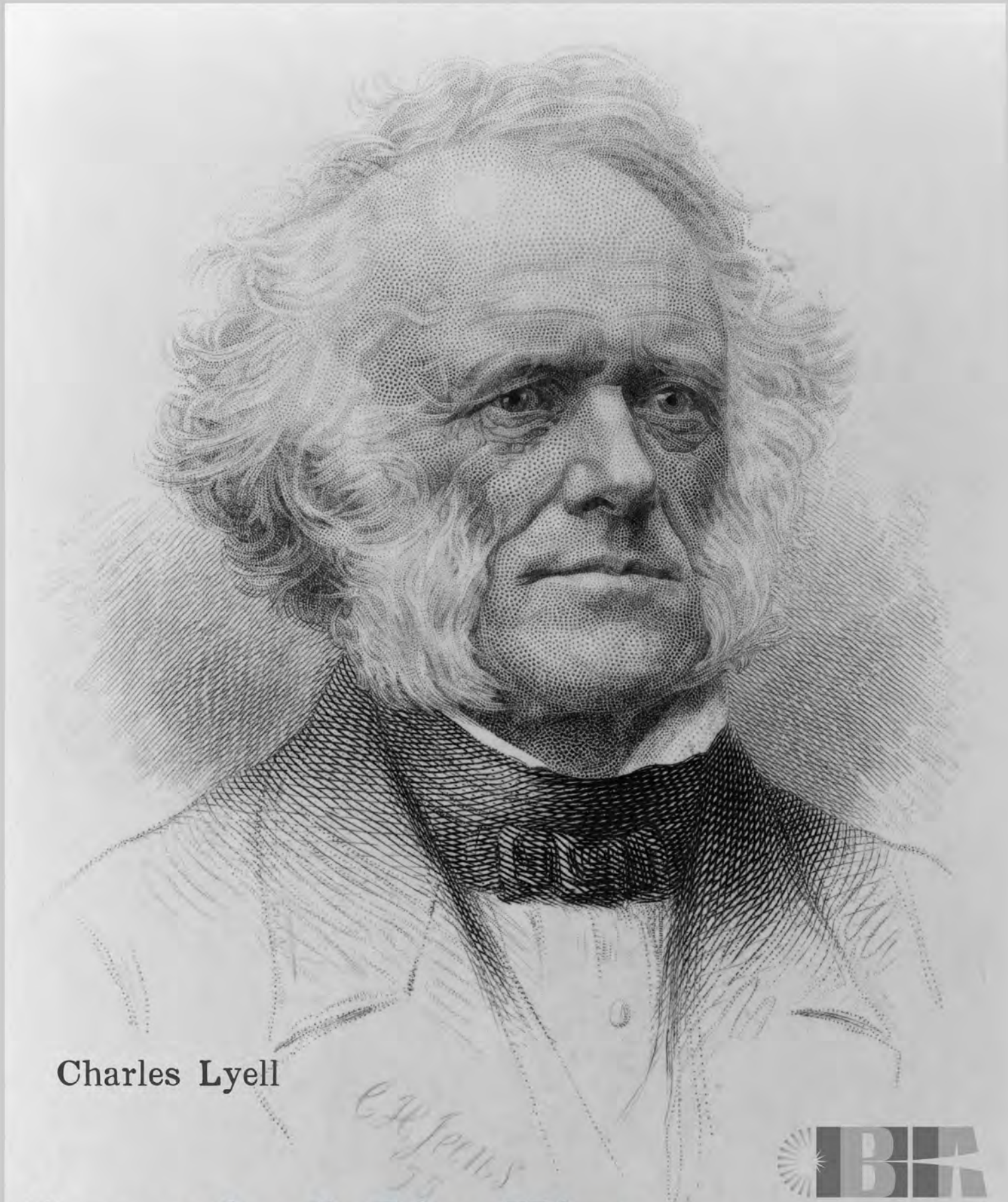

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MacKenzie Dahl has proofread and copyedited the entire issue. She is in the graduate program in the Department of Political Science at Villanova University.

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An Exploration of Historical Transitions with Simple Analogies and Empirical Event Rates

David J. LePoire
Environmental Science Division, Argonne National Laboratory

Abstract
Various qualitative models have been suggested for major historical social and technological transitions. Many of these transitions still have puzzling aspects such as the early transition from hunter-gatherer to agriculturally-based society which required dramatically increased effort. Another puzzle is the emergence of the scientific and industrial revolution in Europe despite many previous similar discoveries in other regions. Explorations of simple models with aggregate, dynamic, and nonlinear processes might lead to insights of the unique aspects of each transition. Topics include the transitions between hunter-gatherers, agricultural societies, early civilizations, market development, capitalism, industrialization, and sustainable societies with factors of land-pressures, economies of scale, suppressed growth, and chain reactions.
Many types of models could be applied to these transitions. First, basic characteristics, such as width and midpoint of the transitions, are determined by analyzing historical events contributing to the transition. However, this does give much insight into the dynamics or parameters of the transition. For more understanding, each of six transitions is explored with a simple phenomenological model. These simplified models do not attempt to quantitatively address the details of the actual historical mechanisms Instead analogies to more natural systems are invoked to gain insights.

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Questions in Major Historical Transitions

In Big History there are many transitions as complexity seems to grow in natural ecosystems and social historical development [Christian 2014, Volk 2017, LePoire 2015]. The focus of this paper are the historical transitions, which are amenable to analysis and historical study. While many consequences of the transitions have been well described, there are still many questions concerning why the transitions happened at all. For example, why did early farmers leave a seemingly easier lifestyle of the hunter-gatherer? Why did large seemingly parasitic cities evolve which were dependent on the agriculture around them? Why did the scientific revolution and industrial revolution predominantly first occur in Western Europe even though many of the inventions had been imported from elsewhere? And a current question: Can a civilization so dependent on unsustainable fossil energy consumption find a path to productive sustainability?

In natural ecosystem transitions, often external environmental changes prompt evolution. These changes have included geological changes from drifting continents which created and destroyed seas, and the warming of the sun from its early beginning about 5 billion years ago to the present as it's elemental composition changes. But other changes have been caused by evolution itself, e.g., the arms race of jaws in the Devonian era, and the development of oxygen generation which essentially were poisons to early life until a mechanism was found to control the oxidation process [Fewster 2016].

In human evolution, it seems like the changes are mostly like the latter causes, internally generated [Ponting 2007]. One period solves a problem of the previous, then grows and prospers until some limit is reached, causing new problems. Searches then begin for alternative ways of resolving these new problems including new technologies and ways of organizing. Some of these problems manifest themselves as limitations of human population under a given lifestyle and the control of energy and its corresponding pollution. When old solutions no longer work, then reform, reorganization, and new understanding are explored [Tainter 1996, Gunderson 2002]. For example, many energy sources can be very dangerous without proper control- early humans figured out how to control natural fires which could have easily destroyed their environment; agricultural villages enabled greater food (energy) production but generated larger environmental issues in human waste disposal and diseases; and current energy sources generate large amounts of pollution such as CO_2 and nuclear waste.

Major Historical Transitions

Major historical transitions include the agricultural revolution from hunter gatherer to an agricultural lifestyle, the industrial revolution using external energy sources to power large-scale manufacturing, and the current transition to a more energy sustainable lifestyle independent of fossil fuels [Fewster 2016]. However there are some intermediate periods where large changes took place. After settling down into farming villages, a major change involved the development of larger cities with non-agricultural specialties such as management, government, religion, and law. The ancient and classical civilizations start (around 3000 BCE) with the first historical ancient civilizations (Egypt, Mesopotamia, China, and the Indus Valley) and ends with the collapse of the Rome Empire (around 476 AD), the largest city in the ancient world. (Similarly, the Chinese Han Dynasty lasted over 400 years from 206 BCE–220 AD).

However, the industrial revolution did not follow immediately, but instead took over a thousand

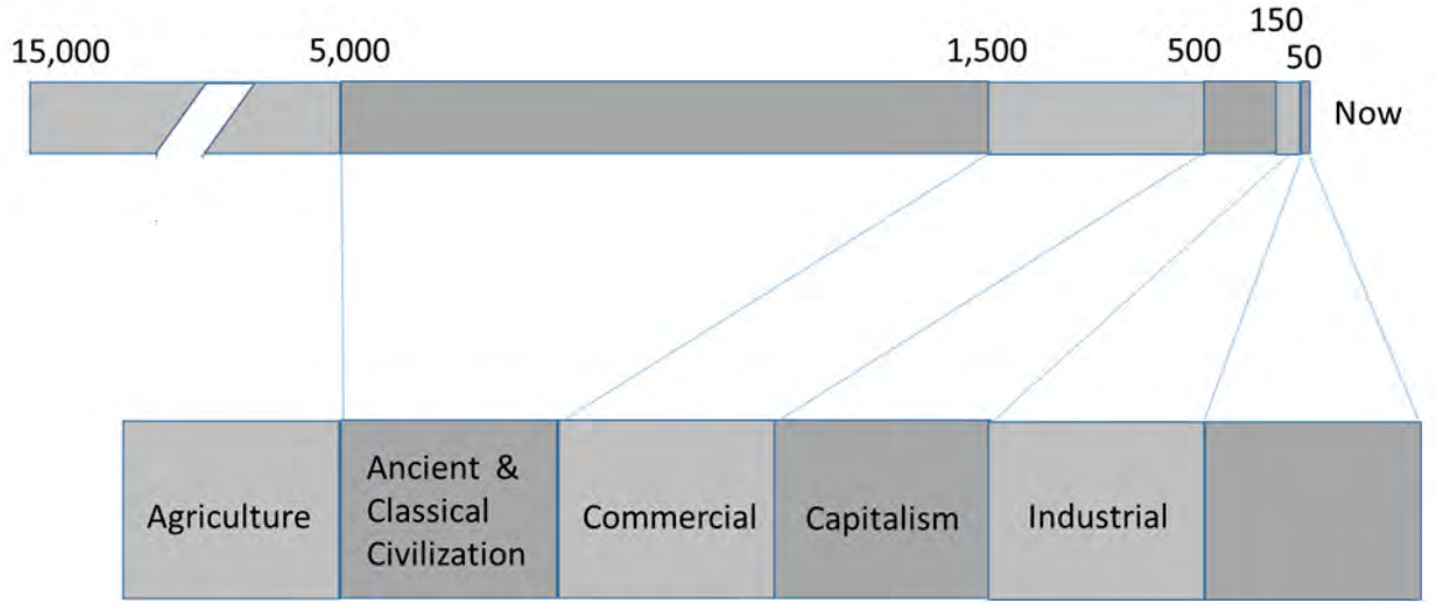


Figure 1. Timeline of historical transitions displayed on a linear time scale (top) and logarithmic scale (bottom). Since there is a factor of 3 reduction in the duration of the phases, each phase has the same width on the logarithmic scale.

years as the economic foundations for the industrial revolution were developed. Competing political regions developed with the incorporation of growing labor, machinery (technology), and natural energy sources (e.g. wind, water, and wood). A labor market was facilitated by the scarcity of workers after the devastation of the Black Death in the mid 14th century. Trading ships required large investments facilitated by financial tools such as loans, stocks, and insurance. As companies became more efficient, trade in luxury items were later supplemented by bulk trading of wood, fish, and salt. These trading companies could sustainably continue to grow through reinvesting their profits into developing infrastructure such as ports and ships.

There seems to be about 6 phases after the hunter gatherers: early agricultural, early civilization, market development, capitalism, industrial, and sustainability (Figure 1). The six transitions between these phases occurred at about 15000, 5000, 1500, 500, 150, and 50 years ago, i.e., subsequent phases started happening at a quicker pace with a shorter duration. There is about a factor of 3 reduction in the durations between consecutive phases. This factor of 3 is also an approximation for changes in accelerating periods for both natural biological evolution and cultural human evolution as well as this human historical revolution heavily influenced by technology [LePoire 2015].

Potential modeling approaches

The modeling of these transitions might occur at many levels of abstraction to gain multiple perspectives [Costanza 1993, Turchin 2003]. For example, modeling methods can be characterized by attributes such as realism, precision, and generality. High-realism models capture as many of the underlying mechanisms at their fundamental levels. High precision models might disregard fundamental understanding and instead be based on empirically derived coefficients. General models may be based on an intermediate conceptual model, highlighting qualitative mechanisms for further strategies but weak in actual numerical predictions and detailed mechanisms.

This study first uses empirical analysis of the transitions by focusing on the rate of important events in the transition. Then an analogy to a physical model is suggested that captures some of the qualitative features of each transition. This study does not attempt to quantitatively address the actual historical mechanisms. Other modeling methods, such as system dynamics models and agent models, might be later used to capture the detailed, disaggregated, and integrated dynamics among the phases.

Various qualitative, narrative explanations have been suggested for other phases of historical transitions. Many of these transitions still have puzzling aspects such as the early transitions from hunter-gatherer to agricultural based society in which the average work day went from a few hours to at least triple that value [Diamond 2005]. Another puzzle that has collected much attention is the explanation of the emergence of the scientific and industrial revolution first in Europe despite many individual similar discoveries previously in other regions [Goldstone 2009].

