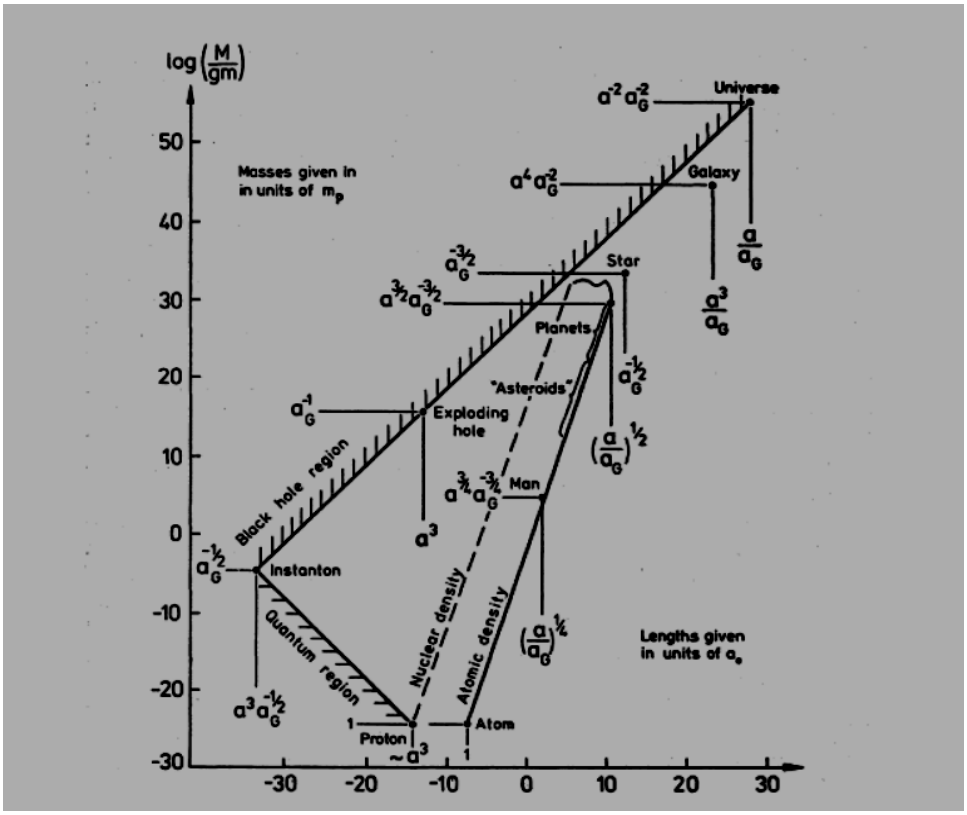
The basic unit of life is a cell. Bacteria are 0.2 to 10 microns but the common bacterium, *E.coli*, is a rod two microns long by one micron in diameter. Animal cells are between ten and a hundred microns. While these cells have membranes to separate the cellular interior from the outside, the smallest natural size of a water droplet (in fog, for example) is about ten microns. At this size the surface tension forces of the water molecules at the boundary are equal to the evaporative forces. This can be estimated with the intermolecular forces of hydrogen bonding (weaker than a covalent chemical bond) and the temperature of liquid water on Earth.

Size of an Atomic Nucleus

Finally, we consider the proton size (smallest atomic nucleus). A few approaches to estimating this size can be taken. One approach is to consider the range of the strong force keeping the three quarks in the proton together, but this strength is not included in the parameters considered so far. Another approach is to find the (Compton) wavelength of light, which has the same energy contained in a particle's mass. Then the proton size compared to the 'classical' electron size would be scaled by the ratio of electron and proton masses. However, this mass ratio (approximately 1/2000) is currently not explained. Despite no direct theory for this ratio, certain relationships between the electromagnetic and strong forces are needed for the existence of complex elements that are needed for life. This results in the conclusion that the proton size is much (about 100,000 times) smaller than the size of an atom.

Other properties (like mass) can also be estimated with these methods. The figure from Carr and Rees's (1979) paper shows the range of sizes (x-axis) and mass (y-axis) from the proton to the universe. Note that an additional item is labeled in the lower left of Figure 1. This is the "Instanton" at the

Figure 1. Estimates of relative sizes from mostly first principles (Source: Carr & Rees 1979)



Planck scale, which is the smallest size anything can be, considering gravity and quantum physics. It occurs at quite a qualitatively different location on the diagram, i.e., the vertex of the quantum and black hole regions. The size is about 10^{-35} m or twenty orders of magnitude smaller than the atomic nucleus.

Comparison to Real Sizes

Now we can take a look at the real numbers and ratios of these distances and sizes (Table 1 and Figure 2). Not only can they be estimated with the few parameters used above, but the ratios from one item to the next in the sequence are somewhat constant, about 150,000. (One item in the list stands out as being a bit out of place. Using 10% of the radius of the Earth rather than the full radius is better.) This number makes sense because remember that we started with estimates of the sizes of an atom and the universe as being the ratio of Alpha to Alpha-G, which is about 1.5×10^{36}. Since there are seven factors between these two, we can see that a factor of 150,000 applied seven times would lead to a factor of 1.7×10^{36}. The Planck scale mentioned above would be another four of these scaling factors smaller than a nucleus.

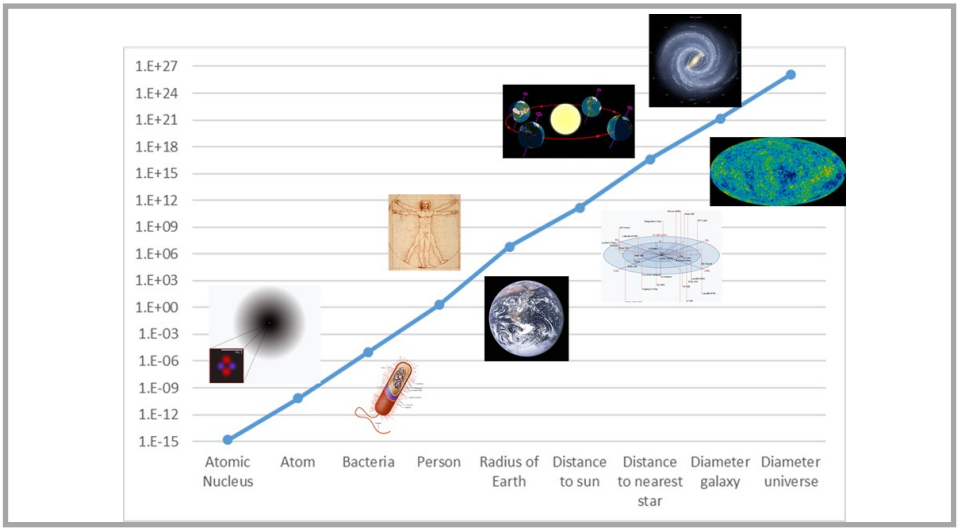
Another way of looking at this reveals some connections among the sizes. An item's size is the geometric average of the two items equally spaced above and below. For example, the size of a person should be about the geometric average of the size of an atom (two steps smaller) and the distance to the sun (two steps larger), i.e., the square root of 150 million kilometers x 0.1 nm. After making sure the units are the same, we end up with a size of about 4 m. This is about a factor of 2 too large, but it is quite amazing it is this close.

How, then, can we relate to a factor of 150,000? We definitely know the difference between $1 and $150,000, but are there some sizes to which we can relate? There seem to be. Commercial jets fly at about 6.5 miles, which is a bit over 10 km (equivalent to a million centimeters); 1/150,000 of this distance is about 7 cm (3 inches), a bit less than the width of a hand. The next time you are in an airplane at cruising altitude, look down and try to visualize someone's hand. (It is easier to see cars and then imagine the people in them). That ratio of sizes and distance, the size of a hand to the altitude is about the same as the ratio among these nine sizes and distances in Big History, i.e., nucleus to atom, atom to bacterium, bacterium to human, human to (smaller) Earth, Earth to sun, distance to sun compared to distance to the nearest star, distance of the nearest star to galactic size, and finally galactic size to the (observable) universe. Alternatively, using the American standard unit of a football field, the smaller distance would be about 1/32 of an inch.

Table 1. Actual Ratios of Distances and Sizes

Object	Size		Ratio	Factor Difference
Proton	1.0E-15	meter		
Atom	1.0E-10	meter	1.0E+05	-3%
Bacteria	1.0E-05	meter	1.0E+05	-3%
Person	1.5E+00	meter	1.5E+05	0%
Radius of Earth	6.0E+06	meter	4.0E+06	28%
Distance to Sun	1.5E+11	meter	2.5E+04	-15%
Distance to Nearest Star	4.2E+00	light year	2.6E+05	5%
Galactic Diameter	1.5E+05	light year	3.6E+04	-12%
Observable Universe Size	9.3E+10	light year	6.2E+05	12%
Factor difference = (log (Ratio) - log (R0)) / log (R0)				
That is, Ratio = R0 ^ (1+Factor Difference)				
R0=150,000				

Figure 2. Plotting data of Table 1 (Source of images: *Wikipedia*)



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A Four-billion-year Story: The Making of India

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Abstract

Sixty-five years ago, A. L. Basham highlighted the making of India in his book, *The Wonder that was India* (1954). It acknowledged human presence 100,000 years ago; the dawn of agriculture around 10,000 BC; the rise of the first villages; ancient goddess figurines; the Indus Valley civilizations; and the great discovery by Sir William Jones of India's languages linked to the languages of Europe. Basham also emphasized the importance of the Himalayas and the great fertile plains watered by the multiple tributaries of the Ganges—the spiritual and cultural center of ancient India. With intensely economic and political perspectives today, we are likely to adopt the narrower focus of Ranbir Vohra's *The Making of India: A Political History* (2013), which leads us through British colonialism to India's emergence as an independent democracy of over a billion people. In recent years a broader perspective has emerged that extends far beyond the beginnings of Indian civilization or even beyond the first nomadic migrants. Discoveries of geology, biology, and paleontology define the making of India as a vast narrative, the creation of a stage with ancient roots upon which modern humans have only recently commenced their walk-on drama. This perspective impels us to think historically, sequentially, and diachronically rather than topically or synchronically. India turns out to be a dramatic example of continental migration culminating in a collision that has shaped Asia far beyond India's borders. The making of India emerges as a dynamic, moving sequence where the most ancient planetary and biological events are seen as contingencies of the present world and human existence. This perspective is more than history; it is big history; more than narrative, it is a grand narrative.

Introduction

The central discovery of twentieth-century geology in India and elsewhere has been a recognition of slow but constant planetary change that put an end to the notion of a world as fixed and finished. "Change," however, is an abstract term without precise parameters. This was clear when geologist James Hutton (1726-1797) put forth his "theory of the Earth." Hutton saw a continual process of mountain erosion, settlement of water-borne erosional materials on ocean bottoms, their hardening into fossil-laden sedimentary rock, and subsequent upthrust of sea bottom that formed new mountains. This was change—a rock cycle—that by definition must have occurred everywhere that mountains tower and rivers flow to the sea. Hutton's conclusion was that this cycle went on "without end"; he could not define a beginning. Hutton was the first to recognize what we call "deep time" (Wood 2019a). To this, the eminent geologist, Charles Lyell (1830-1832), added regional specificity. From his study of geological change at Mount Etna, the Joggins Fossil Cliffs on the Canadian coast, and the Grand Canyon, Lyell documented change at specific sites: ninety eruptions on Etna, millions of years of fossiliferous layers at Joggins, and mile-deep sedimentary layers at the Grand Canyon. Their crucial recognition was that the Earth had an immeasurably long history; such vast changes could not have occurred within any restricted time frame. To this insight, Charles Darwin (1859) added a biological dimension: fossiliferous rocks revealed an equally immeasurable sequence of life forms from primitive to modern with many dead-end pathways to extinction. As the nineteenth century came to an end, these various kinds of change had provided multiple perspectives, but they hung together with impenetrable complexity.

A new view of change began with Alfred Wegener's theory of a supercontinent which he called Pangea (All Earth) which he sketched in his book, *The Origin of Continents and Oceans* (1912), that went through several editions until 1929. His evidence included the obvious "fit" of continents on each side of the Atlantic Ocean and same-species megafauna fossils occurring on landmasses separated by thousands of miles of ocean. His solution was the

theory of a supercontinent he called Pangea (All Earth) where all the landmasses of the planet were once joined (Illustration No. 1).

Wegener's theory of an ancient continent he called Pangea along with drifting continents, which accounted for the widely separate locations of lands once joined, became "a theory that most academics quickly branded eccentric, preposterous, and improbable . . . a classic example of wild, overreaching supposition" (Ballard 2000, 117-119). His theory thus made little headway and was largely ignored for decades. How continents supposedly rooted into the rocky surface of the Earth could possibly move challenged the geological imagination. But ocean-bottom exploration during IGY, the International Geophysical Year (1957-1958), led to the discovery of mid-ocean undersea mountain ridges, seafloor spreading (Dietz 1961), a systematic creation of seafloor, and thus a "history of ocean basins" (Hess 1962). The evidence confirmed that continents did move, and a rapid assessment of the evidence led to the master theory of modern geology: "plate tectonics" (Takeuchi 1970; Sullivan 1974). Within two decades, instrumentation capable of measuring continental movement had developed. This was refined enough to show that North and South America were moving away from Europe and Africa at approximately one centimeter per year. Wegener's continental drift was no longer a theory; it was a fact.

Verification that continents moved brought astonishment and it remains astonishing for anyone first encountering it. This, however, can momentarily conceal its significance. The various kinds of "change" Hutton, Lyell, and Darwin had recognized lacked direction. Lyell's observations confirmed local change; Hutton's flow of erosional material to form ocean bottoms and their subsequent upthrust to form mountains was vertical change. But the movement of continents involved change "that played itself out far more in the horizontal than in the vertical direction" (Ballard 2000, 125). Moreover, this was directional change: continents were moving, but this movement could be tracked backward in time. One could see not only where continents were headed, but where they had been. Geological change suddenly acquired pattern and structure. It signified a history.

Once the reality of Wegener's Pangea was established, geologists began the complex task of working out the earlier history of the planet. One approach was to trace out the precise configuration of Pangea by exploring continental shelves and continuities between geographical features on opposite sides of the oceans. Discoveries included identical chemical signatures on facing coastline rock outcrops originally together during the Pangea era. Working out details of Pangean configuration was soon extended to the daunting task of tracing the history of plate movement before the assembly of Pangea. Bit by bit, clues led to evidence and the pieces of narrative stretching over billions of years began to emerge. As the search went forward, outcrops of very ancient rocks were located and dated. Rocks that indicated formation 3.5 billion (3500 million) years ago were found in Africa, Australia, Greenland, and Northern Canada. Gradually their origins and movements were traced to construct a chronology of plate tectonic events. The ancient narratives of Earth's continents are all of great interest, but the making of India is unique.

Craton

What geologists have learned is that India is the most dramatic example of continental migration, initially moving faster than any other terrane and colliding so forcefully that it altered the geography of Asia far beyond the site of the original collision.

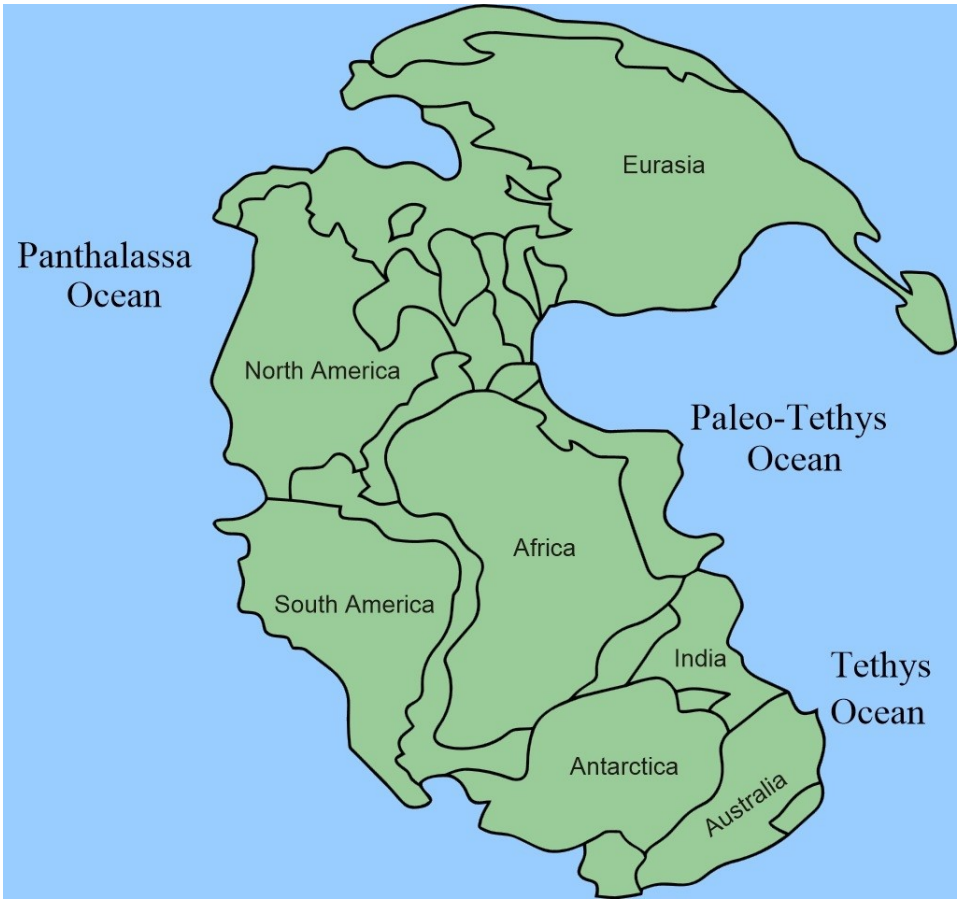

Illustration 1: Pangea. Alfred Wegener proposed an ancient supercontinent called Pangea to account for similar megafauna fossils on continents separated by thousands of miles of ocean. In *The Origin of Continents and Oceans* (1912) he provided sketches of how Pangea might have been configured. His theory of "continental drift" was necessary to account for the locations of today's continents. Source: commons@wikimedia.com.