In a broader context, recent analysis of important events in Big History has shown a logistic trend [Modis, 2002, Panov 2011]. It was suggested that the overall logistic trend is composite, formed by nested logistic growth in discrete learning phases [LePoire 2015]. Discussion has also included comparing this process to evolution of a complex adaptive system with the intensity of energy extraction as a driving parameter [Chaisson 2004, Fox 1988, Marchetti 1980, Jantsch 1980]. The transitions between hunter-gatherers, agricultural societies, early civilizations, market development, capitalism, industrialization, and sustainable societies are explored with physical analogies to demonstrate the unique aspects of each transition. Topics include land-pressures, economies

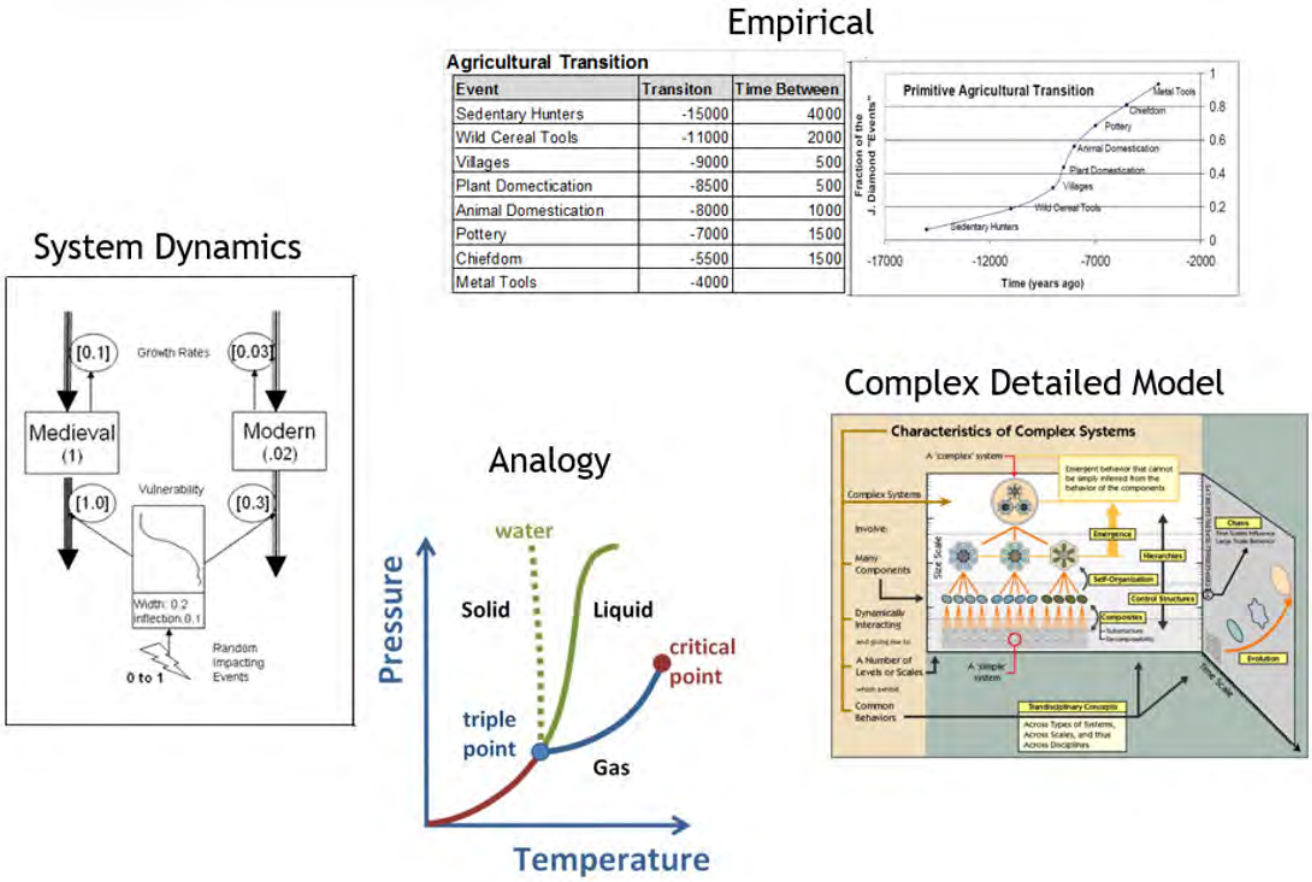


Figure 2. Various types of models that could be used to understand historical transitions include complex detailed models (right) and system dynamics models (left) that capture key processes in the transition. In this paper, the focus is on empirical rate of events (top) during the transition to determine a midpoint and duration of the transition. Then an analogy (bottom) to a physical model is suggested to help understand the qualitative aspects of the transition.

of scale, suppressed growth, chain reactions, and use of limited energy resources.

Transition to Agriculture

What caused the transition from a relatively leisurely hunter-gatherer lifestyle to the more work-intensive agricultural lifestyle? It might not be exactly clear, but we do know that all hunter-gatherer societies did not take the path to agriculture even when it was known as an option. For example, some northwestern Native American tribes continued a hunter gatherer lifestyle based on the quite abundant salmon, although due to the resources, they could remain in villages year round.

Perhaps, as long as good conditions continued, the hunter-gatherer lifestyle was adequate. As the population density of hunter-gathers slowly increased, competition (pressure) increased for land. With the greater stress on the natural resources, environmental conditions, such as drought, might reduce the land's productivity. Supplemental intermediate strategies such as slash-and-burn and swidden agricultural were developed. Agricultural land can support many more people than a hunter-gatherer society although it requires more work such as clearing, plowing, planting, nurturing, harvesting, selecting, and storing. The agricultural process also tended to encourage a

more stationary existence since more investment was required to prepare the land and securely store food and tools.

A hunter-gatherer society could maintain small population growth through techniques such as delayed weaning. In agricultural communities, however, larger families were desired since some jobs were menial and could be performed by younger children. The pressure from these larger agricultural families further increased the competition for land in a positive feedback loop towards coalescence into agricultural communities. This process is similar to a phase transition from a gas (hunter-gatherers) to liquid (farmers) under increased pressure (Figure 3). This dynamic forms the basis of this logistic transition model to agriculture.

The model has two distinct populations of hunter-gatherers and farmers. Both compete for the land resources, although the farmers require a much smaller (e.g., a tenth) land area per person to support their lifestyle. If the population density is low, most people would continue the easier work of the hunter-gatherer lifestyle. This population grows slowly over thousands of years. Eventually, larger populations require most of the local area (which may be diminished due to land loss due to environmental or natural causes). The effort to live on such a densely populated area increases due to competition for the limited resources (e.g, wildlife). A few hunter-gatherers might try new approaches to secure food. As agriculture knowledge grows, eventually some people will settle down as farmers. However, this agricultural lifestyle is able to feed more people and use the children at an earlier age, increasing the population growth rate. This tends to propagate the lifestyle by increasing the competition for land (land pressure) which causes more hunter-gatherers to switch to farmers. Therefore, the transition continues towards agriculture with the important factors driving the transition being the relative land pressure and growth rates.

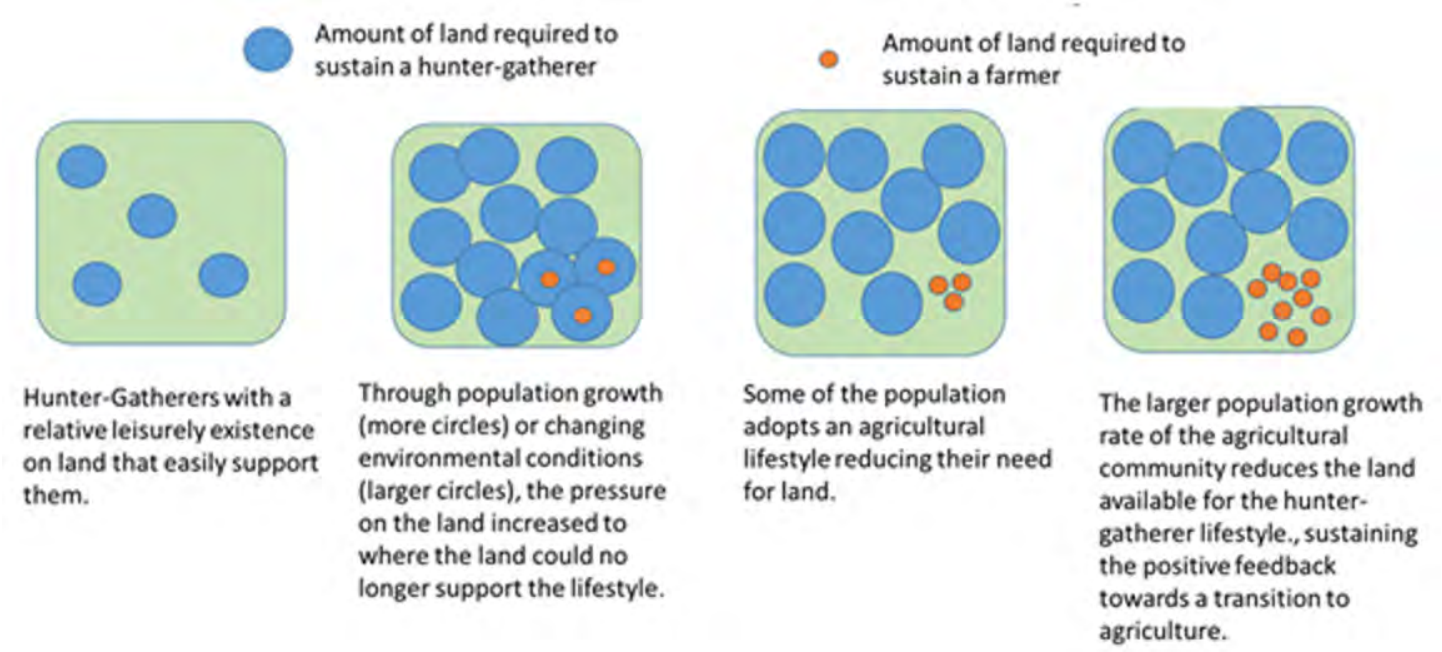
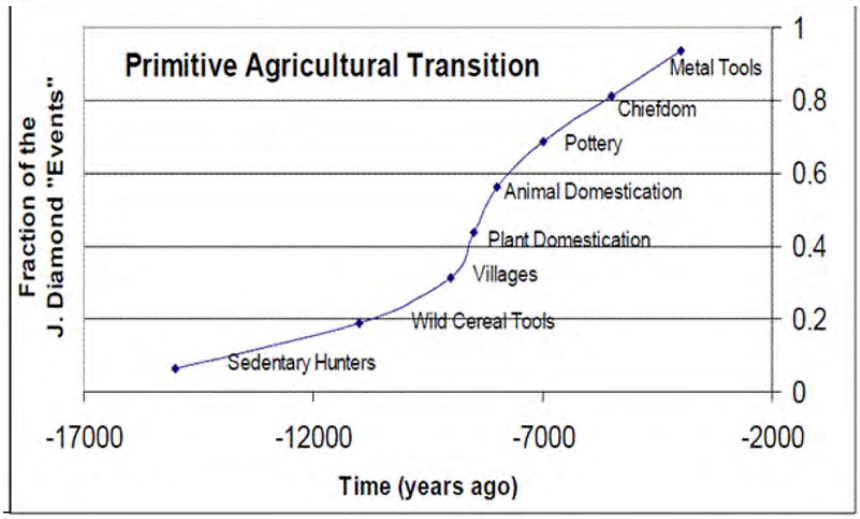


Figure 3. Analogy of transition to an agricultural lifestyle based on land pressure leading to condensation into smaller but more intensive units.

Evidence of intermediate events can be used to estimate the duration and midpoint of the transition. A list of important events in during various development phases was constructed and analyzed corresponding to logistic (or learning) pattern (Figure 4). For example, Diamond [2005] discusses some important events in the transition from hunter-gatherer to agriculture. If each event is treated as being equally important, then this rate of events can be used to form a logistic curve. What one expects from this logistic pattern is a slow rate of events (discoveries) early in the transition process, followed by a quicker discovery rate, with the quickest rate at the inflection point halfway through the transition. Then a another slower phases of discoveries follows, near the end of the transition. The beginning of the transition was about 15,000 years ago with the exploration of sedentary hunters. The inflection point was about 9,000 years ago (7,000 BCE), with forms of plant domestication. The last major event putting the transition over 90% was the introduction of metal tools at about 5,000 years ago (3,000 BCE). The duration of the transition from 10% to 90% was about 9,000 years.

Agricultural Transition

Event	Transiton	Time Between
Sedentary Hunters	-15000	4000
Wild Cereal Tools	-11000	2000
Villages	-9000	500
Plant Domectication	-8500	500
Animal Domestication	-8000	1000
Pottery	-7000	1500
Chiefdom	-5500	1500
Metal Tools	-4000	



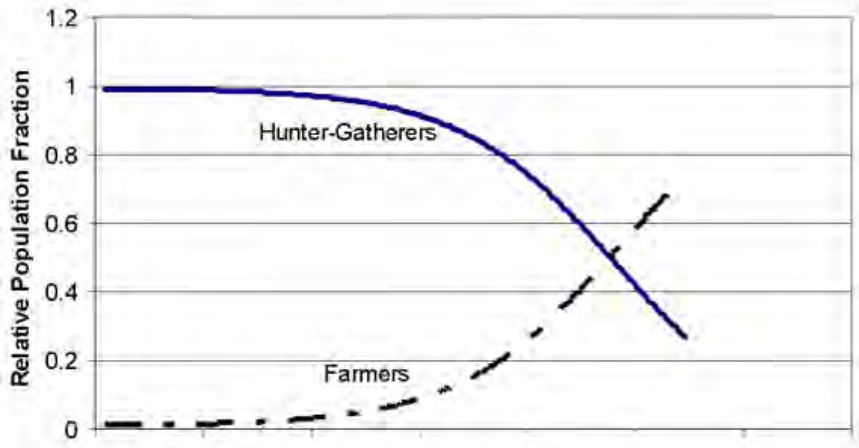


Figure 4. Logistic Trend of major events in the transition to primitive agricultural societies.

Transition to Civilization

The development of cities around agricultural communities happened independently at a few location at various times in history, e.g., Mesopotamia, Nile, Indus, China, and Central America. The urban inhabitants exchanged protection, administration, and specialized crafts for surplus food from the rural communities. Administration included overseeing large public projects such as irrigation and food storage. The urban elite's role was to

manage such risks as invasion and famine to ensure continued growth. This risk management was more important in areas where the population density was higher and natural disasters like floods and famine were more frequent. Decisions to centralize or decentralize organizations remains a key current issue and is dependent on complex considerations of the return on scale of various processes. The exploration and learning in this transition during the ancient and classical civilizations led to one of the largest and centralized empires based around a large city- the Roman Empire where about 20% of the population was either an urban dweller or in the military [Ponting 2007]. However, its highly centralized nature led to dependence on dynamic growth for capturing new area and sources of labor to support the system.

The transition from agriculture villages to hierarchical civilizations is modeled with increasing economies of scale. That is as the city becomes larger the relative cost to the dwellers becomes less expensive. The agriculture villages were more susceptible to natural risks such as drought and flooding, which reduce their population growth. A hierarchical civilization allowed a management of food storage and mitigation of natural impacts with such tools as irrigation. The benefit of this investment in the administration and resource collection would be the capability to be more resilient when natural disasters occurred. Later as civilizations became more prevalent, war and diseases would also be added to the natural disasters. The impact of natural disasters would be larger near the more marginal lands. While at first, the natural river systems of Egypt and the fertile crescent provided suitable conditions, later civilizations further spread with the introduction of new technologies based on better materials such as bronze and iron.

This model, based on economies of scale of specialized management of risks, is portrayed in figure 5. The transition to new levels of civilization proceeds when the mitigation of risks allows for larger average growth. Positive feedbacks arise from the relative military power of the more centralized state.