In the process, India has rafted a history of ancient cratons and the rise of life hundreds of miles from where these originated, relocating this landmass where it became a coastal route traversed by early humans and a place congenial for others who decided to stay and settle.

The prehistoric history of India began to emerge around the mid-twentieth century. In his early work on cratons the oldest foundational crustal underlying Peninsular India, B. Rama Rao (1945, 16) remarked on Archaean rocks in general that they "constitute a complex of highly crumpled crystalline schists and gneisses massed into a confused jumble." These are metamorphic rocks formed from earlier sedimentary or igneous rocks. Rao's description of a "jumble" refers to gneisses formed at high temperatures mixed with schist formed at lower temperatures, a combination not easy to explain. From their conglomerate composition, Rao concluded that the oldest Archean rocks were formed from preexisting rocks that had eroded and been subject to subsequent igneous and metamorphic processes. Rao's explorations identified dozens of components of these cratonic rocks that were laced with recrystallized sediments rich with magnesium and iron. Half a century later, University of North Carolina professor of geology, John J. Rogers (1993), established an age of 3.1 billion (3100 million) years for cratonic rocks, not only in India but also in West Australia and East Africa. The predecessor rocks suggested by Rao may thus have formed as much as 600 to 900 million years earlier, toward the end of the Hadean Era. This estimate pushed the earliest chapter of the making of India as far back as four billion years ago.

From similarities between rocks from widely separated landmasses, Rogers surmised that the cratonic foundations must have formed together in the Archean Era after which they remained crowded together for more than 3 billion years until they drifted apart during the breakup of Pangea. Rogers provided the name *Ur* (German: Motherland) for the earliest stage of these conjoined cratons which he inferred had made up an earlier supercontinent. Further explorations of continental movement soon opened up further reaches of prehistory: intermediate cratonic conjunctions were recognized, and a series of supercontinents were understood as assembling and breaking up between Ur and Pangea.

In a boldly titled article, "History of Continents in the Last Three Billion Years," which expanded his observations from India, Rogers (1996), laid the groundwork for an extended geological narrative. Some of his conjectures have since been modified, but his emphasis on a chronological sequence of events has become a foundation for diachronic geology. Piecing together what has been observed about other cratonic assemblies, we can work out a supercontinent timetable: 2.5 billion-year-old *Laurentia*, 2-billion-year-old *Baltica*, and most of northern Asia collided around 1.5 billion years ago to form *Laurasia*; then a billion years ago these collided with *Ur* and *Atlantica* to form *Rodinia*, the predecessor of Pangea. Rodinia lasted about 300 million years, and then fragmented around 700 million years ago. Laurasia remained somewhat intact while a great southern continent was assembled from most of the southern hemisphere cratons. Once this and Laurasia drifted together around half a billion years ago, the familiar supercontinent of Pangea was formed. Through these various combinings and separations, the Indian basement cratons remained intact.

Rogers' initial speculations about Ur and subsequent supercontinents began with the rocks of the Dharwar craton of southern India where less overlying sediment has left outcrops of the underlying craton exposed. The crustal foundation of India includes four other cratons that were sutured together during the late Pre-Cambrian Era: from these earlier dates have emerged. Basu et al. (1981) have dated remnant Archaean granitic rocks from the Singbhum craton in northeastern India at 3.8 billion (3800 million) years old. In light of Rao's intuition that these preserve components from earlier rocks, the first chapter of the making of India must begin somewhat earlier. The rocks of all five cratonic outcrops display a suite of igneous-origin metamorphic gneisses and schists that appear to have formed around 500 million years after Earth formation 4.5 billion years ago; that is, around four billion years BP. Whatever rocks hardened toward the end of the Hadean were then subject to subsequent erosion and breakdown. Subsequent continental cratons worldwide are thus conglomerates of erosional components from these pre-existing rocks that finally hardened and survived without further meltdown. Today they make up the basement foundations of continental cratons and the Indian Shield.

Plate tectonics was understood as a phenomenon explaining hitherto unexplained geological events. Once the fact of seafloor spreading and subduction was recognized, mechanisms for earthquakes and volcanoes came into focus. But the driving force of plate tectonics was only vaguely understood. Now we infer that continental movement most likely originates with plumes of superheated lava deep in the Earth which rise toward the surface, split, spread, and flow off in different directions. This sets up convection currents near the surface of the Earth's mantle immediately beneath the crust which is of lighter density and thus "floats" on the heavier mantle. Crust thickness varies: under the Indian Ocean, it averages 100 kilometers (62 miles) in contrast with the crust under the cratons of Africa, Antarctica, and Australia which runs to 180 kilometers (110 miles) in thickness (Kumar et al. 2007). Continents supported by huge crustal slabs ride on mantle currents like rafts on a river. Here we see the fundamentals of the entire theory of plate tectonics. In addition, some plumatic material finds its way into cracks and crevices in the Earth's crust as lava intrusions which slowly force crustal plates apart, thus aiding their convectional flow.

Through all of these breakups and reassembles, the India cluster of cratonic fragments seem to have remained intact. Unlike the African craton, which was located at the center

of supercontinents and thus surrounded by other cratons, India generally occupied the periphery. Thus, when Pangea broke up—eventually birthing the seven continents we know today—India was positioned for a separate departure, a migration north from Pangea at what in geological terms was breakneck speed, and an eventual collision with Asia. Calculations indicate that India may have commenced its travels at 20 centimeters (12 inches) per year (Kumar et al. 2007). But as Jonathan Aitchison et al. (2007) have shown, its movement varied over its 100-million-year journey north. Moreover, even though it collided with Asia 40 million years ago, it is still moving at 5 centimeters (3 inches) annually, the result being a continuous crushing and compression of the South Asian landmass and the still-rising peaks of the highest mountains in the world, the Himalayas.

Life

While geological changes were occurring, a parallel narrative was unfolding. The evidence in India consists of stromatolite fossils marking the advent of bacterial colonies more than 3 billion years ago (Sharma 2008). But the broader story has several earlier chapters; the first is planktonic and microscopic. Evidence for the origin of life, or abiogenesis, is found in the oldest cratonic rocks on most of today's continents. Matthew Dodd et al. (2017) have found microfossil evidence of primitive bacterial life dating to the early Archean Era in the Canadian province of Quebec; undoubtedly, these were not unlike today's plankton which make up over ninety percent of Earth's present biomass (Sardet 2015). These Canadian microfossils were found within precipitates from hydrothermal vents which occur on ocean floors and date from 3.77 to 4.28 billion years BP. Hydrothermal vents or "black smokers" several kilometers below the ocean surface which occur along mid-ocean ridges provide an environment isolated from solar radiation, meteoric bombardment, and the intense heat at the Earth's surface during the Hadean Era. Robert D. Ballard (2000), who was among the first to explore mid-ocean ridges and black smokers has provided a riveting account of their discovery along with the varied environments occupied by these "chemosynthesizing organisms," that are powered by the constant flow of metals, gases, and sulphur compounds spewing out of the vents.

As the ocean surface cooled following the Hadean Era, new forms of solar-tolerant plankton evolved: autotrophic bacteria capable of separating hydrogen from H_2O and retaining the hydrogen while releasing the oxygen into the atmosphere and harvesting solar energy to create sugars. This photosynthesizing process defines these as ancestral to the entire kingdom of plants. Cyanobacteria that collected in "mats" or "colonies" formed stromatolites—mushroom-like structures several feet high in shallow water where tides brought a continual supply of nutrients. Leis and Stinchcomb (2015) have assembled a gallery of evidence showing that stromatolites were a dominant form of life for two billion years in every part of the world. Examples from Pilbara Rock in Australia date to 3.4 to 3.5 billion years BP (Walter 1983); from South Africa, 3.5 to 3.6 billion years BP (Knoll and Barghoorn 1977). Stephen Jay Gould (1989) remarked that stromatolites were "the highest form of macroscopic complexity" in the Precambrian world 3.5 billion years ago. But around 500 million years ago they waned under competition from other life forms, and they are rare today, though some still thrive in a few remote locations, most notably in Sharks Bay in Western Australia where they are exposed at low tide. In addition, a variety of open-ocean stromatolites are found at Carbia in Western Australia and Exuma Sound in the Bahamas where subtidal currents provide a constant nutrient flow. However, the fossil evidence is ubiquitous, revealing that stromatolites colonized ancient shorelines everywhere and thus were subject to tectonic movement, coastal mountain building, seafloor uplift, and terrane additions to ancient coasts that moved stromatolite fossils far inland and often to high elevations. There are numerous examples from the 510+ million-year-old Burgess Shale hundreds of miles from the Pacific at an elevation of 8,000 feet in the Canadian Rockies.

In India, Schopf and Prasad (1978) located a conjunction of stromatolites and microfossils dating to 1.4 billion years ago in the Cuddapah Basin of South Central India. A rather spectacular outcrop of stromatolites of similar age was discovered far removed from their original oceanic location in the Uttar Pradesh province of Northern India, now protected in the Salkhan Fossils Park (Leis and Stinchcomb, 60). Based on geochronology, these may have formed originally around the coastal regions of Atlantica to which the Indian cratons were attached in the Archean Era. But these are not the earliest fossils in India. Geologist Naresh Ghose (Ians 2017) has reported locating microfossils, probably formed during the time of the original Ur supercontinent, dating to more than 2 billion years BP in the Gwalioer Basin of the Bundelkhand region. Fossil microbiota from 2.4 to 2.6 billion years ago have been located in Precambrian rocks in various locations in India (Lopuchin and Moralev 1973; Lopuchin and Gowda 1983). In all cases these fossils were carried by the India cratons from their places of origin in earlier supercontinents.

Toward the end of the Precambrian Period around 750 million years ago, a new form of marine life appeared that provided a new biological chapter. Multi-celled organisms emerged, probably from cooperative assemblies of planktonic bacteria, eukaryotes, and the like. The earliest were soft-bodied invertebrates resembling jellyfish. Lacking either bones or shells, invertebrates are poorly recorded in the fossil record, though the Burgess Shale of the Canadian Rockies has preserved some (Briggs et al. 1994). During the Cambrian Era (542 to 488 million years ago) the fossil record reveals an astonishing proliferation of species with hard parts—bones and shells. This occurred as Laurasia—North America, Europe, and northern Asia—was drifting toward the clumped cratons of southern

continents: "At this time," writes M. S. Krishnan (1982, 239), "there existed a great Southern Continent or a series of land masses which were connected closely enough to permit the free distribution of terrestrial fauna and flora. This continent, which included India, Australia, South America, Antarctica, South Africa and Madagascar, has been called *Gondwanaland.*" But since *wana* means "land," Gondwana-land is redundant and so has been officially shortened to "Gondwana" (Illustration 2). The name goes back to the nineteenth century: the geologist Otokar Feistmantel (1876), who was studying fossils in the north central provinces of India, named this region Gondwana after the ancient tribe of Gond who still occupied it.

Shortly after Laurasia collided with Gondwana to form Pangea around 500 million BP, the Cambrian Explosion of proliferating genera and species set in, resulting in a biodiversity of millions of life forms across the supercontinent. Despite the relatively brief duration (50 million years) of the Cambrian Era, 20 to 35 of the major phyla known today emerged. This includes an array of marine phyla, including invertebrate, three-lobed *trilobites*, with over 50,000 separate species identified. As Riccardo Levi-Setti (2014) illustrates, they have been found in Bohemia, China, Morocco, Newfoundland, North America, Russia, and the United Kingdom; they are also found in the Devonian Era Hunsrück Slate west of the Rhine Valley in western Germany along with numerous other highly evolved invertebrates (Kühl et al. 2012). Among fossils, trilobites have inspired more fossil hunters than any other form of life, with spectacular museum collections in Boston, Cancun, Glasgow, London, New York, Prague, Toronto, and Washington DC. Some, like the Houston Museum of Natural Science, have benefited from donations of superlative private collections (Wessman and Eberle 1999). This proliferating form of exoskeletal life, which evolved eyes long before mammals and primates (Clarkson et al. 2006), dominated the world's oceans for 300 million years.

Cambrian fossils in India from rich fossiliferous beds in Kashmir and the Spiti regions consist primarily of brachiopod valves and trilobites (Krishnan, 217). As we trace the fossil record of India from the Cambrian (544-488 mya) through the Ordovician (488-444 mya), and Silurian (444-400 mya), trilobite fossils are plentiful (Sharma 2008), but they decline through the Devonian (400- 359 mya) and Carboniferous (359-300 mya) periods with their extinction complete by the end of the Permian (250 mya). As the Indian record of trilobite fossils gradually decreases, brachiopod valves remain, along with a multitude of shells of many shapes and designs—fans, spirals, cones, and pyramids (Krishnan, 217, 224, 229, 233, 297)—which continue to modern times.

The supercontinent of Gondwana of which India was a part existed from 550 until approximately 180 million years ago. Chronicling events through vast prehistoric eras of India is almost indistinguishable from narrating the history of Gondwana itself. To appreciate this geological and biological history, we need to adopt a double vision for which Mary White has provided suggestive terminology. Her *Flowering of Gondwana* focuses on Australia, but her emphasis on a geo-historical term, "Australia-in-Gondwana" (1990, 34), prompts us to adopt the parallel "India-in Gondwana." Thus evolutionary development and detail belongs not simply to India but to India-in-Gondwana. While the trilobites came and went, thousands of species originated in India-in Gondwana, then continued far beyond the breakup of Gondwana. According to Mora et al. (2011), the approximate number of species worldwide today is 5.5 million land species, 2.2 million

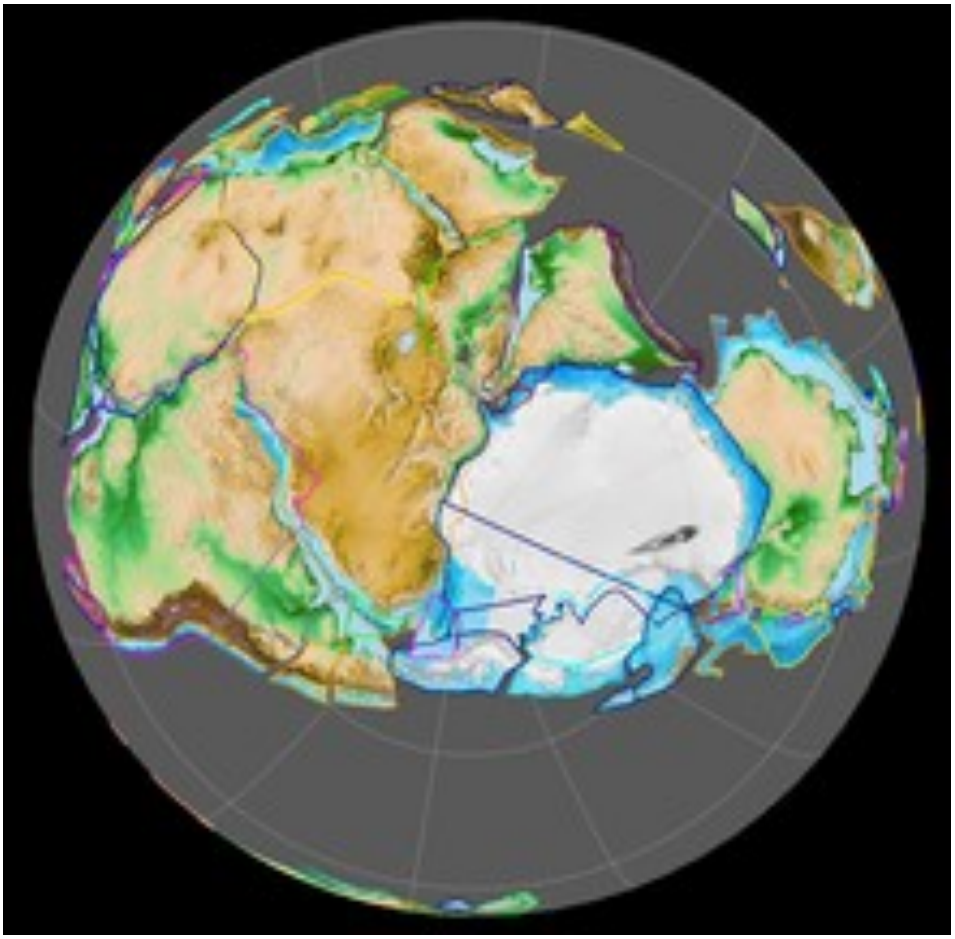

Illustration 2: Gondwana. Before Laurasia (North America and Eurasia) collided with the southern continents and, subsequently, after Laurasia had separated, the gathering of southern continents known as Gondwana persisted as the longest-lasting supercontinent. These southern continents were then clustered with present-day Antarctica. Evidence of glaciation is thus found on all the landmasses that surrounded Antarctica, including southern India. Source: www@wikimedia.com.

marine species, for a total of 8.7 million, though some estimates have suggested as many as 100 million. Since most have very ancient histories, the story of life on Gondwana has several additional chapters, for this is where today's faunal and floral species of India originate.