The sequence of dynastic (or national) durations from Mesopotamia and Egypt is shown in Table 2. The process starts at about 3,000 BCE with early

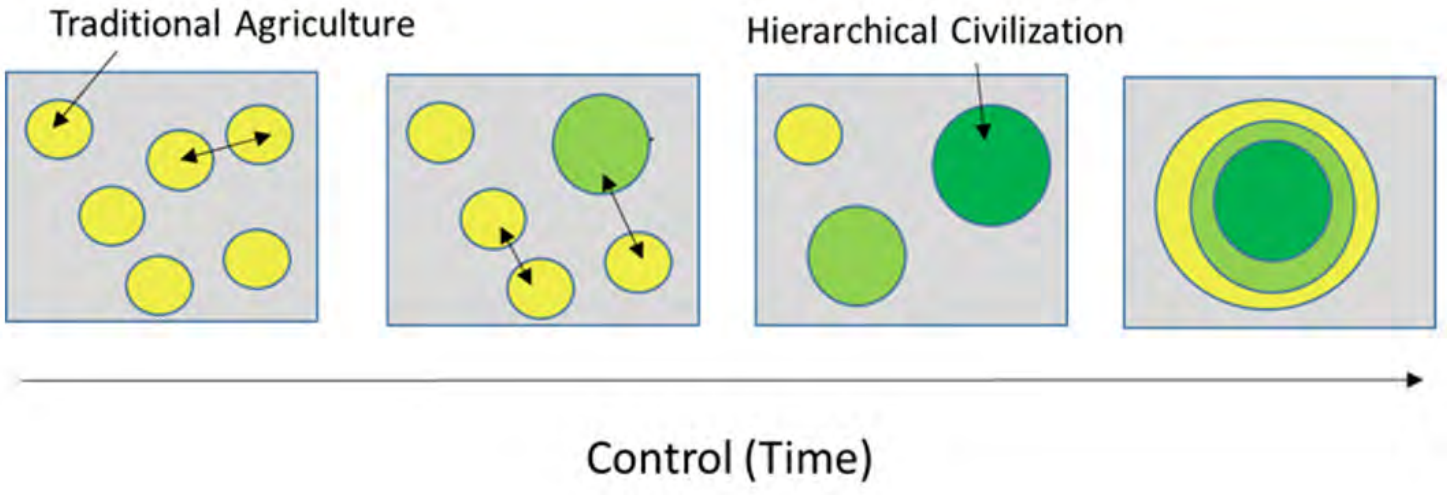


Figure 5. Consolidation model of civilization growth. As agricultural density grows, risk increases with the use of marginal lands and conflicts. A way to mitigate these risks is by forming a hierarchy to organize and distribute. The overhead needed for a hierarchy is smaller (on per person basis) with larger sizes (forming an economy of scale). If the technology changes to enable wider control then more consolidation may take place.

civilizations of Ur and Egypt. Empires rise and fall through learning processes such as incorporating new technologies, government organization, coordination of land and water rights, and developing military defenses. The dynastic duration tends to shorten in time before the midpoint inflection. This inflection, near 600 BCE, is near the collapse of many Bronze Age civilizations which occurred during the Greek Dark Ages. This inflection point is also near the middle of the Axial Age as Jaspers [1953] described it as "an interregnum between two ages of great empire, a pause for liberty, a deep breath bringing the most lucid consciousness." After this inflection point, ideas and technologies, such as iron working, were developed, and the duration of the major empires began to lengthen again leading to the Roman Empire and its direct related civilization the Byzantine Empire ending at about 1,000 AD. Both these empires were still built around one large city, Rome and Byzantium (Constantinople). However, while technology led to many infrastructure developments (such as water systems, ports, buildings and roads), the major energy input was based on agriculture with dependence on slave-based labor [Ponting 2007].

Transition to Commercial Markets

The Roman Empire generated many wonders which would not be duplicated for centuries after its collapse, generally taken to be around 476. However, a new form of civilization was being formed, by the groups exposed to the Roman technology but with more decentralized government and without the slave-based economy of the Romans. The internal fighting occurred over many years as new growth and arrival of new tribes led to their invasion into previously settled land such as the Huns, Germanic tribes, and Vikings. A spell of warmer weather, Medieval Warm Period (950-1250), which allowed higher agricultural yields and therefore higher population, was partially responsible for these expansions.

Ancient/Classic Civilization

Event	Transiton	Time Between
Sumer/Egyptian Old	-3000	787.5
Bablyon / Egyptian Mid	-2212.5	580
Hittite / Egyptian New	-1632.5	432.5
Kassite	-1200	300
Assyrian	-900	292
Chaldean	-608	46
Persian	-562	228
Helenistic	-334	201
Rome	-133	621
Byzantine	488	965
(End of Byzantine)	1453	

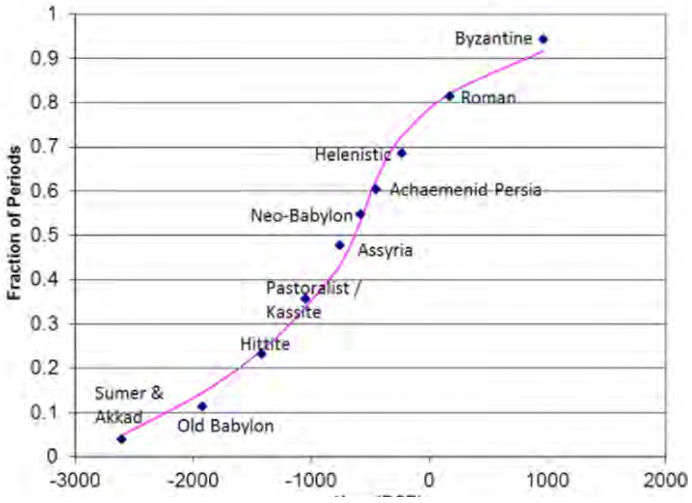


Figure 6. The transition through early civilization (ancient and classical) based on the duration of leading states.

An important set of events led to the establishment of wider trading routes. These events included the expansion of Islam into Spain with the secured knowledge of previous civilizations; the crusades inspired to minimize internal European fighting was supported by growing trade in Byzantium and Italian city-states; the development and diffusion of technology which utilized natural resources such

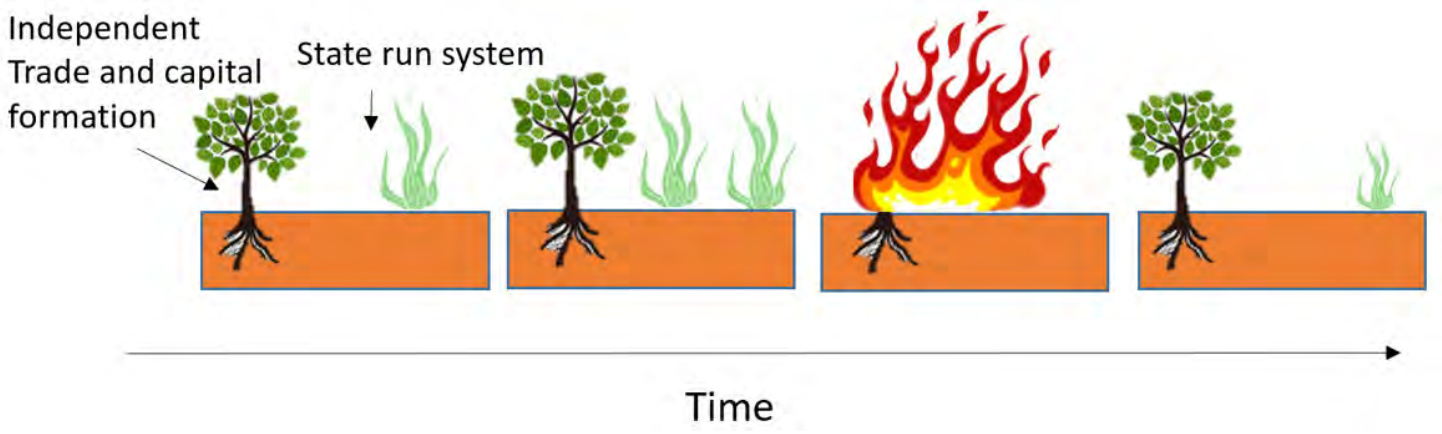


Figure 7. Prairie model of commercial market growth. While the growth rate of weeds (state intervention in the economy) is faster than prairie plants (market growth), periodic fires (disagreements between states) lead to the prairie plants' resilience with deeper roots.

as wood, water, and animals more efficiently, as exemplified by the Cistercians Monks [Gimpel 1976]; and the establishment of a northern European trade network independent of any one state, the Hanseatic League, which began to trade bulk goods such as fish, wood, and wheat. The slimmer profit margins from these bulk goods required more efficient ships and commercial mechanisms.

To construct a timeline, the events in the commercial revolution in Europe are identified [Lopez 1976, Ferguson 2008]. As described above, these events took place between the fall of Rome and the establishment of sustainable capitalism in northern Europe in the 17th century. The beginnings started with the Italian city-states such as Venice which had maintained relationships until 742 with the Byzantine Empire after the fall of Rome. Early market fairs such as the Saint Denis Fair near Paris started in the 7th century as a side-product of religious pilgrimage. In the Viking trading routes formed beginning in the 9th century across Europe including from the Baltic to the Black Sea. This continued in the 12th and 13th centuries with greater trade in Europe from lessons learned from the crusades and led to Champagne fairs. In the north the Hanseatic trading League developed in the 13th and 14th centuries. After the fall of Constantinople in 1453, new routes were explored to bypass the Eastern Mediterranean. This motivated exploration by the Portuguese and later by the Spanish, Dutch, English, and French. The luxury goods trade was transitioned to bulk goods in the northwestern Europe leading to economies of scale for bulk goods and introduce new business organization to share risks (see next section).

The characteristics of the model should include the hindrance of European unification (although the Holy Roman Empire and Habsburgs had attempted to form large empires), allowing more market competition, experimentation and growth of innovations such as various markets and financial tools in loose commercial networks which included the Italian City states and the Hanseatic League. This suggests a process similar to what happens in prairie ecosystems. Prairies consist of both slow growing grasses with deep roots and fast growing plants (weeds) with shallow roots. The prairie grasses can establish themselves only if natural occurring fires occur which destroy the faster growing plants but leaving the resilient deep grass roots untouched. In a similar way, markets systems (prairie grass) in Europe might have been able to grow, e.g., independent investments and banking systems,

because of the absence of unified states to hinder trade growth through state interventions (weeds).

Transition to Capitalism

The commercial markets and the trade of bulk items such as lumber and fish (instead of relying on mostly luxury goods), facilitated the introduction of capital formation often in the form of securing trading ships. The components of the system such as stock markets, loans, banking, legal obligations, and insurance were established during the commercial market phase [Ferguson 2008]. However, the independence of the European states meant that each state had its own way of experimenting with markets and relative interference. In 17th century the Dutch gained political independence from Spain leading to the Dutch Golden Age of art, commerce and exploration. The relative smallness of the country allowed for ideas to spread rapidly through the main financial center of Amsterdam. They also participated in the protestant reformation and also the scientific revolution with the likes of Huygens and van Leeuwenhoek.

While the riches began to accumulate in the Netherlands during their Golden Age with the arts and culture, other countries followed but on a larger scale. The English and Dutch had major naval battles to determine primacy in trade and economic development. The English established themselves as leaders after their civil war and instability by inviting the Dutch king to be their own in the Glorious Revolution of 1688. England's population at the time was roughly twice the Dutch population. This pattern seemed to continue that leadership would pass after about a century to a state that was twice as large in population. This included the transition to the full United Kingdom (which included Scotland and Wales) in the 19th century and then to the U.S. There might be one or two possible future transitions [LePoire 2010]. The pattern with the 4 transitions over the 400 years, suggests a midpoint at about 1800.

The analogy for this growth of capitalism is the growth of an individual fertilized egg cell during development to a multicellular organism. This pattern in the growth of capitalism is complicated by the necessity for a sequence of transitions to larger countries. The larger countries can supply larger markets and more complex infrastructure. This infrastructure includes not only the physical items such as roads and communications

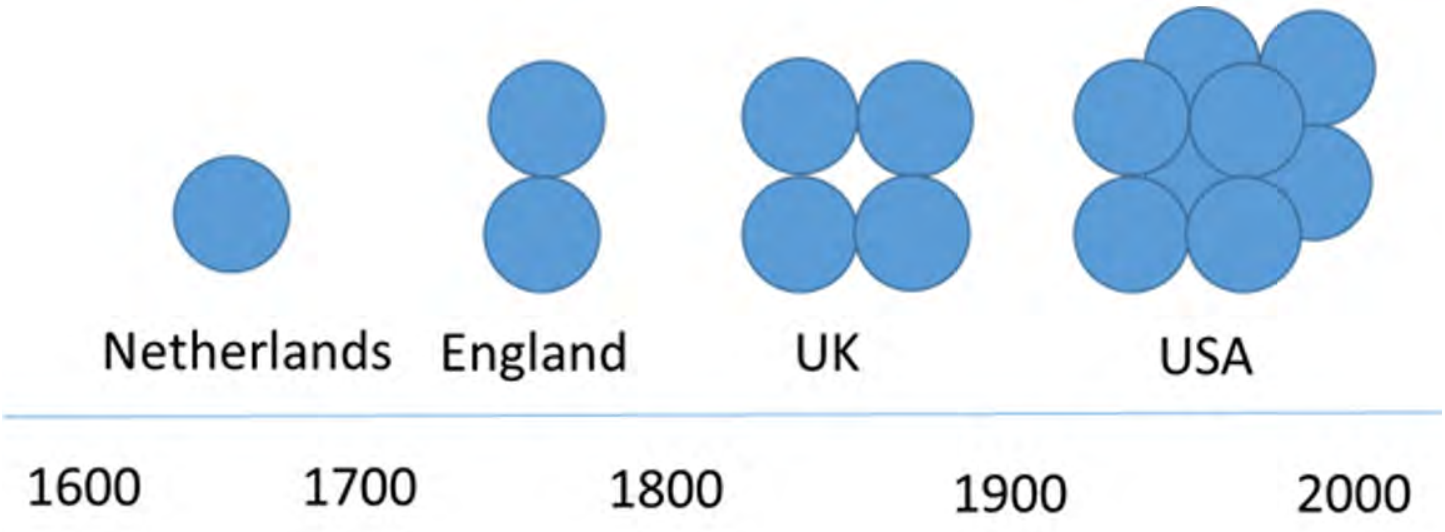


Figure 8. Transition to capitalism as the center of leadership shifts about every century to a location double in size (at the time of transition).

but also the social organizations such as governments and laws. Both cells and economic leadership transition by splitting on a periodic bases (cells: about a day; capitalist leadership about every 100 years). Another difference is that the biological growth is done without addition of any new material (for up to 16 cells) but in the capitalistic leadership transition, the nations grow between the transitions.