Creatures now considered ancestors of vertebrates—bilaterally organized around a stiffened dorsal rod-like structure known as a *notochord*—have shown up in Laurasian sites. The tiny fish-like *Pikaia* in the Burgess Shale of British Columbia first described by Charles Walcott (1911), photographically illustrated by Briggs et al. (1994), and thoroughly analyzed by Morris and Caron (2012) swam the world's oceans twenty million years before true vertebrates. A cephalochordate in southern China called *Yunnanozoon*, "Animal of Yunnan [province]," appears to be morphologically related to *Pikaia*, which dates to the mid-Cambrian Era approximately 520 million BP when life existed entirely in the oceans. Since these were without any hard parts, the surprising survival of their fossils is due to the rare way they were preserved: for *Pikaia,* an undersea mudslide isolated and preserved an entire ecosystem from deterioration of soft body parts (Gould 1989, 69-70).

Since we have no evidence that larger predators had yet evolved, it is likely that these finned *Pikaia* would soon have numbered in the billions as they spread to every part of the planet. By the time they emerged, three billion years of planktonic marine life had developed not unlike today's: "a bewildering swirl of tiny creatures . . . more numerous than the stars in the universe . . . unseen marine communities of viruses, bacteria, archaea, single-celled eukaryotes, and small planktonic animals" (Armbrust and Palumbi 2015). Plankton form the foundation of a food chain that has nourished marine life throughout Earth's history**.** The direct vertebrate descendants of *Pikaia* with major speciation occurring from the Mid-Cambrian through the Silurian and Devonian Eras (520 to 360 million years BP) eventually populated every corner of the planet with approximately half occupying oceans and the other half adapting to freshwater environs. Conway Morris and H. B. Whittington (1979) point to the importance of the *Pikaia* discovery: "The superb preservation of this Middle Cambrian organism makes it a landmark in the history of the phylum to which all vertebrates, including man, belong." *All vertebrates*. Since new species of fish are still being discovered, the total number is unknown, though it is certainly in the hundreds of thousands. Based on the exhaustive worldwide *FishBase* data, fish species of India alone number 250, with subspecies numbering in the hundreds (Froese and Pauly 2018), a proliferation that began during the India-in-Gondwana Era and the supercontinent Pangea. This astonishing diversity of the most basic vertebrate—a precursor for millions of more diverse species brings the significance of these unassuming fossils into the clear light of day. Gould's observation (1989, 322) that *Pikaia* is a "final link in our story of contingency" summarizes how a single species may be ancestral to a whole range of descendants which, in this instance, includes *Homo sapiens*.

Fish speciation of India-in-Gondwana Era may be surprising, but this is still an early chapter in the story of life. A momentous shift occurred in the late Silurian and early Devonian Era from 420 to 385 million years BP. The initial movement onto land of floral species began as the necessary precursor for faunal life ashore. It is generally thought that autotrophic green algae, most likely descended from cyanobacteria, were pioneers in occupying land, probably along beaches where tidal nutrients were available, but eventually evolving to draw nutrients directly from rocks and soil. Lichens, which grow in hostile environments worldwide and on rock, provide a suggestive model. The change of the reproduction process from releasing spores in water may have taken millions of years to evolve spore-retention on land, seed reproduction, and utilization of wind to scatter seed-spores. Moisture transport channels within floral stems, along with retention cells and waterproof skins evolved to retain water within vine-like creeping branches, gradually restructuring plant life as "vascular," a description that now applies to all plant life. Meanwhile, specialization of parts like roots in the ground, stiffened stems, and reaction wood to support heavy angled branches were precursors of today's solidly rooted trees, wide-spreading crowns, and tree tops towering hundreds of feet above the ground. Referring to this greening of the Earth, Loren Eiseley (1957, 62) called it "the epic march of life from the tidal oozes upward across the raw and unclothed continents."

Once established, forests and jungles became the constant cover of tropical and temperate lands, with thousands of species developing in lowlands, wetlands, and river valleys and hardier species adapting to drylands and upland slopes. Thousands of generations of lowland vegetation lived, matured, fell, and decayed on the forest floor. The resulting deposits of coal establish India as fifth in the world in coal reserves and fourth in the world in coal production, though, as geologist Krishnan (1982, 283) notes, many coal seams in India are "of small extent and thickness and generally of inferior quality" (Krishnan 283), forcing importation of high quality coal for steel production. On a different note, the fossil record includes an India version of what is well known in America—a collection of petrified trees. The National Fossil Wood Park at Santhanur in Perambalur, approximately 35 km (20 miles) from Puducherry, displays a collection of two hundred petrified trees, dating to the early Cretaceous Era 120 million years BP.

Working in India, the geologist and paleontologist Otokar Feistmantel (1876) provided the first description of *Glossopteris*, which means "tongue" (*Glosso*) "fern" (*pteris*); it referred to a plant with tongue-shaped leaves up to a meter in length, a pronounced midrib, and veins linked together appearing like a net. *Glossoptera indica* and its variations (*Gangamopteris*, *Gondwanidium*) are

widespread in coal deposits in India from the Permian and Carboniferous Eras; seventy species have been identified in India (Chandra and Surange 1979). Feistmantel recognized that the plant group now known as "Glossoptera flora" extended across all of the southern landmasses (Illustration 3).

Feistmantel found this species in a region of northeast India inhabited by the Gond people, and chose to call its extra-India locations "Gondwana," a metaphorical leap that suggests India as the heartland of the earlier supercontinent. Mary White (1990, 34) brings this into focus: "It would seem that the observations of early explorer scientists, who noted the similarities of vegetation in isolated southern lands, started the modern theorizing about moving continents and former supercontinents"—thirty years before Alfred Wegener's suggestion of a southern supercontinent and almost eighty years before its existence was verified. Eventually Feistmantel's "Gondwana" was officially adopted for the Great Southern Continent where these regions once cohered. The importance of glossopteris in India as a key to the Great Southern Supercontinent has been recognized in the 1997 issuance of a stamp (Illustration 4).

Long before the greening of the landscape was complete, its coloration began. Some seventy years ago, Loren Eiseley published a series of essays which he eventually drew together in a book called *The Immense Journey* (1957). His chapter, "How Flowers Changed the World" is an evocative account of the reproductive innovations of plant life. "The flowers bloomed and bloomed in ever larger and more spectacular varieties. Some were pale unearthly night flowers intended to lure moths in the evening twilight, some among the orchids even took the shape of female spiders in order to attract wandering males, some flamed redly in the light of noon or twinkled modestly in the meadow grasses" (1957, 73). Some may hesitate at Eiseley's attribution of intention to flower blossoms; their decorative coloration may be the result of thousands of mutational experiments, most of them failures, until the most effective variety emerged. Despite remarkable designs that emerge in nature, evolution is a hit-and-miss affair with plenty of loose ends and runny edges. But effective varieties eventually prevailed in the flowering; these included lures and strategies that bound faunal life to floral. No matter how one frames the meandering road to cooperative floral-faunal ecosystems, the flowering plants that produced nectar in order to spread their seeds, cone-seeds that are spread by foraging mammals, and hanging fruit that serve as attractive forms of nutrition—all these provided new sources of food for new species of life. And all these innovations occurred while India was still India-in-Gondwana.

With the land prepared as a habitat that included thousands of varieties of plant life, vertebrate invasions of land were inevitable. India experienced it as fully as every other part of the supercontinent. The transitional creatures were amphibians: tetrapodal creatures evolved from fish that are capable of living in water or on land. A

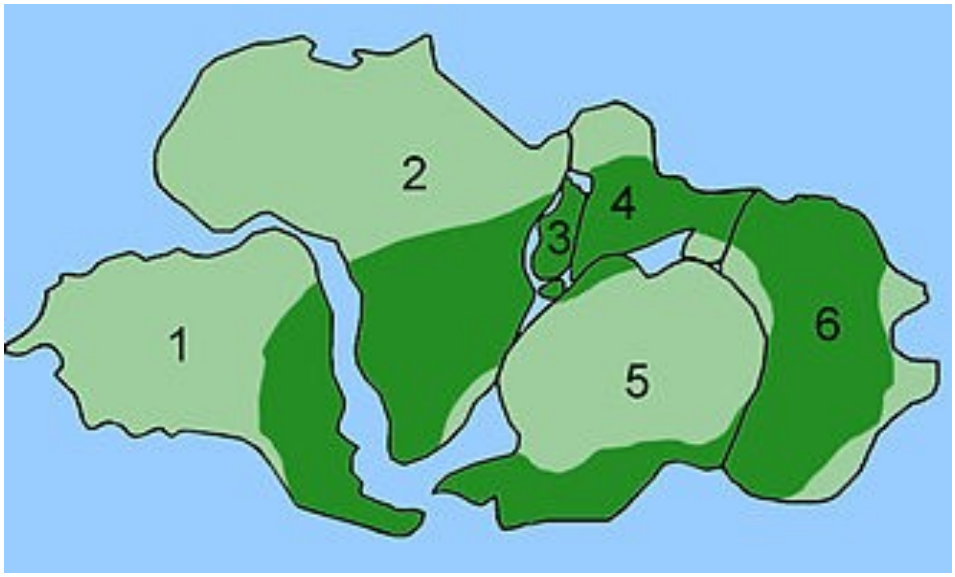

Illustration 3: Glossoptera Range. *Glossoptera* appeared early in the Permian Era (c. 300 million BP). While *Glossoptera* was first identified in India, fossil varieties were recognized as common in South America (1), Africa (2), Madagascar (3), India (4) the temperate rim of Antarctica (5), and Australia (6), thus providing evidence for an ancient gathering of landmasses in a supercontinent now known as Gondwana. *Glossoptera* thrived for 50 million years; most species fell victim to the mass extinction at the end of the Permian (c. 250 BP), with a few survivors evident in India from the early Triassic (Pant and Pant 1987).

Illustration 4: Fossil Glossoptera. On the fiftieth anniversary of the Birbal Sahni Institute of Paleobotany, Lucknow, India issued a series of stamps picturing significant fossils. *Glossopteris*, the largest genus of seed ferns, is known only from its leaves which grew up to one meter (3.3 feet) in length. Since no fossils of woody parts have survived, its configuration as a plant, bush, or tree is unknown. Source: www.paleophilatelie.eu.

huge data bank, Darrel Frost's *Amphibian Species of the World* (2006), lists hundreds; Ranjit Daniels's *Amphibians of Peninsular India* (2005) describes and pictures seventy-two, about one-third of the India total. Their proliferation and survival to the present is surprising since their navigation on land is often poor. With awkwardly placed limbs evolved from side-located fish fins, amphibians such as alligators and turtles experience a muscular challenge and are often poor travelers, walking on wide-spaced limbs and dragging a low, horizontal body along the ground.

In general, correction of this awkward limb placement had to await the emergence of reptiles. The legs of these cold-blooded, egg-laying tetrapods migrated under the body to provide vertical support. Having developed lungs, they no longer lived in water, though they often waded and hunted in it, immersing themselves only as short-term swimmers, never full-time residents. Three orders of reptiles have been identified in India-in-Gondwana, including sixteen Families, with hundreds of species extant today: *A Naturalist's Guide to the Reptiles of India* (Das and Das 2018) provides a rich photographic survey of 280 species; R. Aengel's *Checklist of Reptiles in India* (2018) lists five hundred seventy-two.

The most dramatic reptiles were the dinosaurs that achieved faunal prominence in the mid-Triassic Era and dominated the planet for 165 million years (230 to 65 million years BP). P. C. Sereno et al. (1993) suggest that a small bipedal reptile about a meter in length called *Eoraptor*, "Dawn predator," that inhabited Western Gondwana (Argentina) 231-228 million years BP may be the ancestor that eventually bifurcated into 500 genera and 1000+ species. Many, perhaps the majority, were small—the size of terrestrial birds or our familiar mammal species—with one well-known line experimenting with gigantism. The Tyrannosaur ('tyrant lizard") line, evolved a separate genealogy around 60 million years after *Eoraptor*, around 170 million BP. Tyrannosaurs were bipedal predators, but, as Stephen Brusatte (2010, 2015) has shown, the 20 or so earliest varieties uncovered since 2000 from the Arctic, Russia, Mongolia, and North America were of modest size—some small, some not much bigger than domestic mammals. They tended to be overshadowed by the larger allosaurs and ceratosaurs, but ever since the largest Tyrannosaur, *Tyrannosaurus rex* ("tyrant king of lizards") was discovered in Montana in 1902, it has held center stage. However, the Tyrannosaur experiments with gigantism appear to have commenced with the extinction of allosaurs and ceratosaurs around 100 million years BP, with *Tyrannosaurus rex* achieving enormous size during the last 10 million years before the extinction of all the dinosaurs in 66 million BP.

Some 25 genera of dinosaur fossils are known from India-in-Gondwana. Their dates run from the earliest Mid-Triassic varieties to the modest-size predators of the Jurassic and Cretaceous Eras (230-66 million years BP). Like dinosaurs worldwide, these include bipedal and quadrupedal varieties that range in size from small to mid-size. *Tyrannosaurus rex* is absent from India and in fact from the southern continents; this enormous species evolved on the northern continents of Laurasia after it had separated from Gondwana. Thus dinosaur remains in India are confined to species that had evolved on the southern continents before the Laurasian separation from Gondwana. The iconic variety, with a symbolic Indian name, *Rajasaurus* ("king, sovereign, or royal lizard"), was roughly twenty feet in length (Wilson et al. 2003), half the length of *Tyrannosaurus rex*.

Collision

When Laurentia and Eurasia (= Laurasia) broke away from Pangea (200 to 180 million years BP), the Great Southern Continent of Gondwana remained intact; its southern continents dispersed at various later times. Prior to this breakup, during the Late Paleozoic Era (330 to 240 million years BP), the Gondwana landmasses were subject to approximately 90 million years of glaciation—a result of supercontinent movement over a wandering South Pole (Crowell and Frakes 1970, 1975; Crowell 1978). Geological effects of glaciation are evident in southeastern South America, Africa south of the Sahara, southern India, Madagascar, and Southern Australia. Around 100 million years ago India and Madagascar detached from Gondwana (Powell 1988), probably because of crustal rifting that separated them from the vast land mass of Antarctica. Today the Southwest Indian Ridge on the floor of the Indian Ocean marks the rift where, in all likelihood, an upwelling plume from deep in the Earth's mantle powered the separation, the opening of the southwest Indian Ocean, and the movement of the India plate north. Its estimated velocity was the fastest of any plate movement on the planet—twenty centimeters (7.9 inches) per year. Kumar et al. (2007) note that five seismographic stations on Archaean rock of the Indian Shield indicate a thickness of 80 to 100 kilometers (50 to 62 miles), about half the 180-kilometer thickness of the other Gondwana shields. It is thought that the base of the Indian Shield may have been eroded by passage over plumes or hotspots; in any case, its thinness may account for its unusually rapid migration. How much of the ocean bottom in advance of (to the north of) the India Plate was actually part of it is unknown for it exists now as deeply-subducted crustal fragments sinking into the mantle beneath Eurasia. Ocean bottom that trailed the India craton undoubtedly accumulated from upwelling along the Southwest Indian Ridge and consequent seafloor spreading.

When India began its migration north, the Indian subcontinent rafted a rock-and-fossil record that had accumulated over more than 3000 million years. An interwoven chronology of geotemporal, petrotemporal, and biotemporal events includes microfossils from Archean rocks, autotrophic bacteria, stromatolites, trilobites, vertebrates from fish to amphibians, and reptiles up to the great age of the dinosaurs. Some of these fossil remains indicate that parts of the India craton were periodically flooded during its migration, creating above-water fossilization of undersea life.

(Illustration 5)

As this cratonic raft moved away from Gondwana, existing species lived on. For perhaps 30 million years (96 to 66 million BP) late Cretaceous dinosaurs coexisted with diminutive mammalian species not much larger than a cat or dog that had long coexisted with dinosaurs since they had diverged from reptiles 225 to 200 million years ago. This India raft had moved far beyond its beginning point where it was attached to Antarctica and was halfway to Asia when a dramatic volcanism set in. The drifting subcontinent evidently ran over a deep mantle plume of enormous power that broke through the underlying crust and poured out massive quantities of lava which spread over a huge territory in western, central, and southern India. The resulting formation is known as the Deccan Traps, the latter a Scandinavian word that refers to a step or stair structure that was most likely formed from layers of lava overspreading earlier layers. The Deccan Traps today are up to 2000 meters (6600 feet) thick in the coastal region near Mumbai, tapering off to the east to less than 60 meters (under 200 feet). Upwelling lava was evidently superheated, resulting in an extended horizontal rather than vertical accumulation; virtually level lava flows have been traced for 100 kilometers (60 miles). The whole expanse is now spread over 500,000 km^2 (200,000 miles^2), with a volume of 1,000,000 km^3 (200,000 miles^3). However, now-separated outliers indicate that extensive erosion has reduced both the thickness and area of the original Traps, which is estimated at three times its present size, making it one of the largest geological features on the planet. Fossils located between layers of lava indicate that eruptions were discontinuous, possibly recurring sporadically with pauses of tens of thousands of years, and coming to an end when the Indian subcontinent had moved clear of the underlying hotspot, which now lies under Réunion Island in the Indian Ocean.