Transition to Industrial

As population, trade, and demand for goods increased, energy in the form of water, wood, and wind were limited. This was felt early in England as the forests were depleted, however, this led to exploration of the use of coal which required greater transportation and technology to keep the mines dry. The resulting use of iron and steam engines led to a positive feedback loop in which the technologies used to develop coal resources led to increased coal demand. This system first emerged in the Severn River valley in the mid 1700's. However, many of these technologies had been tried before: blast furnaces were used for iron working in Han China; coke from coal was used for metallurgy in Song China; and Hero of Alexandria constructed a steam powered device and an early windwheel in the 1st century (although not very efficient).

The puzzle why Europe led the scientific and industrial revolution has been discussed quite thoroughly in the past with many explanations [Goldstone 2009, Stark 2005]. Diamond [2005] suggested that geography played an important role in that China had few natural hindrances enabling the establishment of a centralized government whereas Europe had many mountain ranges and a complicated coastline. The Chinese Han dynasty has been likened to the Roman Empire, however, after its collapse, only a few generations passed before the reestablishment of a centralized government which was able to manage the introduction of technologies and innovations. Others have explored this theory more quantitatively in looking at the fractal dimension of the coastlines in enabling trade and reducing the chance of a centralized government [Cosandey 1997].

Why did these earlier inventions not start a similar industrial age? Perhaps combinations of the technologies must occur in a short period under conditions that could sustain growth and continual development. These incentives include the ability of the entrepreneur to profit from capital investments, and the workers the ability to leave the land and work instead in factories. However, if the cultural environment is not able to sustain growth with accompanying complementary innovations, then the momentum is lost.

The industrial revolution had many phases including an early agricultural phase (mid 18th century) with the introduction of mechanization and advanced crop rotation leading to higher productivities. The other phases in Schumpeter's waves of innovation include the textiles and iron (mid 19th century), steam-rail-and steel, electricity-chemicals and internal combustion engine (late 19th century), and petrochemical-electronics and aviation (mid 20th century) [Ayres 1989]. Another wave in the sequence might be the information age with digital networks and software. The rate of innovation can be seen in the number of innovations throughout the era. Analysis of a different set of data show the peak in innovation per capita in the late 19th century [Heubner 2005]. This can be viewed as the highest qualitative (i.e., change in life-style) acceleration, while the current acceleration is more quantitative with a larger population contributing to innovation.

The analogy of a chain reaction models the positive feedback of introducing new innovations and the loss of momentum as the innovations age. The new innovations might come from outside (diffusion through trade) or from internal discoveries. A couple of positive feedbacks occurred: 1) as more people worked in the industrial sector evaluating

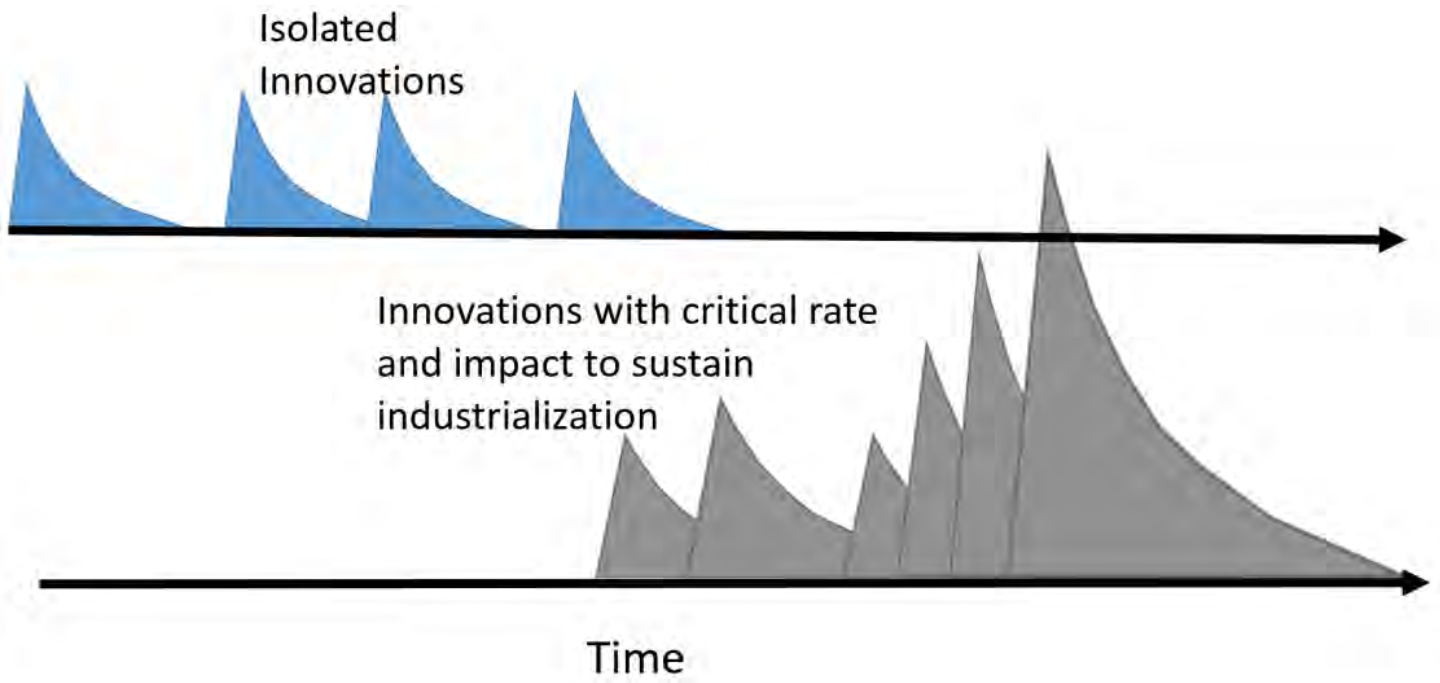


Figure 9. Critical innovation rate model of transition to industrialization. The top shows a society with early innovations but are isolated and do not influence each other. The bottom case is a society that has innovations quickly introduced but each with a longer duration impact. The innovations create a chain reaction.

and implementing new technologies, workers in traditional setting, e.g., agriculture, were no longer needed because of the labor saving devices such as tractors; and 2) new innovations result in a greater number of potential innovations based on increased combinations. However, if the rate of innovations is too slow, they might be forgotten or taken for granted before the next innovation. This leads to a rather slower linear progression compared to the exponential growth with the positive feedbacks at higher innovation rates. Physical and social technologies such as coal, steel, steam power, democracy, capital markets, and communication were brought together in a system able to sustain the transition through their continuous need for innovation. A key factor is the ability to recognize and monitor the feedback to grow or abandon decisions based on market conditions and financial incentives.

Current Transition

The current transition is towards a sustainable civilization where energy, population, and technology are balanced. The transition is complicated by the need to solve the current problems without creating overwhelming new ones within the context of rapidly changing technology [Homer-Dixon 2006, Ausubel 1996]. For example, raising education and health of many people, especially women in developing countries, temporarily increases resource use through improved quality of life before the population growth rates stabilize. If the transition progresses too slow, the resources will not be concentrated enough and the solutions will not be found. If the transition goes too fast, the unresolved unintended problems will accumulate.

The "burnout" or sustainability model is known within many communities including ecology. Transitions in predator-prey models sometimes exhibit

the "J-Curve" where the transition starts going through the characteristic S-Curve but does not stabilize at the higher level but instead collapses to a lower level. This is indicative of fueling the initial growth on some unsustainable resource.

An analogy is made between the transition to a sustainable society to launching a rocket into orbit [LePoire 2018]. A rocket, once launched, needs to reach a critical velocity and height before obtaining a sustainable orbit. Once a stable orbit is attained, there are many further beneficial options such as space observations or facilitating further space exploration. The basis for the analogy is that there are two stationary states for the rocket- the ground and a stable orbit. The ground is analogous to the historical situation of a society based on traditional solar energy for crop growth, warmth, wind, and water. The stable orbit is analogous to an improved situation of an advanced society with more freedom, comforts and fulfillment, which is also stable through technologically capturing a larger fraction of the solar energy (or supplementing it with nuclear fission or fusion).

It is not clear if society's transition to energy sustainability (the metaphorical stable orbit) will be completed successfully. In this analogy, it is not at all clear which plan we should follow towards sustainability since we really do not know the fundamentals that any rocket engineer would know. Such information would include the weight of the rocket, the efficiency of the engines, the amount of fuel, the speed necessary to get into orbit, and the height of the orbit such that the atmosphere is negligible.

A rocket launch can crash from loss of stability, fuel tank explosion, too little acceleration leading to inefficient use of fuel, too much acceleration damaging engines. The rocket might also heat up too much when going through the atmosphere or if the orbit is too low. The rocket might not orient correctly for a stable orbit. Another failure would be for the rocket to enter a stable

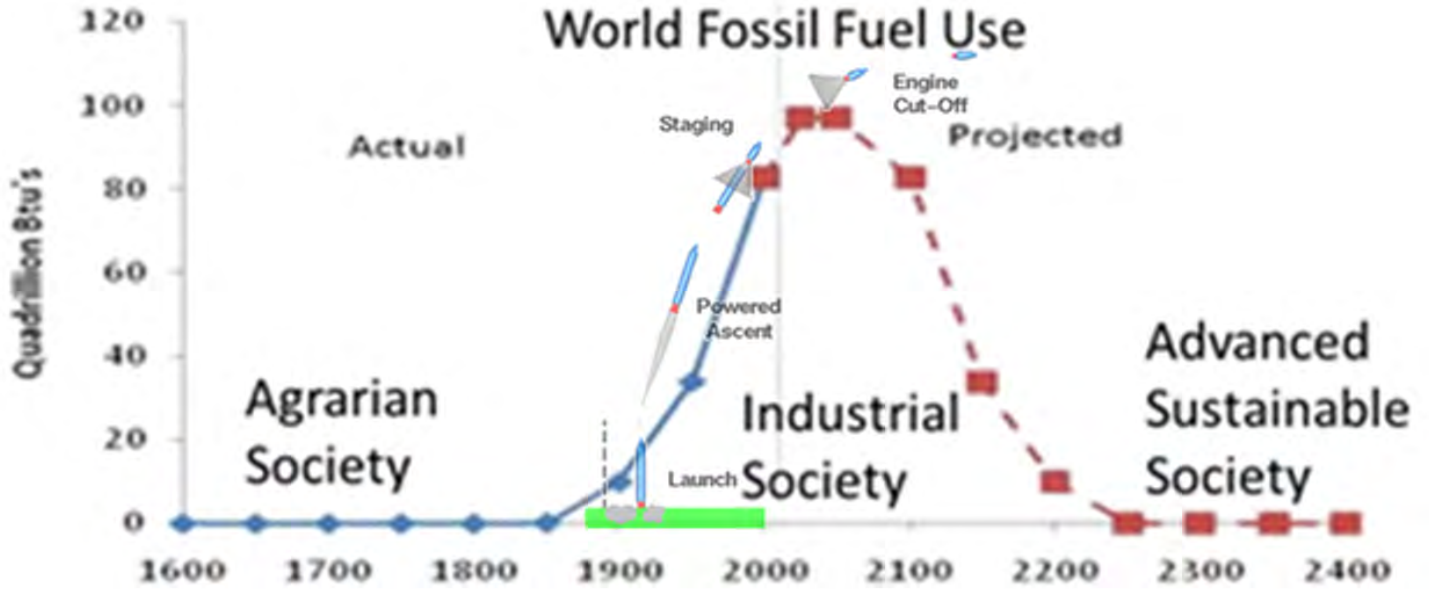


Figure 10. The analogy of a rocket launching into orbit with the launching of civilization into an industrial society based on the use of fossil fuel. Both start at a lower stable state (ground and agrarian society) but use the limit energy resources to reach a stable state at a higher level (orbit and advanced sustainable society).

Transition	Approx. Beginning Point	Analogy	Parameters	Characteristics
Agriculture	13,000 BCE (15,000 ya)	Phase transition between gas and liquid as the pressure increases.	Land pressure	Not reversible unless land pressure is reduced through technology or catastrophic population reduction
(Ancient and Classical) Civilization	3000 BCE (5,000 ya)	Centralize / decentralize Insurance model based on return of scales	Benefits of centralization	Stochastic and reversible depending on random impacting events
Commercial Market	500 (1500 ya)	Prairie ecosystem sustainability through frequent fires which do not burn deep rooted grasses	Fractionation	Stochastic and reversible bases on impacting events hindering further centralization
Capitalism	1550 (450 ya)	Early growth of an organism from one cell to many.	Division rate, rate of growth	Needs to start small and have nearby areas that can take the lead when divisions happen.
Industrial	1850 (160 ya)	Critical innovation rate model	Rate and duration of impact of introduced innovations	Stochastic and reversible depending on growth rate due to innovations and technologies
Sustainable	1960 (60 ya)	Rocket launching model- society consumes fossil fuel resources in attempt to reach a new level of sustainability (orbit).	Technology substitution ability, demographics transition rates	Irreversible because the stock of non-renewable resources (e.g., oil) can only support one attempt at this transition.

Table 1. Summary of the six transitions and their analogies presented in this paper.

orbit but lose the capability to support humans, e.g., buildup of carbon dioxide as started on the ill-fated Apollo 13. For each of these there are corresponding analogies in the transition to an advanced sustainable society. For example, the incentives might not be correct to guide us towards stability, the transition might be too slow (burning fossil fuels but making too little progress) or too fast (using technology that eventually is inappropriate or inefficient).

Summary

A topic of current discussion concerns the rate of technological progress, energy usage, and social change. One contribution to this discussion is historical analysis of important historical transitions. These transitions include development from hunter-gathers, to farmers, to civilizations, to market development, and capitalism. The rate of important events within these transitions indicate potential logistic trends. This trend throughout historical civilizations continues the accelerating rate of biological and human evolution, which seems to be leading to a nearing inflection period (as some have called the singularity). This growth trend might also be viewed as a behavior exhibited by a complex adaptive system. As these systems develop further from equilibrium towards critical states, the systems spontaneously may bifurcate into two potential discrete states. The growth between the bifurcations might exhibit recursive logistic growth. The formation of a larger logistic trend by embedded nested transitions might be interpreted as a form of punctuated equilibrium. It has been suggested that energy usage might be the driving parameter for this generalized evolution.

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Evolution, the 'Mechanism' of Big History - The Grande Synthesis

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Abstract
Big History traces the Cosmologic arc from the Singularity/Big Bang to the present. Similarly, evolutionary biology, as "all of biology", represents the arc of life from its origins. There is mechanistic consilience between Quantum Mechanics, The First Principles of Physiology and evolutionary biology that is perpetually centered on the unicellular level. The phenotypic adaptations in reaction to geophysical and geochemical changes that culminate in culture are forged at the level of the recapitulating unicellular zygote. This perspective offers a synthesis for the animate and inanimate alike as Big History. The cell as the mechanistic basis for both evolution and Big History offers a novel synthesis for Humanism and Science.

Key Words
Big History, Cosmology; Singularity/Big Bang; evolutionary biology; Quantum Mechanics; cell-cell communication

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Introduction

Since evolution is the 'history' of Man (Darwin, 1871), it should be functionally integrated with Big History (Christian, 2018). Furthermore, conventional Darwinian evolution is not mechanistic (Torday and Rehan, 2012), understanding the causal relationships underlying the process. By merging Big History with 'non-machine like' (Nicholson, 2012) mechanistic evolutionary biology, the ultimate goal of Big History (Spier, 2010) would be realized.

The environment has molded life on earth from its very inception. The spontaneous formation of micelles, or protocells, in the primordial oceans set the process in motion (Deamer, 2017). Subsequently, production of carbon dioxide by plants accumulated in the atmosphere, causing a 'greenhouse effect' that partially dried up the oceans (Romer, 1949), forcing some boney fish onto land (Daeschler et al., 2006). In adaptation to the terrestrial environment, specific self-engineered gene duplications occurred during the transition from water to land (Torday and Rehan, 2017), all of which were existential for survival (Torday, 2005).

Later still, during the Phanerozoic era (Berner, 1999), comprising the Paleozoic, Mesozoic, and Cenozoic, atmospheric oxygen tensions varied between 15 and 35%. The increases in oxygen caused gigantism (Berner et al., 2000), whereas the decreases caused physiologic stress due to hypoxia. The hypoxic stresses were hypothesized to have given rise to endothermy/homeothermy by stimulating catecholamine production by the hypothalamic-pituitary-adrenal axis (Torday, 2015). Endothermy/homeothermy, in turn, gave rise to bipedalism, freeing the forelimbs for specialized functions (flight in birds, tool making in Man), and higher consciousness (Torday, 2015). The latter is critical for the concept of Big History because without a sense of self (Miller et al., 2018) Big History would be immaterial.

Therefore, the saltatory integration of evolution with environmental change weds biology to Big History

causally. That realization offers the opportunity to further probe the depths of such interrelationships than would otherwise be possible by superficially studying these processes as associations and correlations, thus gaining far deeper insights to Big History.

The Role of Evolution in Big History

Life on earth has been forged by adaptive interactions between the animate and inanimate through evolutionary biology (Gould, 2002). The perceived influences of the environment on life began with Animism (Bird-David, 1999) and Astrology (Kassell, 2010), the latter culminating in Heliocentrism fostered by Astronomy as the catalyst for the Age of Enlightenment (Debus A, 1987). Subsequently, such insights as The Red Shift and the Big Bang Theory (Hawking, 2011) have added depth to our understanding of our physical origins as a point source (Torday and Miller, 2016a).

Darwin himself hinted at the relationships between the environment and speciation in his Origin of Species, commenting on the topography of Patagonia in great detail, but never developing the idea further for his theory of evolution (Darwin, 1859). On the other hand, Lamarck formally recognized the direct role of the environment in evolution (Gould, 2002), but did not have the scientific knowledge needed to demonstrate the principle. It is only recently that epigenetic inheritance has come back into vogue (Nilsson et al., 2018). It offers the opportunity to recognize the interrelationships between Big History and evolutionary biology.

Big History traces its arc from the Big Bang to the present as a continuum. The rationale for Big History is spelled out in Rodrigue et al's "Our Place in History" (2016). The book is an introduction to the idea that the 'story of everything' can be told, but in order to make it comprehensive, its physical and biological aspects must be merged as functional elements of the totality (Torday, 2018a). At its largest scale, Lovelock (Lovelock, 2003) and Smolin (Smolin, 1999) have established the organic nature of earth and the Cosmos, respectively. At its smallest scale, Atomic Theory (Pullman, 1998) and biological to cell-cell communication (Torday and Rehan, 2012) provide is mechanistic consilience between Quantum Mechanics, The First Principles of Physiology, and evolutionary biology at the unicellular level (Torday, 2018b). The merging of physics and biology within the cell has offered the opportunity to consider the congruence of the inanimate and the animate, referring all the way back to the Singularity/Big Bang (Hawking, 2011) based on empiric evidence for the first time (Zhang et al., 2017). The vertical integration of those principles has been exploited to explain the mechanism of physiologic evolution (Torday and Rehan, 2017), allowing a rationale for incorporating the latter into the concept of Big History.

Big History and Consciousness

There would be no history of biology if we were not conscious of our own existence. But what is consciousness? It has long been debated as to whether it is 'all in our heads' (Kraut, 2013) or 'theater of the mind' (Olcese et al., 2018). More recently, it has been conjectured that it is the essence of our physiology, which is formed by and composed of cell-cell signaling mechanisms (Torday, 2018a). Hameroff and Penrose (2014) have offered an elegant physiologic explanation for consciousness as the networking of neurons through microtubules. Yet all cells possess microtubules in their cytoskeletons, opening up to the concept of consciousness as awareness of our whole body, referred to as allostasis (McEwen, 1998). Empiric evidence for this comes from the observation that when patients recover from general anesthesia they undergo the phylogenetic steps of brain evolution from reptilian to mammalian (Mashour and Alkire, 2013). Conversely, when eukaryotic cells are experimentally exposed to microgravity they lose their capacity to signal with the environment (Purevdorj-Gage et al., 2006) or with one another (Torday, 2003). These observations point

to the fundamental nature of consciousness as the way in which organisms interrelate with the Cosmos, given that gravity was a product of the S/BB.

The advantage of this way of understanding consciousness is that it emanates from the S/BB, integrating the inanimate with the animate as a functional whole (Torday, 2018a). Instead of Anthropic Principle (Barrow and Tipler, 1988), thinking of Man as IN the Cosmos, we are OF the Cosmos, literally (Schrijver K, Schrijver, 2015).

The ultimate purpose for considering Evolution and Big History is ideally to raise our consciousness (Ornstein, 1972). In the past such philosophers as the pre-Socratic Greeks (Guthrie, 1977), de Chardins (de Chardins, 1976), Gurdgieff (Gurdjieff, 1973), Bucke (Bucke, 2009), and scientists such as Alfred North Whitehead (Whitehead, 2019), LL Whyte (Whyte, 1968) and E.O. Wilson (Wilson, 2014) have attempted to do just that, but without a core mechanism like the one being touted herein. Cosmic awareness is implicit in Big History, from the Big Bang forward; it is explicit in cellular-molecular evolution emanating from the Singularity (Torday, 2018a) in a step-wise fashion based on cell-cell communication as a continuum from the origin of life itself (Torday, 2018c).

In the Beginning

The earth formed about 5 billion years ago (Hawking, 2011). And because it had no atmosphere, snowball-like asteroids hit the surface and melted, forming the oceans. There were polycyclic hydrocarbons (like lipids) contained within the ice, which spontaneously formed micelles, or prototypical cells (Moroi, 1992). The lipid origin of life on earth makes both *a priori* sense because lipids exhibit hysteresis, or 'molecular memory' necessary for the process of evolution (Walz et al., 2010), and *a posteriori* because lipids can synthesize nucleotides, but nucleotides cannot synthesize lipids (Mansy and Szostak, 2009). The semipermeable-membraned micelles offered a protected space for the First Principles of Physiology-negentropy (Schrodinger, 2012), chemiosmosis (Mitchell, 1961) and homeostasis (Cannon, 1932).

Endosymbiosis Theory

Endosymbiosis Theory was first proposed by Ivan Wallin (Eliot, 1971), and was later popularized and expanded upon by Lynn Margulis Sagan (Sagan, 1967). They asserted that complex cells with nuclei, or eukaryotes, are the product of the symbiotic partnership between previously free-living bacteria and larger cells. It is now well accepted that cellular mitochondria that are crucial for cellular energy metabolism were formerly free-living bacteria that are now an inherent part of the eukaryotic cellular apparatus. The core concept is that eukaryotes have evolved by incorporating environmental factors over the course of their history. Seen in this context, Big History complements our understanding of physiologic evolution by offering the sequence of changes in the environment, both natural and man-made that have affected our evolution. And since evolution is the history of biology as serial pre-adaptations or exaptations (Gould and Vrba, 1982), it helps in a deeper understanding for the course of human evolution.

Cell-Cell Communication as the Basis for Physiologic Evolution

The gleaning of information from the environment wed to the process of cell-cell communication developmentally and homeostatically constitutes epigenetic inheritance (Torday and Rehan, 2017). This intimate relationship between the organism and its environment forms the basis for evolution; when there is a mismatch between them, it causes physiologic stress, or dyshomeostasis, specifically within the tissues and organs being affected, generating Radical Oxygen Species (ROS). ROS are known to cause site-specific gene mutations and duplications (Storr et al., 2013); the resolution of such conditions through adaptation is what is referred to as evolution. Short of remodeling any given physiologic trait, this mechanism ensures that injuries are repaired based on the same

homeostatic principles of cell-cell communication (Demayo et al., 2002).

Endosymbiosis, Natural Laws and Consciousness

Based on the Endosymbiosis Theory, the cell formulates its own internal 'laws' based on the homeostatic Laws of Nature, formulated by Claude Bernard as the *milieu interieur* (Bernard, 1974). In the aggregate, the individual cellular homeostases are referred to as allostasis (McEwen, 1998), monitored and controlled by the peripheral and central nervous systems. This organized physiologic process of self-awareness is what we refer to as consciousness.

The Cell as the First Niche Construction, Integrates Man and Environment

Niche Construction is the concept that organisms actively fashion their immediate environment in order to optimize their adaptation (Odling-Smee et al., 2013). Yet that is what Endosymbiosis Theory is, so by internalizing factors in the environment that posed a threat to their existence, beginning with the unicellular state (Sagan 1967), can be seen as internal Niche Construction (Torday, 2016a) , or what Bernard referred to as the *milieu interieur* (Bernard, 1974). The concept of the *milieu interieur* was later refined by Walter B. Cannon as physiology (Cannon, 1939). Ultimately, the internalization of physical factors functioning under the Laws of Nature conferred this property on organic life, forming the ties between the cell and the environment as a continuum from the unicell to Gaia (Torday, 2018a). Therefore, Big History could be thought of as the description of this process, whereas understanding the underlying mechanisms that causally link the organism to its environment adds manifold depth to the process (Torday and Rehan, 2016); Torday, 2016a). Furthermore, it offers the opportunity to understand interrelationships that transcend the mere existence of life in the Cosmos, reaching into the interstices to gain fundamental understanding of the process (Torday and Miller, 2018). Such analysis lends itself to finding common ground between eastern and western philosophy (Torday and Miller, 2016b), tearing down the silos of contemporary knowledge to maximize the accounting of Big History (Rodrigue et al., 2016).

Top-Down, Bottom-Up, Middle-Out

Biologic control is referred to as top-down, bottom-up or middle-out. Top-down control is in reference to emergence of physiologic properties (Noble, 2008). Bottom-up, on the other hand references the organization of physiologic traits from its component parts (Sagan, 1967). And middle-out is the result of cell-cell communication through growth factor-growth factor receptor signaling (Torday and Rehan, 2012).

Combined Epigenetic Inheritance and Phenotype as Agent Provides Biologic Scope to Big History

As mentioned above, epigenetic inheritance constitutes the collection of epigenetic marks over the course of the life cycle. The so-called marks are then integrated into the DNA of the germ cells (egg and sperm) as adducts (methylation, ubiquitination, myristylation, etc) that modify the nucleotide 'readout' in accord with environmental changes. The DNA adducts subsequently appear in specific tissues and organs, where they modify the structure and function of the organisms accordingly as epigenetic inheritance (Nilsson et al., 2018).

The centrality of the germ cells to epigenetic inheritance infers the primacy of these cells in the processes of adaptation (Torday and Rehan, 2017), rather than the phenotypes of the adults, as dictated by Darwinian evolution. In this vein, the phenotype can be seen as an active 'agent' for the acquisition of epigenetic marks (Torday and Miller, 2016c). Seen in this light, the individual takes on an active role in Big History based on the biologic imperative of acting as a vehicle for epigenetic inheritance.

Anthropic Principle vs Being Of the Cosmos

The anthropic principle was mentioned in the

Introduction. It is the concept that we fortuitously ended up in this particular place in the Cosmos (Barrow and Tipler, 1988). In contrast to that, evolution has facilitated our adaptation to our environment largely by endogenizing it, making what otherwise would have destroyed us billions of years ago — gravity, oxygen, heavy metals, ions — useful as what we now recognize as our physiology (Torday and Rehan, 2017). For example, by regressing the genes that facilitated lung evolution against major epochs in the geochemistry of the earth (Torday and Rehan, 2011) one can see the causal relationships involved. Conversely, as Jean Guex has shown in ammonites, environmental stress can disrupt and reverse the evolutionary process (Guex, 2016).

Evolution, the Mechanism of Big History

The significance of merging Big History with evolutionary biology is that both acknowledge their origins in the S/BB. In the case of Big History, this perspective confers a deep understanding of who and what we are conceptually. On the other hand, understanding that we have evolved biologically as an 'ambiguity' (Torday and Miller, 2017), our function being to resolve the residual dualities of the S/BB (Torday, 2018a). Seen in this light, evolution offers the organic, epistemologic context for Big History.

Conclusions

As is the case for history, evolution 'rhymes' (Pratt 1974) because it is founded on serial pre-adaptations, or exaptations (Gould and Vrba, 1982). When confronted with an existential problem, the organism re-appropriates genetic motifs that were effective at some earlier stage in its evolution, ultimately referencing the First Principles of Physiology — negentropy (Schrodinger, 2012), chemiosmosis (Mitchell, 1962) and homeostasis (Cannon, 1939). Those principles, in turn, reference the S/BB as their origin (Torday, 2018a). So like Big History, biology is also the product of the Singularity/Bing Bang. By recognizing the homologies between the two processes we can better understand the human condition from its source rather than reasoning after the fact.

There are certain principles such as those of the Old and New Testaments, the Golden Rule, the U.S. Constitution, The Scientific Method, the Periodic Table, the Laws of Nature that have served us well. We have inherited certain Laws of Nature biologically that have served us well throughout our evolutionary history. If we were to understand the absolute interrelationships between such principles we would optimize Big History.