A worldwide catastrophe occurred 66 million years BP when an asteroid struck Earth with an epicenter on the Yucatan Peninsula. The story of the Chicxulub impact can be traced through the geological work of the father-and-son, Luis and Walter Alvarez (1980, 1992, 2017). Whether there is some connection between this impact and the eruption of the Deccan Traps has been put forward as tenuous theory but has not been demonstrated. The effect of the asteroid strike, however, was a worldwide mass extinction that eliminated 90% of terrestrial life, with dinosaurs in India and elsewhere driven to extinction. The Indian subcontinent thus became a graveyard for the last Cretaceous Era dinosaurs, including *Rajasaurus*. The inventory of dinosaur remains in India, however, does not include the enormous *Tyrannosaurus rex* or its smaller ancestors, for the Tyrannosaur line seems to have developed on Laurasia after separation from Gondwana; it is thus found in northern regions—China and North America (Brusatte et al. 2010; 2015). Among the mid-sized dinosaur remains in India, the extensive collection of bones near Balasinor in the western province of Gujarat ranks as one of the most prominent fossil sites in the world. Here dinosaur bones are spread over 70+ acres, littering the surface of the ground; fossilized dinosaur eggs have been located; and scores of skeletal remains of numerous species have been preserved. The Suketi Fossil Park on the bank of the River Markanda, in Nahan, preserves a different era of prehistoric life—primarily vertebrate fossils and skeletons.

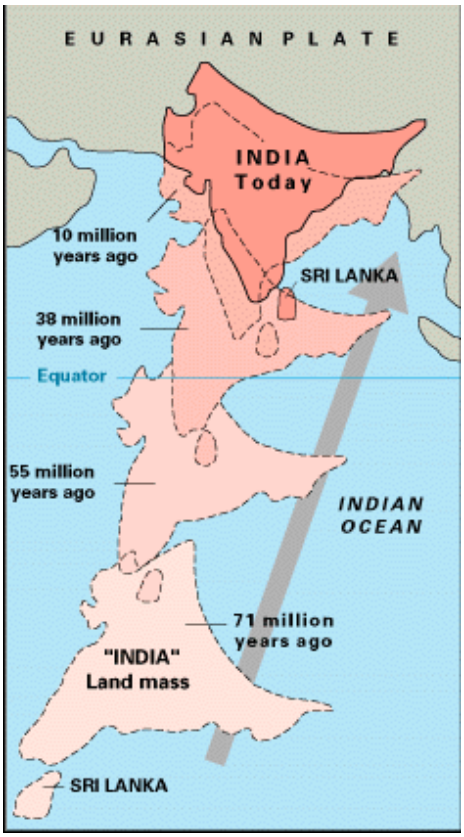

Illustration 5: Migration of India. Plate tectonics carried India north from Gondwana to its collision with South Asia. This illustration shows rapid movement (c. 20 cm. per years) following departure from Gondwana gradually slowing to 5 cm. per year as it approached South Asia. Source: en.wikipedia.com.

The striking uniqueness of India is its collision with South Asia and the profound geographical effect this impact had. Recent studies (von Hinsbergen et al. 2012; Jagoutz et al. 2015) have placed the collision of the Indian craton with offshore islands of Eurasia at 50 million years BP and collision with the Eurasian landmass 10 million years later. If this chronology is accurate, the extinction of late Cretaceous dinosaurs happened approximately 26 million years before India became part of Asia. Species that survived the mass extinction included smaller amphibians, reptiles, avian dinosaurs (birds), and mammals that now emerged as the dominant species. While some evolutionary development of surviving species undoubtedly occurred in India between its separation from Gondwana and suturing to South Asia, the subsequent 40-million-year movement of species between Asia and the Indian subcontinent has rendered these less significant today. Within a few million years, India's animal population included species originating in the immense landmass of Eurasia.

The migration of India north from Gondwana to the south coast of Eurasia was largely marked by the preservation of lifeforms along with an immensely long fossil record of their history. Meanwhile, the collision of the Indian craton with Southern Asia began one of the most dramatic events of planetary history. With the collision of the subcontinent with offshore

islands (c. 50 million BP), the collection of island terranes began, though they were subsequently crushed or subducted. With the full-bodied meeting of India with the Asian mainland, a slow-motion 40-million-year collision was set in motion which is still going on. Prior to the collision, the India plate set a tectonic speed record, moving at 20 centimeters (7.9 inches) per year (Kumar 2007). Since the collision, movement has gradually slowed to the present 5 centimeters (2 inches) per year. One way of observing the effect of India's continuing collision suggested by Krishnan (1982, 73) is the distortion of the Tethyan Basin (the last remnant of the Tethys Sea, which separated Laurasia from Gondwana in the pre-Cretaceous Period). This basin can be traced from Turkey through Iraq and Iran and it may have run as a straight line into the Indonesian Archipelago. This suggestive calculation indicates that the collisional mass of India has pushed the basin north by approximately 1300 kilometers (780 miles). The result was a progressive crushing of landmasses that reduced the area of land along the line of collision. Krishnan, who has written extensively on Indian tectonics (1953; 1967), concludes that "the estimate of the crustal shortening of about 1300 km . . . would therefore seem to be quite a modest estimate for the numerous folds, overthrusts and nappes present in the Himalayan-Karakorum belt" which indicates that "a region of great width was involved in the Tertiary mountain building movements" (1982, 74). While the precise reduction in area may remain beyond precise determination, the impact region is highly visible (Illustration 6), and the volume of rock and sediment affected is incalculable, though the result is obvious. The entire region north of India, including both the Himalayas and the Tibet Plateau, has been forced upward by this landmass collision. What is visible, however, is a partial picture. When continental crust attains elevation through orogeny (mountain building), it also gains depth or thickness that displaces some of the underlying mantle, thus maintaining its buoyancy, like a loaded ship settling deeper into the water.

Illustration 6: Collision with South Asia. The crushing and collision of landmasses is visible in the distorted lines of the Himalayas and the complex mountainous ripples at both ends of the range. The raising of the mountains outpaces erosion caused by wind, rain, snow, avalanches, and rock slides. The area of Asia affected is several hundred miles in width and more than 1500 miles from east to west. Source: www.usgs.com.

The present location of India today presents some striking facts of chronology. During its extensive prehistory, India was elsewhere. Its history of stromatolites and trilobites, fish and amphibians, reptiles and dinosaurs and early mammals occurred while it was part of a sequence of supercontinents extending far back in time: Pangea, Gondwana, Atlantica, Rodinia, and Ur. The whole time span since verifiable life began is 3500 million years while the time India has been a part of Asia is 50 million years. In a scale we can understand, 97.7% of India's geological and biological past occurred elsewhere with the time India was part of Asia calculating to 1.3% of her history. In the final phase of its history, India provides a unique example of continental migration with a collision more momentous than others around the planet. In addition, India reminds us that every craton, terrane, region, and nation has an equally vast prehistory that unfolded elsewhere from where it is now. It has been estimated that most of the continental landmasses of the world have moved at least 10,000 miles. Alfred Wegener would be amazed.

At less than 50 million years of age, the Himalayas make up the newest mountain range on Earth. Their peaks are craggy and jagged and constructed of huge slabs of obducted crust and sedimentary rock. Observation

confirms that the direct impact of convergent plates slowly folded, rippled, crumpled, crushed, and buckled huge slabs of surface crust which have been steadily thrust upward, adding to the overall height of the entire range (Illustration No. 7). Embedded in sedimentary rock, shells, trilobites, and other fossils mark the rippling and folding of seabed forced over the Asian continent. Among these the oldest whale fossil on the planet was discovered (Bajpai 1998): *Himalayacetus subathuensis*, a mammal that returned to the ocean—perhaps to the Tethys Sea. Dating to the Eocene Era 53.5 million years ago, it is one of several Eocene mammal fossils found in the Himalayas (Thewissen 2001).

The highest peak in the world, Mount Everest, stands at 29,017 feet (29,029 to the top of the snow), but the Himalayan range features fifty mountains over 7,200 meters (23,600 feet). The range varies from 150 kilometers (90 miles) to 350 kilometers (220 miles) in width and stretches 2400 kilometers (1,500 miles) across northern India. Immediately north, a tectonic valley roughly 30 to 35 miles across—the remnants of the Tethyan Ocean basin—separates the Himalayas from the Tibetan Plateau, a 2.5- million-square-kilometer (970,000-square mile) plateau averaging 4,500 meters (14,800 feet) above sea level. The volume of all this land displaced and thrust upwards is unimaginable, though the collisional history of the planet suggests immense changes on this scale have happened many times in many locations. Meanwhile the increase in elevation outpaces erosion which began as soon as the first hills were pushed up 40 million years ago. The result is the deep, rich, erosion-fed lands immediately south of the range that form a fertile belt across the north of India. The four greatest rivers of South Asia—the Indus, Ganges, Brahmaputra, and Mekong—are fed by Himalayan ice and snow with massive flows from mountain elevations.

Culture

When we consider our bipedal ancestors around five million years ago, we are confined to the miniscule fraction of time when India was part of Asia. If we focus our perspective to the whole time of Homo sapiens, we are more confined to 300 thousand years, a vanishing fraction of the whole. Yet our day-to-day perspective, in India and everywhere else is so consumed by the human concerns of families, friends, school, work and recreation that these easily swell to become our major or even our only perspective. From this viewpoint, earth and biological history can easily disappear like the splash of stars in the Milky Way now mostly out of sight beyond our dust-laden skies. We need a double perspective. No matter how consuming our lives may be, there is a larger story where the groundwork and possibility for our existence was laid down over

Illustration 7: The Himalayas. The collision of India with Southern Asia led to a crushing and compression of thousands of square miles of landmass that subducted, obducted, and rippled, leading to a deep thickening of continental crust while raising the greatest mountain range on the planet, and creating the Tibetan Plateau. Beginning 50 million years ago, the collision continues today, raising the mountains an average five millimeters a year. Continuing mountain erosion has result in the rich fertile lands of northern India and the Indus, Ganges, and Brahmaputra River Valleys. Source: www.sciencing.com.

billions of years on long forgotten earthscapes. Our significance lies in our ability to imagine the whole story: to realize the place of humanity in the light of this immense prehistory. India provides one of many landscapes for exploring our imaginings.

In the past thirty years we have recognized that *Homo sapiens* migrated out of Africa some time earlier than 65,000 years BP. A growing list of sites and artifacts has shown us that the primary migration route out of Africa was across the Gate of Grief at the south end of the Red Sea to the southern coast of Arabia (Armitage 2011)—now called the Southern Route. In fact, an extensive sequence of artifacts, human remains, and relict settlements along oceanic margins indicates that the primary route that peopled the world was coastal—following the shorelines of South Asia, then beachcombing around the entire Pacific Ocean from Philippines to Patagonia (Wood 2019b). Genetic markers coastal migrants into India, or what Reich et al. (2009) call Ancestral South Indians, provided one of the two major gene pools of India today. Metspalu et al. (2004) suggest that the fertile ecology of India may have made it a primary stopping point for some coastal migrants. Undoubtedly, numerous South Asia rivers—the Indus, Narmada, Sabarmati, Krishna, Godavari, Brahmani, Ganges, and Brahmaputra—would have invited inland riverine migration. But geological events constrained the chronology of human occupation of India. The Mount Toba explosion in Sumatra that dates to 74,000 BP provides an important milestone. As Stephen Oppenheimer (2004) notes, the Mount Toba explosion is thought to have caused such extensive deforestation, ash fall, and ecological damage in India that humans already there might not have survived. Tools atop volcanic ash at Jwalapuram on the Krishna River indicate settlement occurred soon after the Mount Toba event. In general, *Homo sapiens* in India over the next 65,000 years were nomadic hunter-gatherers (Misra 2001), most likely clustered into tribal units of approximately thirty individuals, which Lee and DeVore (1968) have suggested was the "magic number" for prehistoric band size.

The second gene pool dominant in India, identified by Reich et al. (2009) as Ancestral North Indians, were later migrants from the Iran and the Middle East, and points farther north. More than two hundred years ago, this migration became an inevitable assumption when Sir William Jones made his presentation in the *Third Discourse to the Asiatic Society* (1786) in Calcutta, identifying Sanskrit and derivative languages as belonging to what is now known as the Indo-European language family (Cannon 1990). Subsequent research has shown that this family originated in the region of the Black Sea, near or east of Ukraine or possibly Anatolia (Ruhlen 1994). Indo-European peoples had thus migrated, following the east coast of the Persian Gulf into the Indus River Valley, and mingled with the indigenous nomadic people in the region. Historically, they called themselves "Aryans," a term recording the most recent leg of their migration route—out of Iran. Genetic evidence of lactose tolerance among these migrants suggests they arrived after the Agricultural Revolution in the Middle East which dates from 12,000 to 10,000 BP (Maisels 1990, 65-77). Their arrival with agricultural skills in what is now Pakistan is typically placed around 5000 BCE. By 3000 the Indus River Valley was cultivated extensively enough to support numerous permanent settlements; by 2700 BCE the dominant cities of Harappa and Mohenjo-daro represented the high point of Indus Valley culture (Kenoyer 1998). Asko Parpola (2015) confirms the long-standing theory that these migrants established the roots of Hinduism. Sir William Jones had concluded as much in the 1780s: the Hindu *Vedas* and *Upanishads* were written in Sanskrit, the earliest extant Indo-European language—a clear indication that these northern migrants provided not only the language but also the fundamental concepts and beliefs that evolved into Hinduism (Basham 1954; 1991).

The history of India over the past 3000 to 4000 years is encyclopedic in complexity and detail; it began with the decline of the Indus Valley Civilization between 2500 and 1900 BCE (Possehi 1997) and a demographic shift to the upper Ganges-Yamuna River Valleys. Here the Hindu religion matured, though its roots had been established millennia earlier. The nexus of the Hindu-Buddhist civilization, which was primarily mythic, laid out broad parameters that underlie the subsequent cultural history of India. The earliest spiritual texts were the Vedas; of four collections, the *Rig Veda* is the oldest, having been transmitted orally and musically for almost 3,000 years until it was given written form in ancient Sanskrit between 1500 and 900 BCE (Basham 1991). The *Rig Veda* consists of 1,028 hymns that are addressed to early deities (250 celebrated Brahma, the god of creation) and appear to be musical accompaniments to ritual originating in the Indus Valley Civilization.

It is rare that a single text can capture the essence of an entire culture, but *Rig Veda* x.90 manages just that. According to this hymn, creation began by the sacrifice of *Purusha Sukta*, the Cosmic Man, who had a thousand heads and equally prolific number of arms and legs. His sacrifice, which resembles an "Indo-European corpus of myths of dismemberment" (O'Flaherty 1981, 19), transforms him into the world, sky, Sun, and Moon; all the wild and domesticated animals of the Earth; the four seasons; the entire hierarchy of human society from Brahmins to warriors to farmers, and servants. From his sacrifice even the Vedas were created, including the *Rig Veda* where this hymn appears. From the various parts of his body, too, the gods are born—the supreme deities, Indra and Agni, from his mouth—a remarkable detail that suggests that the gods themselves come from the mind and words of man himself. The symbolism of this hymn and its connection to other Hindu writings deserves the attention of anyone seeking to understand the roots of Indian culture (Wood 2017). The overall structure of this narrative says that the multiple heads and limbs of the Cosmic Man are in fact the heads and

limbs of all humankind, 7+ billion heads and double that number of arms and legs, though they cohere as a spiritual unity originating in the creative event itself and evident in the history of Indian society for the past thirty centuries.

The unity of humankind in India earned further confirmation in the *Upanishads*. The word means "forest discourses." These were one hundred nine philosophical writings composed by spiritual philosophers—ascetics who escaped to isolated forest settings, thus setting themselves apart from society to pursue the enlightenment known as *moksha*: the realization that one's *atman* (the individual self) is one with *Brahman* (the cosmic self). This ultimate discovery is summarized in the *Chandogya Upanishad* as *Tat tvam Asi* (VII, viii, 7), "That art Thou," colloquially, "You are It." No matter how many divisions occur, no matter how many conflicting interests appear, no matter what other religions, beliefs, philosophies, ideologies may arise in India, the central truths of the *Rig Veda* and the *Upanishads* assert the underlying unity of the cosmos, world, society, and humankind. This realization is the culmination of the Indian epic, the grand narrative of the making of India.

There are, however, two other discoveries in Indian culture. They do not contradict what these earlier texts assert; rather they deepen and broaden their truths, and remarkably, they seem intuitively to recognize the ancient roots of India that extend deep into the past before civilization and culture existed. One of these recognitions is that the everyday time, clock time, the constricted time of mere decades, centuries, or millennia fails to do justice to India and its understanding of the Infinite. The best-known text of India is the *Ramayana*—most of it available in the Clay Sanskrit Library (Goldman et al. 2005-2006)—a magnificent epic of betrayal, exile, love, rescue, and kingship. As V. Raghavan (1980) assembled in a landmark conference and forty-four regional essays, the *Ramayana* influence has touched nearly every culture in Asia. It is so powerful, so magnificent, so cosmic in scope, that it has inspired cultures across what Ptolemy labeled on his map *INDIA EXTRA GANGEM*, "India beyond the Ganges" (Ptolemy 1991) where it has been translated multiple times in Myanmar, Thailand, and Indonesia and its episodes have been sculpted on temples from Bangkok's Grand Palace in Bangkok, Angkor Wat in Kamboja, the Prambanan Temple in Central Java, Majapahit temples in East Java, and carvings in dramatic relief on the island of Bali (Illustration No. 8).

The central narrative is the captivity of the princess Sita and her dramatic rescue by prince Rama. The story is too complex to summarize, but the narrative unfolds against a time frame unknown in Western literature. Before Rama was born, his father Dasaratha ruled the kingdom of Ayodhya for 60,000 years; after Rama rescues Sita and takes up the kingship, he rules the kingdom for more than 10,000 years. This, of course, is literary myth, but intuitively it tells us that the world and the universe as conceived in India are much greater, with a much longer history, than the mere centuries of present civilization.

A similar mythic temporality is found in the Buddhist tradition. The story of Siddhartha, the prince of a kingdom at Lumbini, now in Nepal, is well known: having witnessed suffering, he left the kingdom behind, sought enlightenment among the forest sages, then ultimately attained enlightenment on his own, from which point he was known as the Buddha. His wisdom is summarized in the Four Noble Truths and the Noble Eightfold Path (Walshe 1995). Following his death a body of legends known as the *Jataka Tales* took shape as one of the earliest literary collections from India. The tales, which have origins in the fourth century BCE, appear to be a folkloric collection, many of them animal tales somewhat like Aesop's fables that have migrated into the Buddhist canon. Here they take the form of lives of former Buddhas (Cowell 1895), each one "containing the life of Buddha during some incarnation in one of his previous existences as a Bodhisatta" (Francis and Thomas 1987, 5). According to the mythology that developed around the Buddha (560-480 BCE), he was the most recent of twenty-five Buddhas born at intervals of 5,000 years. People routinely forget the message of the Buddha; hence it is necessary that he regularly return to renew the Four Noble Truths and the Eightfold Path. Simple mathematics shows that this sequence of earlier Buddhas extends over 125,000 years. The mythology behind the *Jataka Tales* "has little to do with the fundamental teachings of Buddhism" (Conze 1951, 97), and has no part in the profoundly complex philosophy of Buddhism (Guenther 1972). But the mythology itself constitutes further evidence that history and prehistory in India is conceptually far more expansive than other temporal

Illustration 8: Rama and Sita. Although the *Ramayana* epic is dominated by jealousy, betrayal, kidnapping, abuse, and war, its underlying story is the captivating love between king Rama and Queen Sita who suffer through exile and Sita's captivity to attain their rightful destiny as king and queen of the kingdom of Ayodha. Episodes from the story appear in sculptured temple panels from India to Indonesia. Pictured here is a woodcarving from the Island of Bali, recognized worldwide for its painting, carving, sculpture, music, and drama. Source: www.Pinterest.com.

traditions. Moreover, it constitutes a fictional history that adds to the authority and power of Buddha and Buddhism.

While Hinduism has provided a power culture for India that continues today, the practice and theory of Buddhism gained its greatest strength elsewhere: in Sri Lanka, Myanmar, Thailand, with influence in Malaysia, Indonesia, China, and Japan. Its greatest monument is Borobudur in Central Java, now a UNESCO World Heritage Site (Illustration No. 9).

This Buddhist view of time underlying the *Jataka Tales*, greatly expanded, informs the Indian *Mahabharata*, though on a much grander scale. This ancient epic is the longest literary work ever composed. The title means "great" (*maha*) "cherished one," (*bharat*) and refers to the father of two brothers, Bharat, and thus the ancestor of the two tribes descended from these brothers, the Pandavas and the Kauravas. A disequilibrium in human society occurs when the two brothers fall into conflict. Subsequently, their contentious relationship is passed on to future generations to become a blood feud between rival clans. A vast time scheme, which is also described in the *Vishnu Purana*, lies behind the *Mahabharata*. Its units are *yugas* and *kalpas*. As Troy Wilson Organ (1974) clarifies, history unfolds through four *yugas*, or "great years": the *Satya, Dvapara, Treta, and Kali Yugas* stretched through 1,728,000, 1,296,000, 864,000, and 432,000 years for a total of 4,320,000 years, known as a *kalpa*. Rama, we learn, lived in the second age of the world, presumably the Dvapara Yuga, which situates the story of the *Ramayana* well over a million years in the past. The *Mahabharata* feud occurred many thousands of years in the past toward the end of the Treta Yuga. Indians intuitively understood that present human life occurs in a minor sliver of time within an infinitely long history and prehistory. In his presentation of "India and the Infinite" (1979) religion historian Huston Smith pointed out that while the West was still thinking the world might be no more than 6,000 years old, India was already envisioning time stretching into an infinite past and a universe of endless galaxies so vast that modern astronomy slips into its fold without a ripple. The correlation of this mythic temporality with the geotemporality, petrotemporality, and biotemporality of India's past—most of it in India-in-Gondwana—unifies science, philosophy, and spirituality in a manner unique to human civilization.

But lest we seem to overpraise India's intuitive grasp of this larger reality, we need to emphasize the massive tragedy also realized and articulated in Indian philosophy. Siddhartha, who became the Buddha, was motivated by witnessing hunger, sickness, suffering, and death. His Four Noble Truths include the facts that "existence is suffering" and "suffering is caused by selfish craving." This is the ongoing fate of every human, but another great truth is that selfish can be overcome by following the Noble Eightfold Path allegedly uttered by

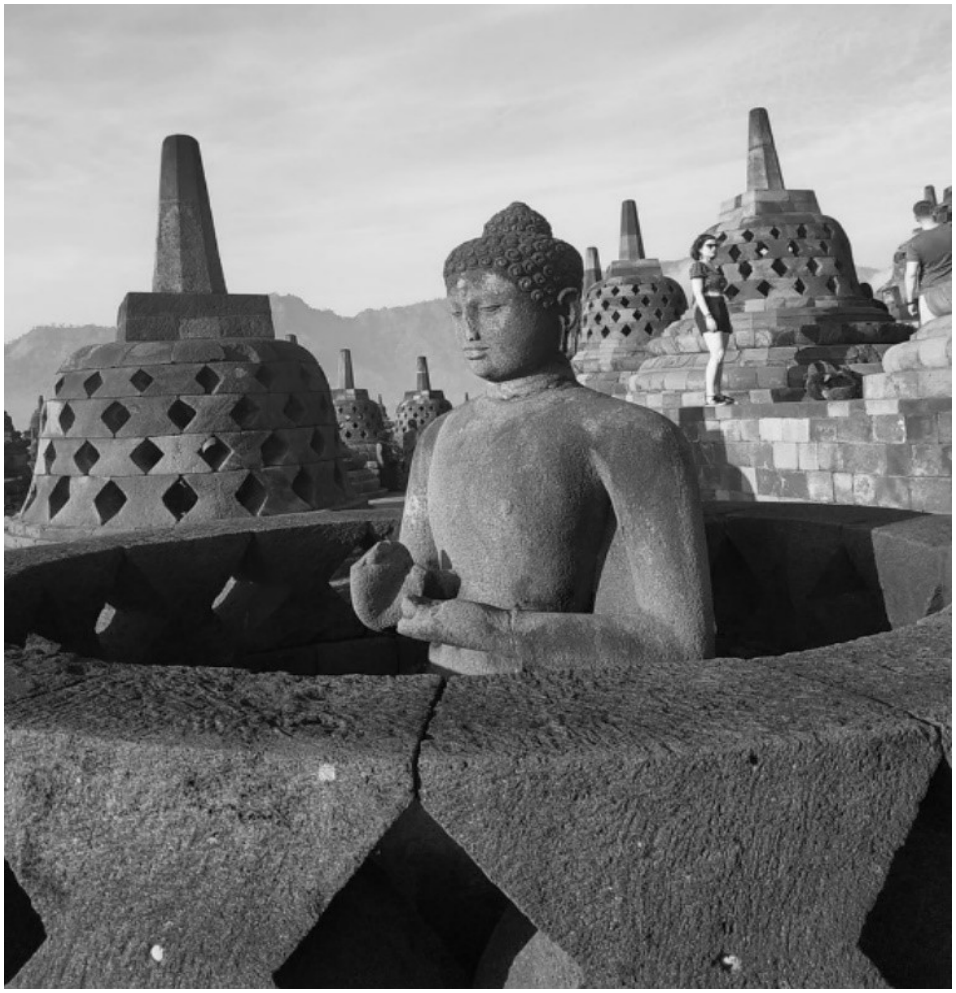

Illustration 9: Borobudur. The largest Buddhist stupa in the world, Borobudur, a square pyramidal structure 118 meters (387 feet) per side, is located in Central Java, Indonesia. It has six square lower levels and three circular upper levels topped by a large central stupa surrounded by an array of smaller bell-shaped stupas. Built over an estimated 75 years, its completion is estimated at 825 CE. The lower levels display 2,672 relief carvings that stretch for hundreds of yards. Of the 504 statues of Buddha, seventy-one are seated in bell-shaped stupas on the top levels (shown in the background) and can be viewed through diamond-shaped openings. In the foreground, one stupa was deliberately left incomplete. Following a 9th or 10th century eruption of nearby Mount Merapi the monument was covered with volcanic ash and jungle growth; thus the monument disappeared for several hundred years, known only as hidden ruins by indigenous locals. Rediscovered early in the 19th century, the monument was cleared of trees and ash by Sir Stanford Raffles. Source: www.unsplash.com.

Buddha himself at Benares following his enlightenment

A variant presentation of human suffering and selfish craving on a massive scale appears in the *Mahabharata* epic. As this enormous story unfolds, generation after generation, the feuding clans grow in numbers. Eventually, after millennia of feuding, they number in the hundreds of thousands, but no one remembers what the original feud between the brothers was all about. Moreover, the warring clans have forgotten the primary truth that *all* humans are ultimately brothers—and sisters, cousins, aunts and uncles, nephews and nieces. Everyone on Earth is related, as in fact genetically we are. The realization of this tragedy comes in a collection of eighteen chapters in *The Mahabharata* when the armies of the Pandavas and Kauravas, descendants of the original feuding brothers, are drawn up on the battlefield before dawn, ready to begin the final, decisive war, scenes from which have been carved in temples across Southeast Asia (Illustration 10). These chapters have taken on a life of their own; they make up the *Bhagavad Gita,* the central spiritual text of Hinduism. The action focuses on a warrior in a war chariot, Arjuna, and his dialogue with his charioteer, who happens to be the god Krishna in disguise. In despair, Arjuna looks out through the mist of morning at the vast armies waiting for the full light of dawn and asks his charioteer what it all could mean.

The answers Krishna provides to Arjuna's questions provide a systematic presentation of Hindu thought and practice, specifically the many ways that humans may overcome egotism and selfish craving and pursue spirituality: the many paths to enlightenment available to people from different levels of society. There are meditational paths, paths through learning and wisdom and work, family life, devotion and love. All of these are different forms of *yoga*—"disciplines" that are equally important in the human quest for knowledge, wisdom, truth, and unity. With this wisdom understood, the tragedy of war now fits into the larger scheme of things, and the war begins.

As we look at Indian culture, we are likely to think of Hinduism as a "religion," but it is so much more. It is a culture that penetrates ever dimension of Indian life. It is not likely that it can solve the problem of armies prepared to fight against their own kin; that is the virtually unsolvable tragedy of human history, of wars that have besieged the underlying unity of human life since civilization began, and they continue today. Amid this tragedy, however, the underlying unity of life remains, and there are many paths to that realization. Our understanding of Hindu culture is too small; seen in its entirely, it is a final episode in an epic journey "from atoms to atman," a grand narrative tracing out the emergence of infinite spirit (Wood 2017). The multiple paths confirm that all of human life—every path, every practice, every task, every human endeavor—is central to the task of finding one's way within the vast panorama of the universe even as this journey may occur amidst the tragedy of conflict and war.

These central truths of the *Mahabharata* and the *Bhagavad Gita* appear to have been recognized as fundamental through Indian history until modern times. The ancestor of warring feuds, Bharat, was idealized as the unifying king before civilization was shattered by division and conflict, war and destruction, and thus a symbolic union of opposites, the One behind the Many. Understood this way, Bharat has remained the transcendent symbol for a great ideal. Thus when India gained independence and framed her modern constitution in 1950, the symbolism of *Maha Bharata*, Great Cherished One, was seen and felt as the unifying power of Indian civilization and culture. The Indian Constitution begins, "*India, that is Bharat, shall be a Union of States*."

Illustration 10: The Mahabharata War. A manuscript scene of Arjuna and his charioteer in the thick of the final battle between the Pandavas and Kuravas. Eighteen chapters of the enormous *Mahabharata* epic that precede this battle make up *The Bhagavad Gita,* the most sacred of Hindu texts, where Krishna, disguised as Arjuna's charioteer, explains the multiple ways to *moksha* (enlightenment)—the many *yogas* of work, study, family life, service, meditation. These spiritual truths mitigate the tragedy of war between two clans descended from feuding bothers, sons of the ancient king, Bharat. The war led to 1,660,020,000 deaths, approximately 300 million more than the present (2019) population of India. Source: https://isha.sadhguru.org.

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A New Era for Our Fellow Creatures

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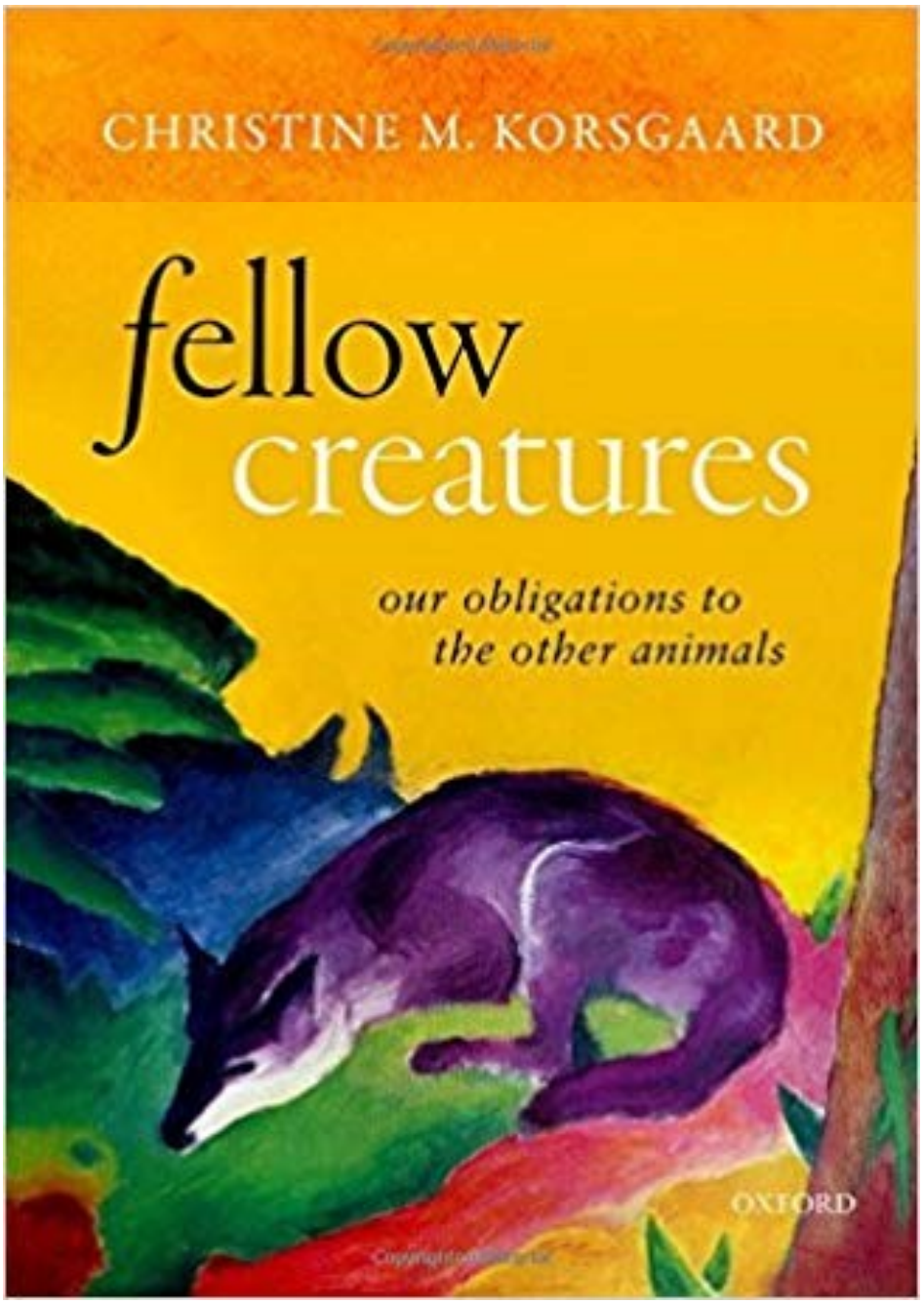

Christine M. Korsgaard is a renowned philosopher who has taught at Harvard University for almost three decades. She works on moral philosophy, interpretations of ethical theory, the works of Immanuel Kant, and the ethics surrounding our treatment of animals. This is her first book that addresses the treatment of animals.

Fellow Creatures: Our Obligations to the Other Animals has been brewing since the author became a vegetarian several years ago. This became her reason, her motivation for writing about the ethical treatment of animals. Animals have changed the course of human history. They have provided food, shelter and clothing, companionship, and labor; they have worked for us; they have even fought for us. Without them our history would have been far less certain and it is unlikely that advanced civilization would have developed. Yet our current society seems to have forgotten how much we owe to animals. I fully subscribe to the author's belief that "the way human beings now treat the other animals is a moral atrocity of enormous proportions" (p. xi). In clear language, and in a style suitable for non-specialists, Korsgaard presents her passionate moral views and her reasoned, objective philosophical arguments, on this controversial topic.