The ancient Greek philosopher Protagoras thought that 'Man is the Measure of all things' (Guthrie, 1977); he was right in spirit, but he needed to know what the 'units' of measurement were to support his idea scientifically. For the scientist, it is the cell (Torday, 2015). For the humanist, the cell is the 'syntax' of Big History. The cell as the mechanistic basis for both Evolution and Big History offers a novel synthesis for Humanism and Science, bringing resolution to C.P. Snow's "Two Cultures" (Snow, 1959).

In his Big History, David Christian references the 'Goldilocks' effect explanation for our fortuitous existence (Christian, 2018). What he describes is the mechanism of homeostasis, without which neither the inanimate nor the animate can exist. Morowitz (2004) describes how the electron and proton balance one another energetically within a hydrogen atom. And in the cellular-molecular approach to evolutionary biology, homeostasis is one of the three Principles of Physiology, controlling the interrelationship between negative entropy and chemiosmosis. The Pauli Exclusion Principle and The First Principles of Physiology are both deterministic and probabilistic, offering the opportunity for stability and plasticity (Torday, 2018b).

The S/BB and The First Principles of Physiology

both emanate from the same point source (Torday and Miller, 2016a). The mechanism of biologic evolution is better understood than that of the S/BB, so the homology between the two offers the opportunity to consider the fundamental nature of the S/BB. It has been proposed that the unicell is the primary level of being (Torday, 2018b), and that complexity is an epiphenomenon due to the misunderstanding of what evolution actually constitutes (Torday, 2016b). Big History similarly opens up to the consideration that the present is the functional moment of reality, enabled by our consciousness of the past, present, and future as one, simultaneously (Torday, 2016b). It is what Maslow refers to as a 'peak experience' (Maslow, 1968). This state of being is achieved through the total integration of physiology by such neuroendocrine hormones as endorphins and oxytocin (Fink et al., 2011).

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Evolução, o 'mecanismo' da Big History: a grande síntese

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Resumo
A Big History traça um arco cosmológico desde a Singularidade/Big Bang ao presente. Similarmente, a biologia evolucionária, em sua condição de "toda a biologia", representa o arco da vida desde suas origens. Existe uma consiliência mecanística entre a mecânica quântica, os Princípios Fundamentais da Fisiologia e a biologia evolucionária, continuadamente centrada em nível unicelular. As adaptações fenotípicas em relação a mudanças geofísicas e geoquímicas que culminam na cultura são forjadas ao nível da recapitulação unicelular zigótica. Essa perspectiva oferece uma síntese tanto para o animado quanto para o inanimado, na forma da Big History. A célula como a base mecanística tanto para a evolução quanto para a Big History oferece uma nova síntese entre Humanismo e Ciência.

Palavras-chave
Cosmologia, Singularidade/Big Bang, biologia evolucionária, mecânica quântica, comunicação intercelular.

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Introdução

Uma vez que a evolução é a "história" do Homem (Darwin, 1871), ela deveria estar funcionalmente integrada com a Big History (Christian, 2018). Ainda, a evolução convencional darwiniana não é mecanística (Torday; Rehan, 2012), compreendendo as relações causais que subjazem ao processo. Ao unirmos a Big History com uma biologia evolucionária mecanística "não mecânica" (Nicholson, 2012), o objetivo último da Big History (Spier, 2010) seria concretizado.

O ambiente moldou a vida na Terra desde seu início. A formação espontânea de micelas, ou protocélulas, nos oceanos primordiais pôs o processo em movimento (Deamer, 2017). Subsequentemente, a produção de dióxido de carbono por plantas se acumulou na atmosfera, causando efeito-estufa que secou parcialmente os oceanos (Romer, 1949), forçando determinados peixes ósseos a avançar em direção à terra firme (Daeschler et al., 2006). Em adaptação ao ambiente terrestre, ocorreram, por meio de autoengenharia, duplicações de genes específicos durante a transição do ambiente aquático para o terrestre (Torday; Rehan, 2017), todas elas decisivas para a sobrevivência (Torday, 2005).

Mais tarde, durante o éon Fanerozoico (Berner, 1999), que compreende as eras Paleozoica, Mesozoica e Cenozoica, tensões atmosféricas do oxigênio variaram entre 15% e 35%. Os aumentos na presença de oxigênio causaram gigantismo (Berner et al., 2000), enquanto as reduções causaram estresse fisiológico decorrente de hipóxia. Supõe-se que o estresse hipóxico tenha dado origem à endotermia / homeotermia ao estimular a produção de catecolamina pelo eixo hipotalâmico-pituitário-adrenal (Torday, 2015). A endotermia / homeotermia, por sua vez, deu origem ao bipedismo, liberando os membros superiores para o exercício de funções especializadas (o voo nos pássaros, a fabricação de ferramentas entre humanos), e a maior grau de consciên-

cia (Torday, 2015). Esta última é crítica para o conceito de Big History porque sem um sentido de *self* (Miller et al., 2018) a Big History seria imaterial.

Desse modo, a integração saltacionista entre a evolução e a mudança ambiental emaranha a biologia com a Big History em termos causais. Essa percepção oferece a oportunidade de perscrutar mais profundamente essa relação do que seria possível através de um estudo superficial desses processos na forma de associações e correlações, permitindo assim insights mais relevantes no campo da Big History.

O papel da evolução na Big History

A vida na terra foi forjada por meio de interações adaptativas entre o animado e o inanimado através da biologia evolucionária (Gould, 2002). A percepção das influências do ambiente sobre a vida começa com o animismo (Bird-David, 1999) e a astrologia (Kassell, 2010), essa última culminando no heliocentrismo, que serviu como catalisador para a Era das Luzes (Debus, 1987). Subsequentemente, insights como o desvio para o vermelho (*redshift*) e a teoria do Big Bang (Hawking, 2011) adicionaram profundidade ao nosso entendimento de nossas origens físicas (Torday; Millar, 2016a).

Darwin sugeriu uma relação entre o ambiente e o processo de especiação em *A Origem das Espécies*, comentando a respeito da topografia da Patagônia em grande detalhe, mas nunca levou a ideia mais adiante na sua teoria da evolução (Darwin, 1859). Por outro lado, Lamarck formalmente reconheceu o papel direto do ambiente na evolução (Gould, 2002), mas não dispunha do conhecimento científico necessário para demonstrar esse princípio. Foi apenas recentemente que a herança epigenética voltou à moda (Nilsson et al., 2018). Ela oferece a oportunidade para reconhecermos a inter-relação entre Big History e a biologia evolucionária.

A Big History traça seu arco desde o Big Bang até o presente, num contínuo. A lógica em favor da Big History está presente em Rodrigue et al., "Our place in History" (2016). O livro é uma introdução à ideia de que a "estória de tudo" pode ser contada, mas para que ela seja compreensível, o físico e o biológico precisam ser unidos na condição de elementos funcionais de uma totalidade (Torday, 2018a); na escala mais ampla possível, Lovelock (2003) e Smolin (1999) estabeleceram a natureza orgânica da Terra e do Cosmos, respectivamente; na menor escala possível, uma vez que a evolução compreende toda a biologia (Dobzhansky, 1973), ao reduzir o físico à teoria atômica (Pullman, 1998), e o biológico à comunicação intercelular (Torday; Rehan, 2012), encontra-se a consiliência mecanística entre a mecânica quântica, os Princípios Fundamentais da Fisiologia e a biologia evolucionária em nível unicelular (Torday, 2018a). A junção entre física e biologia no interior da célula oferece a oportunidade de considerarmos a congruência entre o inanimado e o animado, remetendo a uma trajetória que começa na Singularidade / Big Bang (S/BB) (Hawking, 2011) baseada em evidência empírica pela primeira vez (Zhang et al., 2017). A integração vertical entre esses princípios tem sido explorada para explicar o mecanismo da evolução fisiológica (Torday; Rehan, 2017), abrindo espaço a uma lógica que permite incorporar a última ao conceito de Big History.

Big History e a consciência

Não haveria história da biologia se não fossemos conscientes de nossa própria existência. Mas o que é consciência? Tem sido debatido há muito se a consciência se trata de algo que está "plenamente em nossas cabeças" (Kraut, 2013) ou se ela se trata do "teatro da mente" (Olcese et al., 2018). Mais recentemente, foi conjecturado que a consciência é a essência de nossa fisiologia, que é formada e composta por mecanismos de sinalização intercelulares (Torday, 2018a). Hameroff e Penrose (2014) oferecem uma explicação fisiológica elegante para a consciência na forma de um relacionamento de neurônios através de microtúbulos. No entanto, todas as células possuem microtúbulos em seus citoesqueletos, abrindo a possibilidade do conceito de consciência como a percepção do corpo inteiro, referida como alostase (McEwen, 1998). Evidência empírica para isso advém da observação de que quando pacientes se recuperam de anestesia geral, passam por etapas filogenéticas da evolução cerebral, do reptiliano ao mamífero (Mashour; Alkire, 2013). Por outro lado, quando células eucariotas são experimentalmente expostas à microgravidade, perdem sua capacidade de trocar sinais com o ambiente (Purevdorj-Gage et al., 2006) ou umas com as outras (Torday, 2003). Essas observações apontam para a natureza fundamental da consciência como a maneira pela qual organismos se

inter-relacionam com o Cosmos, dado que a gravidade foi um produto da Singularidade/Big Bang (S/BB).

A vantagem desse modo de entendimento da consciência reside no fato de que emana da S/BB, integrando o inanimado com o animado num todo funcional (Torday, 2018a). Ao invés do Princípio Antrópico (Barrow; Tipler, 1988), que pensa o humano *no* Cosmos, nós somos *do* Cosmos, literalmente (Schrijver; Schrijver, 2015). O propósito último para considerarmos a evolução e a Big History é, idealmente, elevarmos nossa consciência (Ornstein, 1972). No passado filósofos como os gregos pré-socráticos (Guthrie, 1977), de Chardin (1976), Gurdgieff (1973), Bucke (2009), e cientistas como Alfred North Whitehead (2019), L.L. Whyte (1968) e E.O. Wilson (2014) tentaram fazer justamente isso, mas sem um mecanismo central como o invocado aqui. Consciência cósmica está implícita na Big History, do Big Bang em diante; ela é explícita na evolução celular-molecular emanando da Singularidade (Torday, 2018a) de uma maneira gradual baseada na comunicação intercelular como um contínuo desde a origem da vida (Torday, 2018c).

No começo

A Terra formou-se a cerca de cinco bilhões de anos atrás (Hawking, 2011). E pelo fato de não dispor de uma atmosfera, asteroides congelados atingiam a superfície e derretiam, formando os oceanos. Neles existiam hidrocarbonetos policíclicos (como lipídeos) contidos no gelo, que espontaneamente formaram micelas, ou células prototípicas (Moroi, 1992). A origem lipídica da vida na Terra faz tanto sentido, a priori, porque lipídeos exibem histerese, ou "memória molecular" necessária para o processo de evolução (Waltz et al., 2010), e a posteriori, porque lipídeos podem sintetizar nucleotídeos, mas nucleotídeos não podem sintetizar lipídeos (Mansy; Szostak, 2009). As micelas com membranas semipermeáveis ofereceram um espaço protegido para os Princípios Fundamentais da Fisiologia – negentropia (Schrodinger, 2012), quimiosmose (Mitchell, 1961) e homeostase (Cannon, 1932).

Teoria da endobiose

A teoria da endobiose foi proposta inicialmente por Ivan Wallin (Eliot, 1971), e foi posteriormente popularizada e expandida por Lynn Margulis Sagan (Sagan, 1967). Afirmaram que células complexas com núcleos, ou eucariontes, são o produto da parceria simbiótica entre bactérias previamente independentes e células maiores. Agora é bem aceita a ideia de que mitocôndrias, que são cruciais para o metabolismo energético celular, foram anteriormente bactérias independentes que se tornaram parte inerente do aparato celular eucariota. A noção central é a de que eucariontes evoluíram através da incorporação de fatores ambientais ao longo de sua história. Visto nesse contexto, a Big History complementa nosso entendimento da evolução fisiológica ao oferecer a sequência de mudanças ocorridas no ambiente, tanto natural quanto antrópico, que afetaram a nossa evolução. E uma vez que a evolução é a história da biologia na forma de pré-adaptações seriais ou exaptações (Gould; Vrba, 1982), tal permite um entendimento mais profundo para o percurso da evolução humana.

Comunicação intercelular como a base para a evolução fisiológica

A coleta de informações do ambiente, casada ao processo de comunicação intercelular constituem, desenvolvimental e homeostaticamente, uma herança epigenética (Torday; Rehan, 2017). Essa relação íntima entre o organismo e seu ambiente forma a base para a evolução; quando há incompatibilidade entre eles, surge estresse fisiológico, ou disomeostase, especificamente em tecidos e órgãos afetados, produzindo espécies radicais de oxigênio (ERO). ERO são conhecidas por causar mutações locus-específicas e duplicações (Storr et al., 2013); a resolução de tais condições por meio da adaptação é aquilo a que nos referimos como evolução. Em vez de remodelar um dado traço fisiológico, esse mecanismo garante que danos sejam reparados com base nos mesmos princípios homeostáticos da comunicação intercelular (Demayo et al., 2002).

Endobiose, leis naturais e consciência

Com base na teoria da endobiose, a célula formula suas próprias "leis" internas baseadas nas Leis da Natureza homeostáticas, apresentadas por Claude Bernard como o *milieu intérieur* (Bernard, 1974). No agregado, homeostases celulares individuais são chamadas de alostases (McEwen, 1998), monitoradas e controladas pelo sistema nervoso periférico e central. Esse processo fisiológico organizado

de autopercepção é aquilo a que nos referimos como consciência.