In *Fellow Creatures* she establishes her argument in the framework of two philosophical commitments: 1) Kant's ethics, which effectively support the

notion of animal rights and the concomitant idea that we, therefore, have obligations toward them; and 2) a particular point of view derived from the theory of Aristotle about why some things are good and others bad. She defends as her core thesis the basic correctness of Kant's account of why we have obligations to animals, although she admits that Kant himself did not explicitly endorse this idea as explicitly as she does here. Thus, Korsgaard argues that the common understanding of Kant's general theory—i.e. the notion that animals are non-rational, unselfconscious beings (thus giving them no rights) is mistaken, and that Kantian philosophical terms do not necessarily exclude animals from being ends in themselves. "Even within the framework of Kant's theory," she writes, "it is possible that rational beings legislate moral laws whose protections extend to other animals. . . . We rational beings must claim the standing of an 'end-in-itself' not only for ourselves, but for the other animals as well" (131).

Korsgaard goes on to explain how she sees Kant's ethics as leading to the conclusion that animals are not mere means to human ends, but ends in their own right. She does not support Kant's notion that our duties to animals are indirect; instead, she believes that our obligations to other animals—although not exactly the same as our obligations to other people—"arise from the relations to ourselves" (XI). She feels that "Valuing", with a capital letter, is an original activity of Life, *i.e.*, an important characteristic of a sentient being's relationship to itself.

Throughout most of the chapters of this book—parts I and II—the author reels off these ideas and others derived from them, aiming to defend her interpretive view of Kant's ethics. Although these sections are heavily theoretical, they provide non-specialist readers, even those without a strong background in philosophy, the opportunity to immerse themselves in Kantian ethics and to acquire some basic knowledge that will surely help them to understand debates about the treatment of animals from an ethical point of view. Korsgaard explains in great detail her proposed terminology, covering all the necessary key concepts, like "creatures," for example, which she uses to refer jointly to both humans and other animals, or the term "companion animal," instead of "pet," the latter of which she considers demeaning.

All together her use of terminology, her ethics, and her general approach are convincing and will cause any reader to sympathize with her arguments and her point of view. In addition, Korsgaard explores evolution, extinction, senescence, and other topics that are an added value in this book. She even takes a look at the so-called "immortal jellyfish" (*Turritopsis dohrnii*), which is one of the few known cases of animals capable of reverting completely to a sexually immature, colonial stage after having reached sexual maturity as a solitary individual.

The final part of the book—part III, the last three chapters—deals with more practical issues, which, as such, are far more accessible to the general reader, as well as those who come from the natural sciences. Here Korsgaard offers her insightful vision on controversial issues like eating meat and using animal products that require us to kill animals or make them suffer; the abolishing the treatment of animals as pets; and using of working animals, animals in the military, or the animals in scientific experiments. At this critical juncture, she argues that one needs a good reason to kill or harm an animal, and often we do not have it. She considers that all situations that involve the treatment of animals as a mere means to our ends are morally wrong, concluding that the "fundamental wrong is the system that allows us to view animals as our resources, here for us" (220). Further topics she addresses with clever insight and good judgment are of an ecological nature and have environmental implications, *i.e.*, the value of the species, communities, the habitat loss and the biodiversity crisis. In her own words, "ecosystems, and even the world biosphere, nature itself, have intrinsic value, and [. . .] the value of a species consists in its contribution to those" (192).

This amazing book represents a great opportunity for a specialized and non-specialized audience to dive into animal ethics and the ethical treatment of animals and to ascertain how the philosophical reflection can help us to provide a more robust response to a current, pressing problem in our society. Hopefully, this book may serve to raise awareness worldwide about animal cruelty and presently neglected animal rights, making us one step away from ushering in a new era for our fellow creatures.

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The Past, Present, and Future of Progress

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The conquest of the earth, which mostly means the taking it away from those who have a different complexion or slightly flatter noses than ourselves, is not a pretty thing when you look into it too much. What redeems it is the idea only. An idea at the back of it; not a sentimental pretense but an idea; and an unselfish belief in the idea—something you can set up, and bow down before, and offer sacrifice to [. . . .]" —Joseph Conrad (*Heart of Darkness*)

"The story of human progress is truly heroic. It is glorious. It is uplifting. It is even, I daresay, spiritual."
—Steven Pinker (*Enlightenment Now*)

"[I]f you dream of a society in which truth reigns supreme and myths are ignored, you have little to expect from Homo Sapiens. Better to try your luck with chimps."—Yuval Noah Harari (*21 Lessons for the 21st Century*)

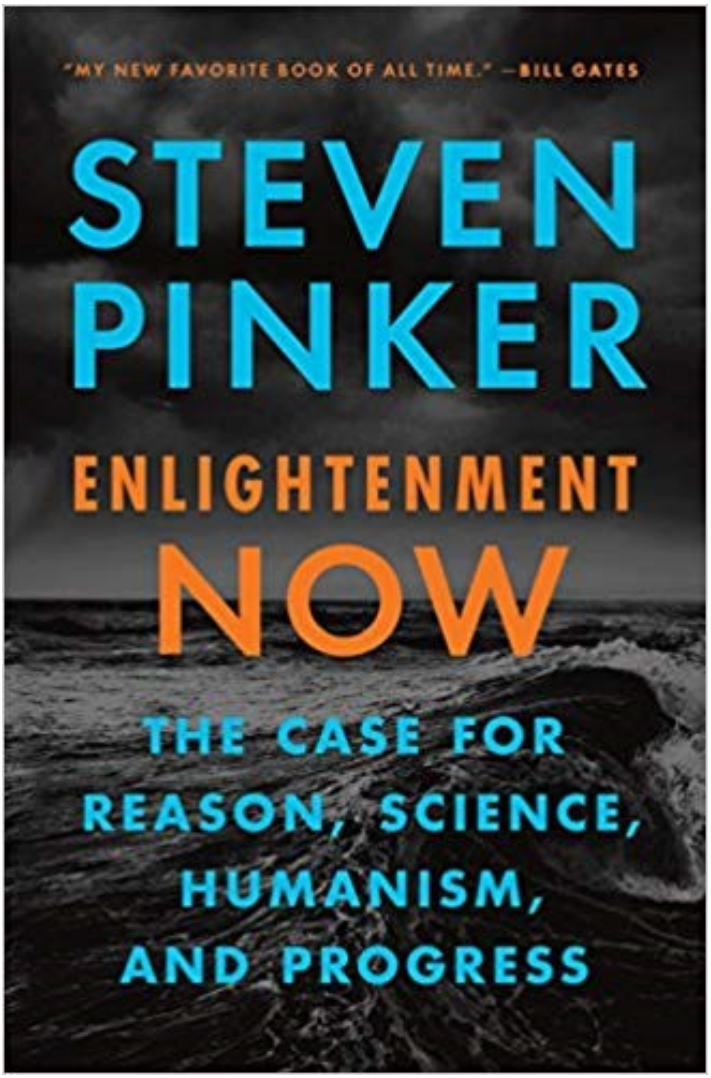
At a time when anger and anomie appear to be the order of the day, and the ideals of the Enlightenment are being bombarded from every direction, Yuval Noah Harari and Steven Pinker have entered the fray once more to remind us that all is not lost and to ensure us that reports of the death of liberalism are greatly exaggerated. Taken together, Pinker and Harari, in their most recent books, offer a calculated and compelling assessment of how far humanity has come as a species and where we should look to go in the future. In *Enlightenment Now: The Case for Reason, Science, Humanism, and Progress,* Pinker contends that now, more than ever, as the dominant narrative has become that of a deepening global crisis and the failure of modernity, classical liberalism needs a forceful and steadfast defense. Using a bewildering amount of data that are neatly broken down into digestible graphs, Pinker is able to argue convincingly that not only has the Enlightenment project worked reasonably well but that when properly appreciated, "the ideals of the Enlightenment are, in fact, stirring, inspiring, noble—a reason to live" (Pinker 6). Harari's *21 Lessons for the 21st Century* picks up at the point where Pinker leaves off. After establishing early in his book that liberalism is (as Pinker also contends), "the most successful and most versatile political model humans have so far developed for dealing with the challenges of the modern world" (Harari xviii), Harari then looks to the immediate future and asks whether the ideals of the Enlightenment will be enough to deal with the oncoming revolutions in information technology and biotechnology. He maintains that in the next few decades humankind will be confronted with the most challenging dilemma we have ever faced. If liberalism wishes to survive in a world where infotech and biotech collide, it will have to adjust and reinvent itself once again.

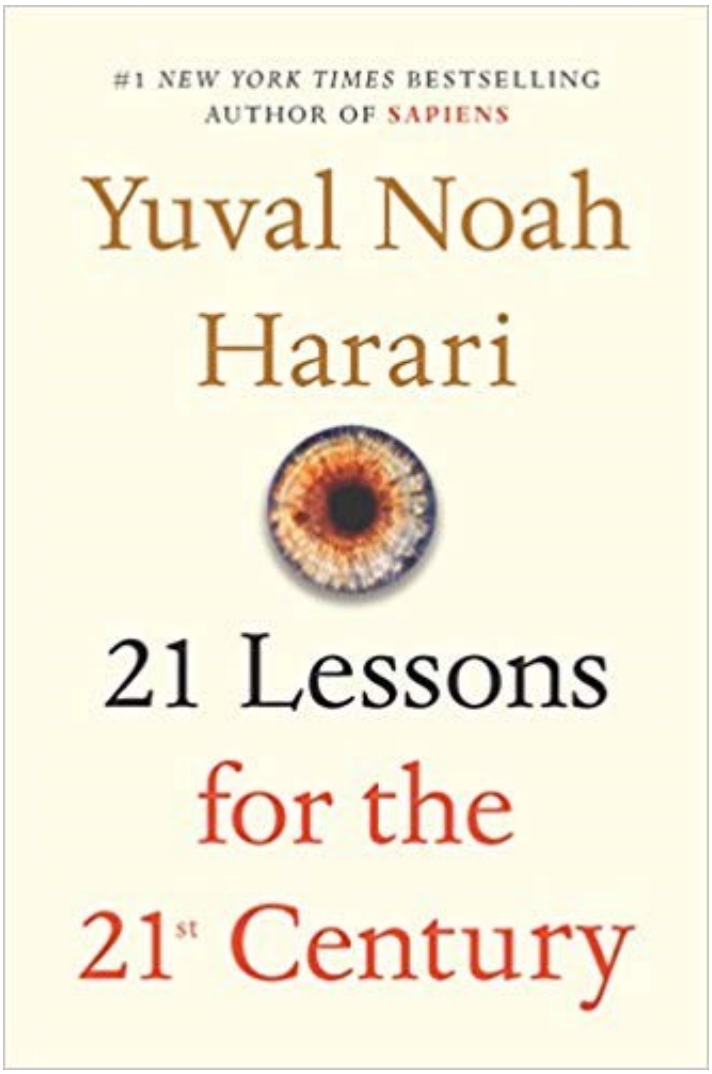
Both men agree that we are living at a time when it is difficult "to find meaning and purpose if traditional religious beliefs about an immortal soul are undermined by our best science" (Pinker 3) and that we are, therefore, "left with the task of creating an updated story of the world" (Harari 16). In a world where many exhibit "an inability to conceive of a higher purpose in anything other than religion," and where "cynicism about the institutions of modernity" (Pinker xv) has become the norm, how will this new story go? Is a new, captivating, and unified narrative even necessary— or desirable? Harari, for one, is unequivocal on the matter: "If this generation lacks a comprehensive view of the cosmos, the future of life will be decided at random" (Harari 266). Although Pinker and Harari do agree on much and more, they also have their points of disagreement. In fact, they are somewhat reminiscent of Pestov and Sergey Ivanovich at one of

Stiva's parties in *Anna Karenina*. "Both [are] men respected for their character and their intelligence" but are in marked disagreement on several subjects, "not because they belong to opposite parties, but precisely because they [are] of the same party," where "each has his own special shade of opinion." However, at this party, the task of "jeering without anger" at their "incorrigible aberrations" will fall to me.

In two early chapters titled "Counter-Enlightenments" and "Progressophobia," Pinker takes aim at the academic pessimism that has infiltrated and spread throughout universities—in particular, the Arts and Humanities departments. Pinker venomously attacks everyone from the Romantics and Rousseau to Fanon and Foucault—with a particular rancor reserved for Nietzsche—and urges us to abandon these thinkers with their emphasis on the shortcomings of modernity in favor of those who extol the virtues and values of the Enlightenment. As Pinker rightly asserts, it is these masters of suspicion, or as he disparagingly calls them, "prophets of doom," who have become the rock stars of the liberal arts curriculum. Where Pinker is on weaker footing is in his tacit assertion that we would all be better off if these men never existed. In one passage (penned with palpable vitriol and bitterness), Pinker defends the Enlightenment project against charges that it is a Western creation that refuses to account for the great diversity of thought throughout the world and, therefore, is unsuited to deal with all the world's problems. While refuting the charges that "the Enlightenment is the guiding ideal of the West," Pinker tellingly responds, "If only!" before going on a two-chapter tirade against any intellectual tradition that does not fall within the purview of the Enlightenment. This line of thinking is shortsighted and problematic for several reasons—many of which Harari directly addresses.

To Pinker's charge that universities have become infested with a pessimistic frame of mind and that there is a dire need to change this outlook to a more optimistic one, Harari offers a simple and straightforward explanation. In the book's introduction, while detailing his reasoning for writing the book in the manner in which he does (focusing on the shortcomings of modernity and the liberal worldview), Harari states that "I do so not because I believe liberal democracy is uniquely problematic but rather because I think it is the most successful and most versatile political model humans have so far developed [. . .]" and that, moreover, "[w]ithout criticizing the liberal model, we cannot repair its faults or move beyond it" (Harari xviii-xix). Put differently, progress does not happen and has never happened by praising how great and perfect the world is but rather by recognizing and criticizing our flaws in order





to improve them. This is an obvious point that Pinker not so much ignores; instead, he seems to view as a useful tool of a bygone era, yet it is no longer applicable to our modern world ruled by the self-correcting procedures of science and reason. In a quite frankly shocking display of presentism, Pinker praises the "muckraking journalists and novelists like Upton Sinclair" (Pinker 186) for propelling progress during the early 20th century while simultaneously bemoaning the fact that in recent years works on topics such as genocide, terrorism, cancer, and racism have received major literary prizes as works on progress have been given short-shrift. In a book about progress, this blatant disregard for how progress continues to work is troublesome.

Moreover, throughout the book, Pinker showcases a surprising display of bad intellectual history that I can only assume is used intentionally to bolster his argument. For instance, in a percipient paragraph discussing "scientific racism," which reached peak popularity in the late nineteenth and early twentieth centuries, Pinker correctly concludes that "[y]et to pin ideological racism on science [. . .] is bad intellectual history" (Pinker 397). Although his statement is 100% correct, the problem arises when Pinker then turns around and participates in this same bad intellectual history by blaming all of modernity's ills on the counter-enlightenment thinkers and progressophobes. To display such a concise and cogent understanding in the one case only to turn around and commit the same errors is a baffling showcase of willful ignorance and intellectual dishonesty.

As perplexing as Pinker's reasoning is in the matter, it may have its roots in something Harari directly confronts in a particularly insightful chapter titled "Post-Truth: Some Fake News Lasts Forever." After succinctly explaining that humans have always lived in an age of post-truth because *Homo sapiens* is a post-truth species, Harari moves on to a discussion on truth vs. power. As he masterfully details, truth and power have always been mostly incompatible and can travel only so far together before they are forced to go their separate ways. This is not a new discovery but rather a dilemma that scholars are aware of and have been wrestling with for hundreds of years. If you want a powerful story, you have to invent fictions; on the flip-side of that, if you want a truthful story at some point, you will have to renounce power. When sitting down to write, scholars have to ask themselves, "Do they serve truth or power? Should they aim to unite people by making sure everyone believes in the same story, or should they let people know the truth even at the price of disunity?" (Harari 247) Some of the most successful scholars and all of the most powerful narratives throughout history have valued unity over truth— in part because they understand that humans as a species prefer power to truth. When writing his book, Pinker was faced with this same dilemma, and at times (though indeed not always), he chooses to sacrifice truth on the altar of power.

Before this runs the risk of reading as a full-on diatribe against Pinker, it must be stated that *Enlightenment Now* is a thoroughly engaging and invaluable read that gets much more right than it does wrong. One of the stronger points of the book comes when Pinker details how the Optimism Gap combines with the Availability Heuristic to form a bias toward negativity, which is further reinforced by the daily news cycles to form a distorted view of reality that convinces us that the world is all going to pot. Other strong chapters include his chapters titled "Terrorism" and "Science." In the former chapter, Pinker reminds us (through data, as is his forte) that the very nature and design of terrorism is to create an outsized panic by combining major dread with minor harm. While in the latter chapter, Pinker's coverage of C. P. Snow and Snow's advocation of a "Third Culture" going forward is particularly refreshing. In his chapter, "Democracy," Pinker shines when discussing what he aptly refers to as our civics-class idealization of democracy and makes the compelling case that throughout history, people have always voted with their hearts and not their minds. However, what Pinker does best in his book (sometimes subtly, other times heavy-handedly) is to remind us that it is the very "nature of progress that it erases its tracks, and its champions fixate on the remaining injustices and forget how far we have come" (Pinker 215). It is this last profound point of Pinker's, which he underscores throughout, that brings me to my final critique.

Throughout his book, Pinker is able to make a compelling case for progress in large part because he takes a long-durée view of history. Pinker is correct that if we take a broad view of history as opposed to a narrow one, what we begin to see is a more progressive and optimistic trajectory of history. However, it is equally important to keep in mind that we should never replace wholesale one view for the other. It can be extremely dangerous and misleading to emphasize long-term progress at the cost of short-term atrocities. Doing so can make indefensible inhumanities seem like right actions justified through the name of progress. Although it can be easy to agree with Pinker that we live at a time when progress needs a determined defense, it is vital that this defense must not turn into a fetishization of progress.

So, now that we have been dually introduced to both the self-eradicating nature of progress and the dangers in fetishizing progress—what does the future of progress look like? As Harari points out, we find ourselves living in an age of bewilderment where simultaneously the credibility of liberalism is being questioned, and the twin revolutions in information technology and biotechnology are confronting us head-on and threatening to reshape the world as we know it. In such a time of uncertainty, one cannot be faulted for calling into question the progressive projection of history and wondering what the future will hold. Questions such as "Who are we? What should we do in life? What kinds of skills do we need? Given everything we know and don't know about science, about God, about politics, and

about religion, what can we say about the meaning of life today?" (Harari xviii) require fresh answers in an era of looming ecological crisis and the growing threat of weapons of mass destruction. Add to the mix the fact that the revolutions in infotech and biotech are "giving humanity the power to reshape and reengineer life" (Harari xviii), and these questions become even more pressing. As Harari concludes, nothing is more crucial in an age of bewilderment than self-observation and self-knowledge. In the penultimate chapter of *21 Lessons* titled "Meaning: Life Is Not a Story," Harari underscores the vital importance of understanding ourselves. As he states, "in order to understand ourselves, a crucial step is to acknowledge that the 'self' is a fictional story that the intricate mechanisms of our mind constantly manufacture, update, and rewrite" (Harari 305). This story that we tell ourselves, about ourselves, often bears little resemblance to reality, and the vast majority of our experiences never enter into the narrative of the inner self that we choose to create. As misleading and false as the stories of ourselves are, they nevertheless provide us with explanations to the questions of who we are; where we come from; and where we should look to go. However, as Harari eloquently explains: if you really want to understand yourself, "The first thing you need to know about yourself is that you are not a story" (Harari 306), and that we should cease to identify with these sanitized and fictitious inner narratives with which we choose to delude ourselves. In the immediate future, self-observation and self-knowledge will be paramount, for "Unless you are happy to entrust the future of life to the mercy of quarterly revenue reports, you need a clear idea of what life is all about" (Harari xviii).

Although Pinker offers an optimistic take on our past and present and Harari takes a more tempered and pessimistic approach to our immediate future, taken together, *Enlightenment Now* and *21 Lessons for the 21st Century* offer a sobering, calculated, and thoroughly researched assessment of the state of the world and should be given a serious look by anyone concerned with the contemporary story of who we are, where we come from, and where we should look to head in the immediate future.

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Big History and the New Story

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Father Thomas Berry was born in North Carolina in 1914, the third of thirteen children. He joined the Passionist Order in 1933, after his first year of college, and he earned a PhD from Catholic University in 1948, focusing on Giambattista Vico. Berry studied in China in 1948-1949. He developed a lifelong interest in Asian religions, later writing *Buddhism* (1967) and *Religions of India: Hinduism, Yoga, Buddhism* (1971).[1] In the United States, Berry taught at a variety of Roman Catholic universities. At Fordham (1966-1981), he helped to create a distinctive religious studies program, teaching courses in world religion and cosmic Christianity.

In 1970, Berry founded the Riverdale Center of Religious Research on the Hudson River just north of Manhattan.[2] The center promoted human spiritual transformation and reflection on the mysteries of reality. Berry directed the center from 1970 to 1995. From 1975 to 1987, he was president of the American Teilhard Association and editor of *Teilhard Studies*.[3] Berry retired to Greensboro, North Carolina in 1995, living in an apartment above a former stable owned by his brother Joe and sister-in-law Jean. He suffered several strokes and moved to a care facility in 2008, dying in 2009.

More than a scholar and a priest, Berry was a "shaman."[4] As a priest and a scholar, he was trained in theology and in history, culture, ideas, and religion. He described himself variously, using terms like "cosmologist," "geologian," and "Earth scholar." In the context of Big History, he might best be described as an "ecotheologian" in the spirit of Teilhard de Chardin. Berry promoted ecumenical and interfaith dialogue over his long life and career, notably with a deep interest in indigenous spirituality. More famously still, he promoted the "New Story," a spiritually inflected creation account, epic of evolution, or Big History.

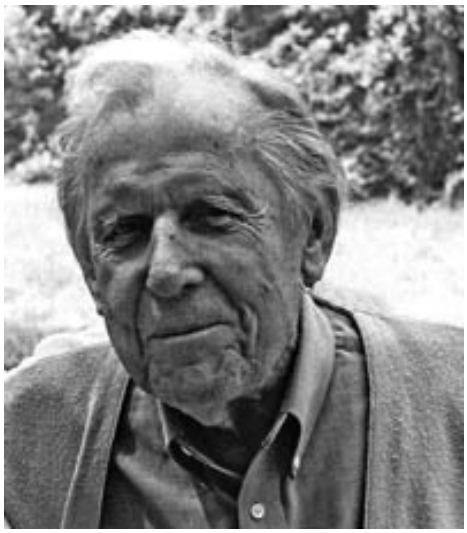
"The story of the universe is the story of the emergence of a galactic system in which each new level of expression emerges through the urgency of self-transcendence," Berry argued in "The New Story" in 1978. His "gospel" message was that the "human emerges not only as an earthling, but also as a worlding. We bear the universe in our beings as the universe bears us in its being. The two have a total presence to each other and to that deeper mystery out of which both the universe and ourselves have emerged."[5]

Berry retold this "New Story" in many forms, notably in *Dream of the Earth* (1988), *The Great Work: Our Way into the Future* (1999), and with cosmologist Brian Thomas Swimme in *The Universe Story* (1992). Swimme and Mary Evelyn Tucker, in turn, retold it in a book and documentary film entitled *Journey of the Universe* (2011).[6] Berry's goal was for people not just to learn about indigenous cultures, religious traditions, and modern science, but to learn from them how to live.

This same goal animates Tucker, Grim, and Angyal's biography of Berry. Readers will learn much about Berry, but the biography also is written to encourage readers to learn from Berry's life and work. It is not a hagiography. Neither is it a work of neutral or critical scholarship. Rather, it is an engaging appreciation of Berry by scholars who were his students and colleagues. This point should not be read as negative. It is to honor the spirit of the book—that readers not just learn about Berry but learn from him about how to understand and live well in the modern world.

Berry defined his calling as closer to that of a shaman than a scholar or a priest—"one who entered deeply into the powers of the universe and Earth and brought back an integrative vision for the community," in Tucker, Grim, and Angyal's words. "It was the shamanic dimension of my own psychic structure that required that I go into some manner of inner experience with the natural world," Berry explained near the end of his life. "This was not simply to enter into some form of the spiritual life but to take on a social role."[7] That role came in promoting the New Story and the activism it called forth.

Tucker, Grim, and Angyal tell Berry's life as an arc from an old story to the New Story. "From his beginnings as a cultural and intellectual historian"—and his upbringing as a traditional Roman Catholic—"Berry became a historian of the Earth." He "witnessed in his own lifetime the emergence of a multicultural planetary



Thomas Berry. Source: Wikipedia

civilization as cultures came in contact around the globe," and he wanted to put this story in "the larger arc of Earth history and the evolution of the universe." Berry "recognized the power of an evolutionary story to engage humans in the great questions: where have we come from, how do we belong, why are we here?" Humanity needed the New Story to meet the needs of a globalizing humanity transforming not just themselves but the planet too. Berry believed that such a transformation was "not only possible but already emerging." Tucker, Grim, and Angyal argue that the possibility of transformation is "the promise of Berry's perspective." The New Story "adds fresh energy to what Berry called the 'Great Work,' namely, what each person and community can contribute to a flourishing future."[8]

Thomas Berry is not structured as a straightforward biography or a life-and-times story. The first two-thirds of the book cover Berry's formative experiences, the development of his thought, and the major components of his career as a teacher, guru, and activist. The last third of the book, in greater depth, explores both their sources and their evolution. It includes chapters on "narratives of time," Teilhard de Chardin, Confucian thought, and indigenous traditions.

Nasser Zakariya's assessment of "epics of evolution" helps to assess where Berry's "New Story" fits with Big History.[9] Zakariya explores the tensions, even contradictions, in how epics of evolution try to weave together scientific fact and explanation with a mythic arc. Like other epics of evolution, Big History blends elements of modern science with philosophical and religious assumptions that are rooted in premodern religious and cultural traditions. Sometimes the blending is implicit and intellectual.[10] Sometimes it is overtly spiritual or religious in character. In this fashion, Berry's New Story uses modern science but is defined by its spirituality, drawing on Judaism and Christianity, other world religions, and indigenous traditions. The New Story was not materialist, but appealed to primordial experience, mystery, and mysticism. It reflected Berry's eco-theological interests and his inter-faith sensibility.

Like many Americans, Berry viewed Native Americans as the world's "first ecologists."[11] One of his influences was Nicholas Black Elk, a Lakota healer-shaman and Roman Catholic catechist. Black Elk lived closely to the land, especially as a boy before the American conquest of the Lakota in the 1870s. He never gave up his Lakota culture and rituals, but he converted to Roman Catholicism and baptized more than four hundred Native Americans. The Church has begun the process of canonizing Black Elk.[12] Black Elk's life journey was very different than Berry's, of course, but they shared an inclination to treat traditions not as mutually exclusive but cross-pollinating.

What Big Historians will make of Berry's New Story depends on whether they are put off by or value engaging with mysticism and religious traditions. Berry described himself among other things as a "cosmologist." The term can refer to both scientific and philosophical or theological accounts, or a mix of all three. Mythopoetic accounts probably belong in a different, if overlapping, category (e.g., the account in Genesis 1-3 is a quite different genre from a systematically developed cosmology written by a twentieth century theologian). But mythopoetic elements often are woven into epics of evolution, especially popular ones. Even if it is not always clear whether such weavings are intellectually coherent, they are appealing to people because they offer scientific reference points, cultural rituals, and spiritual and emotional experiences.

Berry's New Story has been influential among some advocates of Big History and his ideas have been featured at conferences—notably when the documentary film *Journey of the Universe* was screened at the Big History conference at Dominican University in California in 2014. The conference at Villanova in 2018 included New Story-style "liturgy" in its opening and closing sessions—all to some controversy. A conflict between "spiritual agendas" and "science" has been part of discussions at Big History conferences in 2014, 2016, and 2018 and in the pages of *Origins* and the *Journal of Big History*. [13]

Perhaps the greatest value of *Thomas Berry: A Biography*, then, is that it can help the International Big History Association to work through how to engage both Big History scholarship and New Story-style impulses in the Big History movement; for Big History is more than an academic discipline. From the start it has aspired to, in Berry's words, "the 'Great Work,' namely, what each person and community can contribute to a flourishing future." The conclusion of David Christian's TED talk (2011) and its popularity, attest to the appeal of this "great work."

My own view is that Big History's value is precisely that it is not just meant to teach people about history, but to provide them intellectual tools to live better as individuals and citizens. It exemplifies the holism of a liberal arts approach to learning. Academia does not need yet another new trans-disciplinary movement aspiring to be a new discipline; it needs public scholars who bring together science, politics, historiography, philosophy, and, yes, religion in compelling ways. If so, then it is appropriate to explore the cosmological and eco-spiritual impulses of figures like Berry, both as something to study and critique and as something from which to learn.

This biography, the writings of Berry, Swimme, and Tucker, and similar

writings are a way to explore what intellectually engaged writing looks like that crosses the borders among scholarship, advocacy, spirituality, and popular writing.[14] Whether one agrees with Berry's ideas, or with Tucker, Grim, and Angyal's belief that we have much to learn from Berry, there is intellectual, moral, spiritual, and political profit in engaging a book like this.

Notes

1. Thomas Berry, *Buddhism* (New York: Hawthorne Books, 1966); *Religions of India: Hinduism, Yoga, Buddhism* (New York: Bruce-Macmillan, 1971).
2. http://thomasberry.org/life-and-thought/about-thomas-berry/the-riverdale-center-for-religious-research
3. http://teilharddechardin.org/index.php/teilhard-studies
4. This is the term that Tucker, Grim, and Angyal use; see Mary Evelyn Tucker, John Grim, and Andrew Angyal, *Thomas Berry: A Biography* (New York: Columbia University Press, 2019), 38.
5. Thomas Berry, "The New Story: Comments on the Origin, Identification, and Transmission of Values," *Teilhard Studies* 1 (1978). It was also published in *CrossCurrents* 37:23 (Summer/Fall 1987): 187-199.
6. Thomas Berry, *The Dream of the Earth* (San Francisco: Sierra Club, 1988); Brian Thomas Swimme and Thomas Berry, *The Universe Story: From the Primordial Flaring Forth to the Ecozoic Era—A Celebration of the Unfolding of the Cosmos* (San Francisco: HarperSanFrancisco, 1992); Brian Thomas Swimme and Mary Evelyn Tucker told Berry's New Story in a book and documentary film, *Journey of the Universe* (New Haven: Yale University, 2011).
7. Tucker, Grim, and Angyal, *Thomas Berry*, 38.
8. Tucker, Grim, and Angyal, *Thomas Berry*, xviii.
9. Nasser Zakariya, *The Final Story: Science, Myth, and Beginnings* (University of Chicago Press, 2017). Note Ken Baskin's thoughtful review of the book in "A Cosmological Crisis?: A Review of Nasser Zakariya, *The Final Story: Science, Myth, and Beginnings*," *Journal of Big History*, III:4 (2019): 171-176.
10. For more on this issue, see my essay, Katerberg, "Myth, Meaning and Scientific Method in Big History," *Origins* V:12 (December 2015): 3-12 (https://bighistory.org/Origins/Origins_V_12.pdf). See also Allan Megill, "'Big History' Old and New: Presuppositions, Limits, Alternatives," *Journal of the Philosophy of History* 9:2 (2015): 306-326.
11. Tucker, Grim, and Angyal, *Thomas Berry*, 241. Shepard Krech III has criticized what he calls the mythology of the "ecological Indian," arguing that historic indigenous practices, before and after Europeans arrived in the Americas, included dramatic alterations to the land in their agriculture and hunting, including damage to environments. He also describes how Native Americans in the 1960s-1980s came to weave their traditions together with modern ecological ideas and goals; see *The Ecological Indian: Myth and History* (New York: Norton, 1999).
12. Kirk Petersen, "Vatican considers sainthood for Black Elk," *National Catholic Reporter*, August 25, 2018, https://www.ncronline.org/news/people/vatican-considers-sainthood-lakota-sioux-medicine-man (accessed 22 September 2019). Black Elk's canonization is controversial as is the authenticity of his conversion. The weight of evidence in Black Elk's case and in relationships between Christian and Native spirituality and revitalization movements suggests significant cross-fertilization. For conflicting views of Black Elk, see Joe Jackson, *Black Elk: The Life of an American Visionary* (New York: Farrar, Straus and Giroux, 2016); and Michael Steltenkamp, *Black Elk: Holy Man of the Oglala* (Norman: University of Oklahoma Press, 1997). For an excellent study of cross-cultural and cross-religious influences, see Louis Warren, *God's Red Son: The Ghost Dance Religion and the Making of Modern America* (New York: Basic Books, 2017).
13. See my account in Katerberg, "Is Big History a Movement Culture?" *Journal of Big History* 2:1 (2018): 63-72 (https://jbh.journals.villanova.edu/article/view/2255/2121).
14. For other examples from Christian traditions, see John Haught, *New Cosmic Story: Inside Our Awakening Universe* (New Haven: Yale, 2017); and David P. Warners and Matthew Kuperus Heun, eds., *Beyond Stewardship: New Approaches to Creation Care* (Grand Rapids, MI: Calvin Press, 2019). Note also the illustrated companion to *Beyond Stewardship* at https://spark.adobe.com/page/4ddndTy8JoFcT/ (accessed 28 September 2019). Haught is a Catholic's exploration of the boundaries between science and theology; *Beyond Stewardship* is a Protestant effort to develop a "New Story." For more examples of "green Christianity, see Christopher Hrynkow, "Greening God? Christian Ecotheology, Environmental Justice, and Socio-Ecological Flourishing," *Environmental Justice,* 10:3, June 2017 (https://www.liebertpub.com/doi/full/10.1089/env.2017.0009). See the "Faith and Environment" page on the *Earth Day* Network site (https://www.earthday.org/campaigns/campaign-for-communities/communities-of-faith/; accessed 28 September 2019) for examples of and "earth keeping" and "new stories" from a wider array of religious traditions.

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In the Midst of the California Wildfires

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26 October 2019, Bodega Bay, California, USA

You are doubtless reading these words as published some weeks or perhaps even months after the destructive wildfires that struck California in October of 2019, but in the moment at which I am setting these words to page, my wife Diana and I remain, unwilling to leave despite a mandatory evacuation order, in our coastal home. Just one week ago, I'd completed reading (for the second time) the 2019 non-fiction book by Dr. Lucy Jones: *The Big Ones: How Natural Disasters Have Shaped Us (and What We Can Do About Them).* When I'd reached the final page last week, I had no idea that we would soon be experiencing the very subject matter of the book I'd just finished reading.