A célula como a primeira construção de nicho, integra o humano e o ambiente

Construção de nicho é a noção de que organismos alteram ativamente seu ambiente imediato de modo a otimizar sua adaptação (Odling-Smee et al., 2013). E é isso o que a teoria da endobiose é, de modo que internalizar fatores no ambiente que colocam risco à sua existência, começando pelo estado unicelular (Sagan, 1967), pode ser visto como uma construção de nicho interna (Torday, 2016a), ou o que Bernard se referiu como *milieu intérieur* (Bernard, 1974). O conceito de *milieu intérieur* foi posteriormente refinado por Walter B. Cannon como fisiologia (Canon, 1939). Finalmente, a internalização de fatores físicos funcionando sob as Leis da Natureza conferiram essa propriedade à vida orgânica, formando os laços entre a célula e o ambiente como um contínuo, do organismo unicelular a Gaia (Torday, 2018a). Assim sendo, a Big History poderia ser pensada como a descrição desse processo, tendo em vista que a compreensão dos mecanismos que vinculam causalmente o organismo ao seu ambiente vem a agregar profundidade ao processo (Torday; Rehan, 2016); Torday, 2016a). Além do mais, oferece a oportunidade de entender a inter-relação que transcende a mera existência da vida no Cosmos, alcançando os interstícios para ganhar compreensão fundamental dos processos (Torday; Miller, 2018). Tal análise se presta a encontrar um campo comum entre a filosofia oriental e ocidental (Torday and Miller, 2016b), rompendo os silos do conhecimento contemporâneo para maximizar os retornos da Big History

De cima para baixo, de baixo para cima, do meio para fora

Refere-se ao controle biológico como de cima para baixo, de baixo para cima, ou do meio para fora. Controle de cima para baixo se dá em referência à emergência de propriedades fisiológicas (Noble, 2008). De baixo para cima, por outro lado, faz referência à organização de traços fisiológicos a partir de suas partes componentes (Sagan, 1967). E do meio para fora é resultado da comunicação intercelular através de sinalização do receptor do fator de crescimento (Torday, Rehan, 2012).

Herança epigenética combinada e fenótipo como agentes proveem escopo biológico à Big History

Como mencionado acima, a herança epigenética constitui a coleção de marcadores epigenéticos ao longo de um ciclo de vida. Essas chamadas marcas são então integradas ao ADN das células germinativas na forma de adutos (metilação, ubiquitinação, miristoilação, etc.) que modificam a "leitura" do nucleotídeo de acordo com mudanças ambientais. Os adutos no ADN aparecem subsequentemente em tecidos específicos e órgãos, onde modificam a estrutura e função dos organismos na forma de herança epigenética (Nilsson et al., 2018).

A centralidade das células germinativas para a herança epigenética demonstra a primazia dessas células nos processos de adaptação (Torday; Rehan, 2017), em vez de os fenótipos dos adultos, como estabelecido pela evolução darwiniana. Nesse caminho, o fenótipo pode ser visto como um 'agente' ativo para a aquisição de marcadores epigenéticos (Today; Miller, 2016c). Sob essa luz, o individuo assume um papel ativo na Big History baseado no imperativo biológico de agir como veículo para uma herança epigenética.

O princípio antrópico *vs.* o provir do Cosmos

O princípio antrópico foi mencionado na Introdução. É a noção de que fortuitamente terminamos nessa posição particular no Cosmos (Barrow; Tipler, 1998). Em contraste com isso, a evolução facilitou nossa adaptação ao nosso ambiente amplamente endogenizando-o, tornando úteis coisas que de outro modo poderiam ter nos destruído bilhões de anos atrás – gravidade, oxigênio, metais pesados, íons, na forma daquilo que conhecemos hoje como nossa fisiologia (Torday; Rehan, 2017). Por exemplo, regredindo os genes que facilitaram a evolução dos pulmões contra épocas principais na geoquímica da Terra (Torday, Rehan, 2011) pode se identificar as relações causais envolvidas. Tal como Jean Guex mostrou a respeito dos amonóides, o estresse ambiental pode romper e reverter o processo evolucionário (Guex, 2016).

Evolução, o mecanismo da Big History

A significância de unir a Big History à biologia evolucionária está em que ambas reconhecem suas origens na Sin-

gularidade/Big Bang. No caso da Big History, essa perspectiva oferece um entendimento profundo de quem e o que estamos conceituando. Por outro lado, entendendo que evoluímos biologicamente como uma "ambiguidade" (Torday; Miller, 2017), nossa função é resolver as dualidades residuais da Singularidade/Big Bang (Torday, 2018a). Sob essa luz, a evolução oferece o contexto orgânico e epistemológico para a Big History.

Conclusões

Como é o caso da história, a evolução "rima" (Pratt, 1974) porque é fundada em pré-adaptações seriais, ou exaptações (Gould; Vrba, 1982). Quando confrontada com um problema existencial, o organismo se reapropria de motivos genéticos que estiveram efetivos em algum ponto anterior de sua evolução, referenciando em última instância aos Princípios Fundamentais da Fisiologia – negentropia (Schrodinger, 2012), quimiosmose (Mitchell, 1962) e homeostase (Cannon, 1939). Esses princípios, por sua vez, remetem à Singularidade/Big Bang como sua origem (Torday, 2018a). Como a Big History, a biologia é também o produto da Singularidade/Big Bang. Ao reconhecer as homologias entre os dois processos podemos melhor entender a condição humana a partir de sua origem, ao invés ponderarmos sobre ela a partir de seus desenvolvimentos posteriores.

Há certos princípios como os presentes no Velho e no Novo Testamentos, na Regra Áurea, na Constituição dos Estados Unidos da América, no Método Científico, na Tabela Periódica, nas Leis da Natureza, que têm nos servido bem. Herdamos certas Leis da Natureza biologicamente que têm nos servido bem ao longo de nossa história evolucionária. Se entendêssemos as absolutas inter-relações entre esses princípios iríamos otimizar a Big History.

O filósofo da Grécia Antiga, Protágoras, pensou que o "Homem é a medida de todas as coisas" (Guthrie, 1977); ele estava certo em espírito, mas nós precisamos saber o que eram as "unidades" de medida para dar suporte a essa ideia cientificamente. Para o cientista, ela é a célula (Torday, 2015). Para o humanista, a célula é a "sintaxe" da Big History. A célula como a base mecanística tanto para a evolução quanto para a Big History oferece uma nova síntese entre Humanismo e Ciência, trazendo uma resolução para o problema das "duas culturas" de C. P. Snow (1959).

Em sua Big History, David Christian se refere a uma explicação com base no efeito Cachinhos-de-Ouro (*Goldilocks effect*) para nossa fortuita existência (Christian, 2018). O que ele descreve é um mecanismo de homeostase, sem o qual nem o inanimado nem o animado podem existir. Morowitz (2004) descreve como elétrons e prótons se equilibram energeticamente num átomo de hidrogênio. E na abordagem celular-molecular à biologia evolucionária, a homeostase e um dos três Princípios Fundamentais da Fisiologia, controlando a inter-relação entre a entropia negativa e a quimiosmose. O Princípio de Exclusão de Pauli e os Princípios Fundamentais da Fisiologia são ambos determinísticos e probabilísticos, oferecendo a oportunidade para estabilidade e plasticidade (Torday, 2018b).

A Singularidade/Big Bang e os Princípios Fundamentais da Fisiologia ambos emanam do mesmo ponto de origem (Torday; Miller, 2016a). O mecanismo da evolução biológica é mais bem compreendido do que aquele da Singularidade/Big Bang, de modo que a homologia entre os dois oferece a oportunidade de considerarmos a natureza fundamental da S/BB. Foi proposto que o nível unicelular é o nível primário do ser (Torday, 2018b), e que a complexidade é um epifenômeno dada a má compreensão daquilo em que a evolução efetivamente se constitui (Torday, 2015b). A Big History da mesma forma se abre à consideração de que o presente é o momento funcional da realidade, facultado pela nossa consciência do passado, presente e futuro como algo uno, simultaneamente (Torday, 2016b). É a isso que Maslow se refere como "máxima experiência" (Maslow, 1968). Esse estado de existência é alcançado por meio da total integração da fisiologia através de hormônios neuroendócrinos como endorfinas e oxitocinas (Fink et al., 2011).

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Latinus Scientificus: The History and Culture of Scientific Latin

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Abstract
English is the first language of 330 to 360 million people but three times this number speak it as a second language. With an estimated 1.5 billion speakers, it is the most widely spoken language on the planet, though not universal; many regions are bereft of English speakers. A language with few contemporary speakers but widespread use is *Latinus Scientificus* (Scientific Latin)—a modernized version of the classical Latin of Caesar, Cicero, Horace, Livy, Ovid, and Virgil two thousand years ago. Kept alive by the Roman Church, Latin evolved into the Romance languages (French, Italian, Portuguese, Romanian, and Spanish) and influenced virtually every other European language, including several stages of influence on English. Meanwhile classical Latin continued as the language of learning at the hands of theologians, humanists, and philosophers until the eighteenth century. Then, at the hands of Carl Linnaeus, Latin terminology was systematically developed for botanical description, then adapted for zoology, chemistry, anthropology, and medicine. While spoken and written Latin is now confined to the inner circle of the Roman Church and its official documents, scientific Latin has become the universal language of precise scientific taxonomy and description. The Latinization of personal names and places within scientific Latin reveals it as a still developing language. The influence of Latin as the language of learning and science has led to a more general influence in literature and general culture.

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In the year CE 393, more than eleven centuries of Olympic Games dating at least to 776 BCE in Greece came to an end. A generation later, in CE 410, Rome was overrun by the Visigoths. The last Roman emperor, Flavius Romulus Augustus (whose name ironically includes both the legendary founder of Rome and its first and most renowned emperor) was deposed in the year 476 after just ten months, effectively bringing to an end a civilization alleged to have begun more than twelve centuries earlier. Given this apparent end to the Roman Empire, I am somewhat astonished to recall that 1483 years after the fall of Rome, in the year 1959, I graduated from high school with four years of Latin. Our grammar text was *Living Latin* (1956), a joke among fifteen-year-olds: we routinely referred to our classes in "dead" Latin. My Greek text, White's *First Greek Book* (1937), escaped such derision.

In those days, the rumor circulated that anyone headed for medical school needed high school Latin because doctors use it to write prescriptions. I wasn't headed for medical school; I ended up in literature and language studies where knowledge of Latin and Greek roots and suffixes has been of continuing use in figuring out the underlying meanings of English words. My University of Toronto bachelor's diploma is printed in Latin; a few years later, my master's and doctoral diplomas were in English—a sign perhaps of the declining status of classical studies. Yet every so often we are reminded that Latin still has currency. In *T-Rex and the Crater of Doom* (1997), geologist Walter Alvarez titled his second chapter *Ex Libro Lapidum Historia Mundi* without, we might add, feeling it necessary to provide a translation: Out of Rocks, the History of the World. Later (2015) he used the same Latin as the title of an article with a loose rendering

in his subtitle, "Reading History Written in Rocks," an aptitude that underlies virtually everything Alvarez has written. For readers unfamiliar with Latin, T-Rex is an abbreviation for *Tyrannosaurus rex*, The Tyrant King of Lizards, a name that provides an introduction to this paper.

Though the spoken language gradually disappeared, morphing into descendant languages across southern Europe, the Latin language is still with us. Beginning somewhere in the misty history of Rome—traditionally founded in the eighth century BCE—Latin evolved a vocabulary, power, and artistry that resulted in a remarkable historical, philosophical, and literary tradition. It could have died with the Roman Empire but instead it lived on and thrived, adapting to new uses, and was eventually transformed into *Latinus Scientificus,* Scientific Latin. This paper traces this evolution which is woven through the history of Western civilization, the rise of science, and modern culture. It is an evolution understood in bits and pieces, primarily by linguists, but it has a place in the history of thought, western culture, and big history.

Taxonomic Latin was pioneered and developed by Carl Linnaeus (1707-1778). Today, a modernized and much expanded Latin is now the global language of science—specifically the source of terminology in biology, including both botany and zoology. Using Linnaean binomial nomenclature, 1.2 million terrestrial, ocean plant, and animal species have been named out of an estimated 8.7 million, meaning that an estimated 86% of species on Earth and 91% in the ocean have yet to be named (Mora 2011). Approximations of time and cost to complete this work run into hundreds of years and billions of dollars. Collectively, completing this scientific inventory may be the most extensive project in any language, with no end in sight if the aim is to name and classify all living things: the estimate for microbial species ranges from 100 billion to one trillion.

The use of Latin and Greek dominates the formulation of scientific terminology; there really are no other sources for scientific descriptors. But the creation of scientific words is not simply a matter of random borrowing; it has developed into a systematic linguistic process.

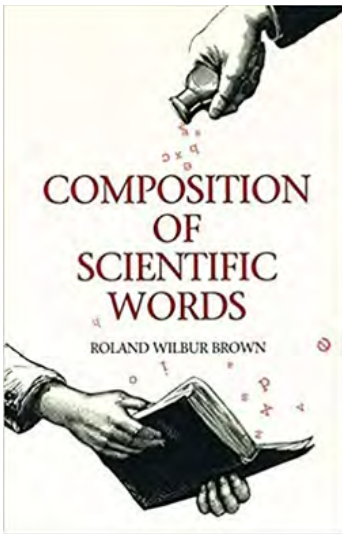


Illustration 1. Roland Wilbur Brown's book, *Composition of Scientific Words*, at 882 pages, provides some indication of the process of science word creation and the extent of scientific terminology developed from Latin and Greek.

The story of how Latin survived the demise of the Roman Empire to become the medium for this vast enterprise constitutes a cultural history of great interest that includes its extension into other sciences: anthropology, chemistry, geology, and medicine. Latin, along with an infusion of borrowed Greek, was an evolving language throughout the Roman era (753 BCE-CE 476), but the classical Latin that later scholars admired and emulated dates from its central period, 100 BCE to CE 50. During the European Renaissance, scholars idealized classical Latin and writings of this era. Julius Caesar's *De Bello Gallicus* (On the War in Gaul) is simple and strikingly clear; one thinks of Hemingway in English. Cicero's *De Natura Deorum* (On the Nature of the Gods) and Livy's multi-volume *History of Rome* provide the benchmarks for classical prose. In poetry, Horace's *Odes*, Virgil's *Aeneid*, Ovid's *Metamorphoses*, and Lucretius' *On the Nature of Things* define the artistic power of the Roman language. During the later imperial era, Latin declined somewhat in expression and power, and is known as *Latinus vulgare* (Common Latin). It is best understood as the spoken language of Roman soldiers, settlers, and conquered

people, particularly in Southern and Western Europe. Isolated from stabilizing written forms and influenced by earlier indigenous tongues, Common Latin quickly developed into separate languages known today as the Romance languages: French, Italian, Portuguese, Romanian, and Spanish—this last having the second largest number of speakers in the world today after English. Characteristics unique to Classical Latin—noun declensions, verb conjugations, verbs at the end of sentences with inflection the key to meaning—have largely disappeared in these descendants. Word order of noun-verb-object with extended use of prepositions has become a major key to meaning.