But such obliviousness as mine is very much a theme of Jones's book. *The Big Ones* goes well beyond the physics of natural disasters. Though a leading seismologist herself, Jones explains only enough of the natural phenomena to allow the reader to comprehend the sheer unopposable power of earthquakes, volcanoes, floods, and the like. These forces of nature are truly beyond human control, but well within human control is how we plan for disaster and how we respond to it once it has struck. This resonates deep within me today because, although it is true that wildfires have ignited naturally for millions of years, the wildfire sweeping toward my home at this moment was likely ignited by faulty electrical transmission equipment. Modern human beings have hundreds of unnatural ways of sparking what was once a purely natural occurrence. In *The Big Ones,* Jones weaves an interconnected narrative of human psychology, culture, politics, economics, and technology. Her storytelling is compelling in itself, while her rich mix of disciplines should be a pleasure to readers who appreciate a Big History approach to understanding our world.
Though the chapters are each multifaceted, the book as a whole is organized by simple chronology, starting with the volcanic destruction of Pompeii in 79 AD, and proceeding with each chapter devoted to a particular event, leading up to recent 21st-century disasters. The chronological organization serves an important purpose in developing the key ideas Jones wishes to impart. We may not see much change in the physical phenomena of planet Earth, but we see a huge evolution in the cultural and technological responses to disaster over the last two thousand years. In sharp contrast, we also see human nature remaining relatively unchanged, exhibiting over and over behaviors such as scapegoating, wishful thinking, and the leveraging of natural events to achieve political ends.

Jones opens with a theme that is familiar to Big Historians but much underappreciated by many people in a modern world that insulates us from our natural surroundings:

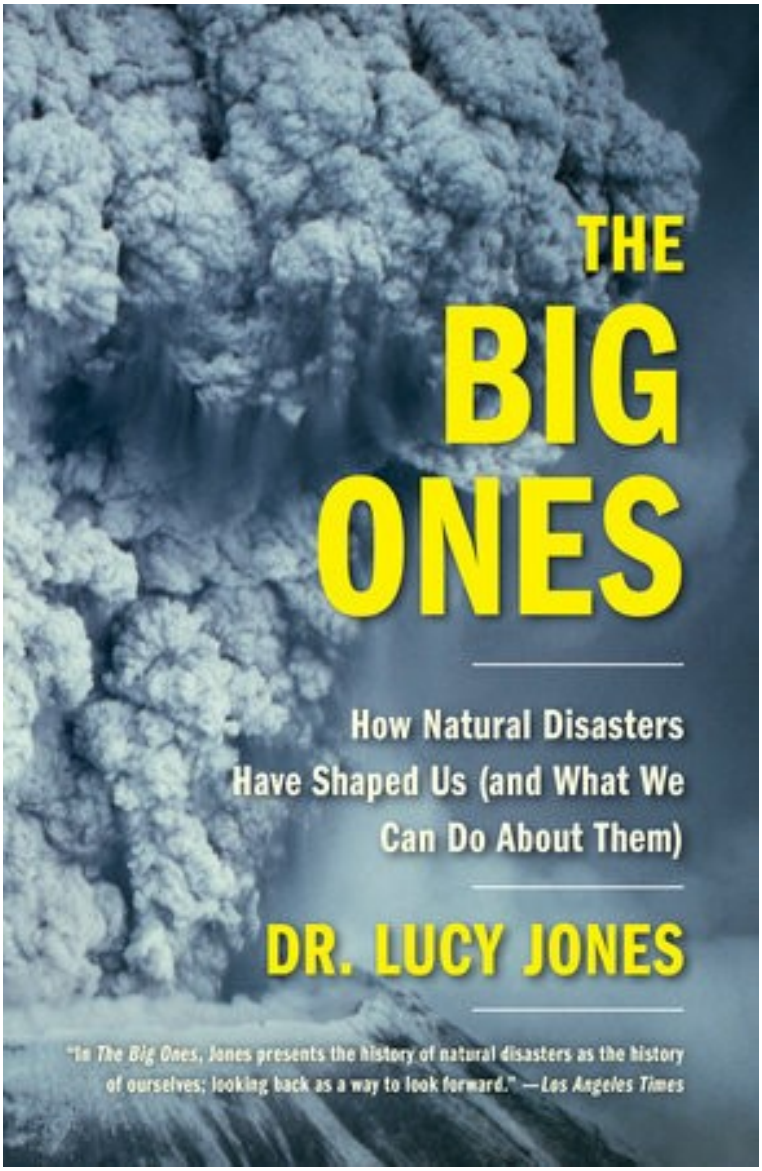
> We plant farms near rivers and near the springs that form along faults, for their access to water; on the slopes created by volcanoes, for their fertile soil; on the coast, for fishing and trade. These locations put us at risk of disruptive natural forces. (8)

My wife and I were certainly aware of those facts eighteen years ago when we purchased our Bodega Bay home, a property that sits almost directly atop the San Andreas Fault. Indeed, Bodega Bay exists precisely because of tectonic plate movements. But Diana and I were both born and reared just north of San Francisco, a region where the 1906 earthquake and the specter of a future Big One loom large in the popular imagination from an early age. Like most Californians, we have

developed a variety of coping mechanisms and emotional adaptations to this knowledge. (For example, I am coping right now by concentrating on writing this book review because I have no control over the conflagration blazing just forty miles away.)

How humans respond to the pure randomness of natural disasters is another important theme of *The Big Ones*. Such randomness "means that every moment presents a risk, leaving us anxious" (10), to which I would add that humans simply cannot go about their everyday lives in a permanent state of anxiety. Jones draws on what psychologists describe as "normalization bias," the tendency by which "what we experience now or in recent memory becomes our definition of what is possible" (10). For Diana and me, recent memory includes nearby wildfires of the previous two years that inundated our region with noxious smoke and a horror movie orange sky for weeks. But we never saw the flames near our home; our electricity stayed on; life continued despite the discomforts. Our "new normal" became frequent nearby wildfires but not something we had experienced directly. As Jones explains further, "We think the common smaller events are all we have to face, and that, because the biggest one isn't in anyone's memory, it isn't real" (10).

But the "new normal" began changing for us just a few days ago (as I write this), in the early morning of October 24th. We'd gone to bed the night before with very routine expectations for the next few days. Our first hint of something strange came, not from the Weather Channel, nor from the local electric company, nor from any of the various governmental entities charged with ensuring public safety. No, our first hint came from our cat, Miracle. Around four in the morning, Miracle began poking us with her paws and pacing back and forth across our bed, not unusual behavior for her when she wants food or attention. But two hours later, the young cat's fussing and fretting still continued. I began dreading my drive to work after losing so much sleep due to Miracle's prolonged nervous behavior. Several hours later, fortified by much coffee, I was on the road to my job at Dominican University while listening to the local news on the radio. Wildfire was the lead story, indeed almost the only story being covered that morning. A blaze had begun around nine-thirty the previous night about fifty miles from our house. Now Miracle's fidgeting made sense. She must have smelled the first traces of distant smoke while Diana and I slept peacefully unaware.



However, before you imagine that I am about to wax eloquent about the wonders of feline threat-perception, I must point out the contrasting case of Miracle's litter-mate and brother, Merlin. Far from living up to the prophetic fame of his namesake, Merlin continued to lounge about the house as always, a laid-back little lion-king, blissfully oblivious to any possible danger. Although it's reasonable to speculate that Miracle might have smelled smoke, the fact is that animals of any kind are not good predictors of impending disaster, despite the popular belief that they are. This is one of the many popular myths regarding natural disasters that *The Big Ones* debunks. Jones emphatically makes the point that the animal-predictor hypothesis, which was taken seriously by scientists for decades, has been methodically and exhaustively investigated and has yielded no supporting evidence whatsoever.

Another popular myth that Jones addresses repeatedly, and in convincing evidence-based detail, is the claim that scientists already know how to predict various disasters, but are hiding what they know from the public. Quite to the contrary, scientists have been actively and energetically attempting to predict disasters for over one hundred years without coming up with a reliable method. In particular, the United States, China, Japan, and Italy have invested huge amounts of time, effort, and money attempting to solve this problem. But if no one

can predict disasters, why does the myth persist that prediction is already possible? Jones offers several explanations.

The first is basic wishful thinking. Disasters are scary, but we could be less afraid if we could be warned in advance. When scientists refuse to give such warnings, conspiracy theories are born. Many people choose to believe, for example, that the government has a top-secret method for forecasting earthquakes, rather than accept the fact that an earthquake can strike at any second with no warning whatsoever. Jones personally receives requests on a weekly basis asking her to divulge this secret knowledge. In one poignant example, a woman wrote that she knew that Jones was not allowed to share her secret information, but perhaps Jones could announce when her own children were taking a trip out of town.

A second difficulty is the counter-intuitive quality of statistical information. Scientists do have the historical records to make reasonable probability statements. For example, I recently learned (because I was renewing insurance) that my own home has a 3% chance of flooding within the next one hundred years. But that's not the kind of answer frightened people want. They want to know exactly when the next Big One will hit them, and that information simply does not exist.

A third factor fueling the myth of disaster prediction is that some short-term events are predictable, creating the illusion that longer-term prediction must also be possible. But current short-term prediction is limited to obvious observations with simple cause-and-effect relationships. Weather satellites can observe tropical storms forming near the equator; and experts can make sound predictions of the speed, strength, and path of the nascent hurricane; but the observable process is already well underway by the time such predictions are made. Likewise, the causal relationship between earthquakes and tsunamis is well understood. The tsunamis that devastated the coastlines of the Indian Ocean in 2004 and Japan in 2011 (which each receive a detailed chapter in *The Big Ones*) were entirely predictable results of magnitude 9.1 and 9.0 earthquakes—but those enormous quakes were themselves thoroughly random, absolutely unpredictable events.

Because of the seismic technology and global communication networks in place in 2004, Jones was notified by e-mail about the Indian Ocean quake only fifteen minutes after it occurred, and could easily foresee the devastating tsunami that would soon follow. Unfortunately, the technological infrastructure was not available to warn the coastal populations along the Indian Ocean that a deadly wave was heading for their shores. This was all the more tragic because all the necessary seismic detectors and communication devices already existed, but it takes the cooperation and vision of scientists, engineers, bureaucrats, and governments to create such a rapid-response international warning system. The ease of modern air travel meant that thousands of foreign tourists and business travelers were in the stricken regions, with the result that citizens of fifty-seven countries perished, making this a disaster mourned by a truly global community. Within two weeks, aggressive steps began to update the antiquated warning systems.

When the magnitude 9.0 quake struck offshore at Fukushima, Japan, on March 11, 2011, coastal residents of western North America were rapidly alerted that a tsunami was headed their way. Video via television and Internet showing the devastation taking place in Japan aroused both sympathy and fear. In the days following the Fukushima earthquake, Diana and I closely followed the news reports of the resulting tsunami traversing the Pacific Ocean and heading for the California coast and quite literally aiming at our front door.

One morning just after daybreak, we received a reverse-911 phone call, the recorded voice predicting arrival of the tsunami in five hours and urging residents to seek high ground. I needed to leave for work, so Diana took charge of loading our dog (on leash) and our cat (in a pet carrier) into our SUV. We'd bought this rugged vehicle specifically for emergency conditions, especially the annual flooding to which the roads near our home are vulnerable. While I tried to concentrate on my duties at work, Diana drove the SUV to the parking lot of the general store (yes, those still exist) located on a hillside from which she could see our house. Not surprisingly, all of our closest neighbors had picked the same spot to await the arrival of the big wave. There was no doubt it was coming. The suspense lay in the fact that the experts could not predict its size upon reaching landfall.

As Diana described it to me that evening, it turned out not to look like a wave at all. Instead, it looked like a fast-motion film of the daily tide: the water in the harbor dropped rapidly, right down to the muddy bottom, then refilled just as rapidly, stopping just short of the level required to overflow the banks protecting our home and the homes of our neighbors. It held that height for a few seconds—and all watching held their breath—then the sea water dropped about a foot, stabilizing at the normal level for that time of day. Everyone broke into applause, whistles, cheers, and some car-horn-honking. Later, in a more reflective moment, Diana and I, well aware that the roles could easily be reversed with the next big California quake, weighed our own good fortune against the catastrophe still unfolding in Japan. There is simply no way to know when such a disaster will strike.

27 October 2019, Bodega Bay, California, USA

Official warnings began arriving on Thursday, October 24th, by e-mail, text, and automated phone messages; each new message becoming increasingly dire, arriving with increasing frequency. The wildfire was largely uncontained. Record-breaking high winds were expected to whip the flames across hundreds or thousands of acres yet untouched. One town after another received mandatory evacuation orders, the speed of the conflagration being described on the

local news as "three football fields per minute." It was all headed right for us. Even though the skies remained temporarily blue and clear in our little village of Bodega Bay, every new text or automated phone call raised our anxiety another notch. My wife and I began to jump at every sound, and with two cell phones plus a land line at home, we had an ongoing chorus of ring tones going off, each new automated text or voice message delivering increasingly ominous news.

By Saturday, October 26th (yesterday as I write this), fewer than three full days after the blaze began, Diana and I received the phone call we'd been dreading: electricity being turned off by the utility company as a safety precaution and mandatory evacuation ordered for our little coastal town. Our SUV was already packed with the essentials, including Diana's wheelchair. You see, Diana has been coping for years with a steadily debilitating arthritic condition, a glacial affliction that makes moving about incrementally harder for her each year. She still walks short distances, using a pair of fore-arm crutches, but it was critical to have the wheelchair packed and ready for the other end of our journey, wherever that might be. Evacuation was going to be especially rough on her.

We weighed the mandatory evacuation order against our up-close knowledge of our own particular circumstances. The fire was nowhere near us yet. Were we being flogged into fleeing by overzealous safety officials? Was the Pacific Gas & Electric Company cutting our electricity prematurely? Part of me was deeply suspicious of the motives of both our government and the private corporation that delivers our power. But then I thought of the scapegoating psychology that Jones documents in her book. Was I falling into the trap of blaming faceless "big government" and "big business" just to avoid the reality of what was happening?

If we ignored the order and chose to remain in place, what were our risks? On the one hand, we are about as far west of the blaze as a person can get without falling into the Pacific Ocean. On the other hand, this is a rural area with limited roads and only one practical escape route. What if we guessed wrong, and found ourselves trapped by an inferno? My strong gut feeling was that the whole combination of electricity cutoffs and evacuation orders was bogus, a sham display of private and public officials covering their own derrieres. As I tried rationally to calculate our odds, another portion of Jones's book kept coming to mind, her discussion of the evolutionary psychology that drives life-or-death decisions:

> Evolutionary pressure rewarded brains that saw patterns, even in randomness. When we heard a rustle in the grass, we could imagine it was a random breeze and ignore it, or we could hypothesize that it hid a waiting predator and try to escape it. For the many times it was a breeze, the wrong answer made us unnecessarily anxious, but it did not interfere with our survival. For the rare times that it was a predator, the anxious survived, and those who believed it to be random made a fatal error. (22)

If we gambled by remaining in our home, would we be making such a "fatal error"? Some of our neighbors came by to check on us and commiserate; they, too, were contending with the same questions.

In the end, we decided to remain in our home, but vigilant. We still had cell phone service, so we could easily see updates on the spread of the fire. By the next morning it was plain to see that hundreds of people in Bodega Bay had made the same choice. Traffic bustled back and forth on local streets. The sound of gasoline-powered generators was humming from nearby households everywhere. If we had guessed wrong, at least we had plenty of company.

30 October 2019, Bodega Bay, California, USA

As I complete this writing, several more days have passed, and we remain in our home, with Diana exhausted and asleep in her armchair while the two cats, Miracle (the early warning system) and Merlin (the nonchalant aristocrat), take turns sleeping in her lap. Fortunately, the fire itself is still quite distant from us, and we have been advised to continue to "shelter-in-place" for the time being. The skies in Bodega Bay are thick with wildfire smoke. The sun is crisply outlined as a bright orange disc. The electricity remains off. We are cold and uncomfortable, but we are also counting our blessings. So many other people have already lost their homes or been forced to flee with no place to go. This is bad, but it is hardly "the big one" for us.

Speaking as a scientist, Jones explains the rigor expected in defining a relativistic word like "big" in objective, measurable terms, especially when communicating with other scientists. Much of her work is consumed by translating how scientists speak in terms that are useful to urban planners, public safety officials, and the general public. Much of the value of reading *The Big Ones* is that it deepens the reader's understanding of this complicated interplay of objective research and practical decision-making. How big is "big"? How big does a disaster have to be to count as "the big one"? What is the biggest "big one" for which we should prepare?

In my personal experience, there is a psychological, emotional, intuitive use of the phrase "the big one" that demands no such rigorous definition and thrives in common usage because it feels right. Californians talk about "the big one" with a quasi-legendary quality, as though it were the name of a monster hinted at in a prophetic vision, always moving toward us but never quite arriving. No matter what happens—earthquake, storm, wildfire—the damage and destruction you live through may be horrendous, but it is never quite "the big one," because we know in our hearts that something even worse is always possible. The Big One is always coming.

Reference

Jones, Lucy. 2019. *The Big Ones: How Natural Disasters Have Shaped Us (and What We Can Do About Them).* New York: Anchor.