Apart from these descendants, the influence of *Latinus vulgare* is evident in loanwords in almost every other European language: Albanian, Czech, Danish, Norwegian, Polish, Russian, Slovakian, Swedish, and Ukranian. This influence of common Latin vocabulary, if not its artistry, traces to its adoption as the sacred language by the Roman Church. The conversion of the Emperor Constantine in CE 312 effectively defined Christianity as the official religion of the Roman Empire a century and a half before its fall, adding authority to all Christian writings across Europe. The earliest New Testament gospels were composed in *Vetis Latina* (Old Latin), but in 382 Pope Damasus commissioned Jerome to do a complete translation into Latin which is now known as the *Versio Vulgata*, the "version commonly used," abbreviated to The Vulgate, which was so widely recognized that it was eventually confirmed as the official Bible of the Roman Church at the Council of Trent (CE 1545-1563). Through the first fifteen centuries of the Common Era, continuation of Latin in the Romance languages and its use by the Church made Latin the most influential language in Europe.

Latin itself is a descendant of earlier tongues broadly grouped as "Italic," most of which, like Etruscan, are long extinct. Tracing language to ultimate origins may be impossible because spoken words are ephemeral: they disappear into thin air, and written language extends no more than 5000 years into the past. It has been a feat of ingenuity that we have reconstructed the parent of the Italic languages, and indeed of a dozen other branches, to a hypothetical Indo-European (IO) parent estimated to have been spoken between 6000 and 8000 years ago somewhere in the region of the Black Sea.

Original Indo-European roots can be reconstructed from the vocabularies of living Indo-European languages and known sound changes to produce a tentative Indo-European vocabulary.

This does not mean that we instantly recognize every descendant of Indo-European; a first glance at the Germanic tongues does not suggest an affinity with Latin. With several millennia of isolated evolution, the Germanic and Italic branches had become mutually unintelligible by the early cenrturies of the Common Era, at which point we can identify a Latin word that has crept into German as a foreign presence. This is where Latin first begins its influence on English.

It began during the Imperial Era following the deification of Augustus (27 BCE) with Latin vocabulary seeping into West Germanic on the Continent, then carried into Britain by the Angles, Saxons, and Jutes. Approximately 175 Latin words borrowed from Latin into West Germanic survived loss on the Continent and obsolescence or extinction in England to become embedded in Old English (Serjeantson, 1935, 271-277). A second influence occurred following the recall of the Roman military from England (CE 410). Between then and the Norman Conquest (CE 1066): another 500 Latin loanwords recognizable today found their way into Old English (Serjeantson, 277-288). A substantial cluster of religious words in English originated with the transfer of Christianity directly to Britain: Latin *apostolus*, *credo*, *crucem*, *discipulus*, and *martyr* survive as apostle, creed, crucifix, disciple, and martyr.

Following what purist linguists Thomas Algeo and John Pyles (2005, 124) called "the great catastrophe of the Norman Conquest," a third wave of Latin influence occurred through Norman French, the language of a newly installed monarchy and aristocracy imposed

on the laboring classes of Feudal Britain. From the 11th to 14th centuries, thousands of Latin-through-Norman French words were added to English, notably in subjects like religion, law, and privileged living. Science was virtually undeveloped during the Middle Ages; thus scientific words from Latin (sometimes with earlier origins in Greek) in English were confined to simple astronomical and geographical terms (comet, equator, circumference), names of plants (asparagus, delphiniums, juniper, lilies, roses, violets), animals (asp, locust), and minerals (copper, onyx). A fourth influence occurred during the 15th and 16th-century when a revived interest in classical culture and learning led to numerous additions of words formed from Latin roots. Typically these additions were of a general nature: area, innuendo, census, curriculum, impetus, radius (Serjeantson, 264-265).

Sometime during the late Old English period, vowel sounds began to soften, hastened later by the influence of Norman French. The velar stop inherited from the Germanic parent language abated, softening the pronunciation of many consonants. These changes, along with the infusion of Latin vocabulary, moved English from a Germanic tongue to a mid-position between the Germanic and Italic branches of the original Indo-European parent language. James Lovelock (1988, 17) has remarked that "the tribal war between the Normans and the Saxons was long enduring: the medieval schoolman, knowing where power and preference lay, chose to support the Victorious Norman establishment and to keep Latin as their language." Latin for the schoolmen, the Norman descendant of Latin for the people: this made English even more open than most other European languages to Latin influences with massive additions of Latin-origin roots through the era of Renaissance humanism and the rise of science. Melvyn Bragg (2003, 109-120) characterized this period as "a Renaissance of words." Many Latin additions to English were unchanged in spelling; the fact that many of these (bacteria, corona, fungus, opus, strata, and virus) are now regarded as our own reveals how compatible English had become for Latin additions.

The influence of Latin on other European languages is evident though not so pervasive. As noted, its medium was primarily religious works. Throughout the period of Roman Church dominance, Latin was the language of creeds, theology, and such landmark religious works as Augustine's *Civitas Dei* (City of God), Boethius' *Consolatio Philosophia* (Consolation of Philosophy), and Thomas Aquinas' *Summa Theologica* (Complete Theology), and it continued beyond the fold of the Roman Church in John Calvin's *Institutio Christianae Religionis* (Institutes of Christian Religion) as the Protestant Reformation redefined the foundations of Christian authority.

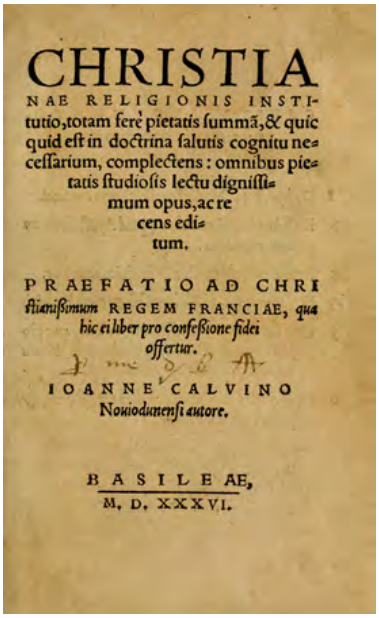

CHRISTIA
NAE RELIGIONIS INSTI-
tutio, totam fere pietatis summã, & quic
quid est in doctrina salutis cognitu ne-
cessarium, complectens: omnibus pie-
tatis studiosis lectu dignissi-
mum opus, ac re
cens edi-
tum.
PRAEFATIO AD CHRI
stianissimum REGEM FRANCIAE, qua
hic ei liber pro confessione fidei
offertur.
IOANNE CALVINO
Noviodunensi autore.
BASILEAE,
M. D. XXXVI.

Illustration 2. John Calvin's *Christianae Religionis Institutio* (1536), translated into English as Institutes of the Christian Religion (1559), became the defining source of Protestant religion, including the Puritan migrants to the American colonies. The dividing of title words, Christia/nae and Insti/tutio may indicate limitations in available typeface sizes.

The influence of Latin during the Medieval period can hardly be overstated, as massive documentation in Ernst Robert Curtius' *European Literature and the Latin Middle Ages* (1948) makes clear.

During the Renaissance, Latin influence grew to become the medium for a variety of secular works. In 1509, Disiderius Erasmus (1466-1536) published his satirical *Stultitiae Laus or Moriae Encomium* (In Praise of Folly). In 1516, Thomas More published his political satire, *Utopia* (No place); though his title is drawn

from Greek, the work was written in Latin. One of the earliest novels written in Latin, Johannes Kepler's 1608 *Somnium* (The Dream), has been recognized as early science fiction. In the 16th and 17th centuries, the earliest works in science were published in Latin. On his deathbed in 1543, the Polish Copernicus released his *De Revolutionibus Orbium Cœlestium* (On the Revolution of Heavenly Orbs) which set forth his heliocentric theory of the solar system. In 1610, The Italian Galileo reintroduced the theory in *Siderius Nuncius* (The Sidereal Messenger). In 1620 the British essayist and philosopher Francis Bacon set out the principles of observation and deduction in *Novum Organum Scientiarum* (New Instrument of Science). The Danish physician Nicholas Steno, who relocated in Italy, confronted the mystery of animal fossils enclosed in rock in *De Solido intra Solidum* (On a Solid inside a Solid); in 1641 the philosopher Descartes completed *Meditationes de Prima Philosophia* (Meditations on First Philosophy), setting out a new approach to philosophical certainty; the Portuguese born philosopher Baruch Spinoza's magnum opus, *Ethica* appeared in 1677; and the British mathematician Isaac Newton laid out the principles of calculus in *Principia Mathematica* (1687).

The most dramatic influence of Latin in the sciences was in biological description. Detailed descriptions of plants originated millennia earlier with a disciple of Aristotle, Theophrastus of Eresos (370-c. 285 BCE), whose *De Causis Plantarum* (On the Origin of Plants) and *De Historia Plantarum* (On the History of Plants) have survived. His insights, along with those of numerous other Greek and Roman writers, were consulted by Pliny the Elder (CE 23-79). In the development of Latin as a descriptive language for botany, one can hardly overestimate the influence of Pliny's *Historia Naturalis* (Natural History) which went through 190 Latin editions between 1469 and 1799. Pliny adopted Latin words metaphorically and thus supplied a few familiar botanical terms—*corona, pistillum*, and *pollen*—and numerous others


SIDEREVS
NVNCIVS
MAGNA, LONGEQVE ADMIRABILIA
Spectacula pandens, suspiciendaque proponens
vnicuique, præsertim verò
PHILOSOPHIS, atq; ASTRONOMIS, quæ à
GALILEO GALILEO
PATRITIO FLORENTINO
Patauini Gymnasij Publico Mathematico
PERSPICILLI
Nuper à se reperti beneficio sunt obseruata in LVNÆ FACIE, FIXIS IN-
NVMERIS, LACTEO CIRCVLO, STELLIS NEBVLOSIS,
apprimè verò in
QVATVOR PLANETIS
Circa IOVIS Stellam disparibus interuallis, atque periodis, celeri-
tate mirabili circumuolutis; quos, nemini in hanc vsque
diem cognitos, nouissimè Author depre-
hendit primus; atque
MEDICEA SIDERA
NVNCVPANDOS DECREVIT.
VENETIIS, Apud Thomam Baglionum. M DC X.
Superiorum Permissu, & Priuilegio.
M VIIII LL. IN

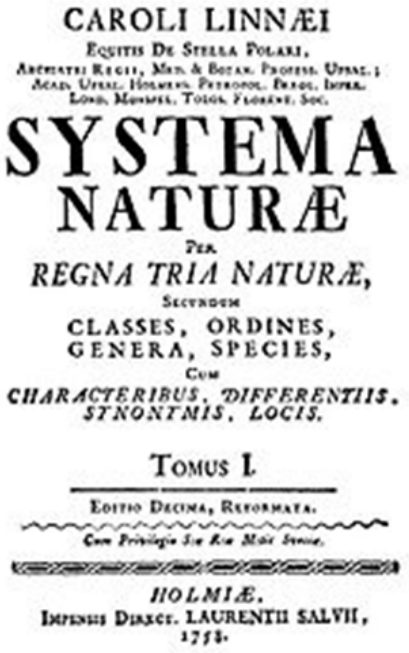
Illustration 3. Galileo's *Siderius Nuncius* (1608), translated as The Starry Messenger (1610), presented the heliocentric theory of the Universe which led to his inquisition in Rome, forced renunciation of his theory, and house arrest for the last eight years of his life.

recognizable only by professional botanists. Pliny's influence is seen in the 1601 *Rariorum Plantarum Historia* (History of Rare Plants) by Cariolus Clusius (1526-1609).

The most extensive pre-Enlightenment use of Latin for botanical description came from the English botanist John Ray (1627-1705) whose 3,000-page *Historia Plantarum,* divided into three massive folios (1686-1704), described an astonishing 18,000 species. Ambitious it was, but his planned illustrations were never included for lack of funding. Moreover, Ray's encyclopedic inventory of plants was not informed by an overriding classification system; in fact, as Paoli Rossi (2000, 179) notes, "Ray did not believe . . . that nature could be geometrically and symmetrically arranged." Though vast, his was the last inventory of plants uninformed by some sort of orderly system. Meanwhile Joseph Pitton de Tournefort (1656-1708), a French botanist at the Jardin des Plantes in Paris, published *Elements de Botanique* (1696), then republished it in Latin as *Institutiones Rei Herbariae* (1700) where, in the introduction, he explained his classification system based entirely on genus with distinctions drawn from morphological differences in the corolla, the reproductive parts of flowers. Using this constricted methodology, Tournefort described

more than 10,000 species classified into nearly 700 types. While not as comprehensive as Ray's *History of Plants*, as Julius von Sachs (1890, 78) pointed out, Tournefort's striking illustrations made from copper-plate engravings along with felicity of description made his works popular and influential in the eighteenth century until displaced by the mid-century work of Carl Linnaeus.

The development that took botanical description beyond mere inventory occurred with Linnaeus' linguistic revolution which laid out the parameters for scientific description and notation that established Latin as the universal language of science. He could have chosen to write in Swedish, but this might well have reinforced a trend toward separate vocabularies for science in the numerous vernacular languages of Europe and elsewhere. His influence lay first in a variety of Latin treatises produced between 1736 and 1753: *Fundameta Botanica* (Botanical fundamentals), *Genera Plantarum* (Origin of Plants), *Philosophia Botanica* (The Science of Botany), and *Species Plantarum* (Plant Species). His encyclopedic coverage in Latin established these as standard works that scientists all over Europe could and did consult. Second, Linnaeus utilized available terms as they had been used in previous works ever since Theophrastus and Pliny while remaining true to established lexical definitions. As William T. Stearns (1992, 34-35) put it, "he selected from the classical words converted into technical terms by his predecessors those which seemed apt, pleasing, and unambiguous." His third contribution was the adoption of Latin words for botanical use with no regard for their original classical meanings. An instructive example from his 1736 publication, *Fundamenta Botanica* (Fundamentals of Botany) is *corolla*—"a little crown or garland" in classical usage—which he adopted specifically for the prominent attractive surround of a flower's sexual parts. Richard Robinson (1950) has distinguished this usage from lexical definition by what he calls "stipulative definition," an arbitrary but creative distillation of new meanings for classical vocabulary. Such terminology carries the flavor of classical Latin put to new uses, though such stipulative definition has recurred in numerous fields and could hardly be avoided throughout the history of science.


CAROLI LINNÆI

EQUITIS DE STELLA POLARI,

ARCHIATRI REGII, MED. & BOTAN. PROFESS. UPSAL.;

ACAD. UPSAL. HOLMENS. PETROPOL. BEROL. IMPER.

LOND. MONSPEL. TOLOS. FLORENT. SOC.

SYSTEMA NATURÆ

PER

REGNA TRIA NATURÆ,

SECUNDUM

CLASSES, ORDINES,
GENERA, SPECIES,

CUM

CHARACTERIBUS, DIFFERENTIIS,
SYNONYMIS, LOCIS.

TOMUS I.

EDITIO DECIMA, REFORMATA.

Cum Privilegio Sac. Reg. Majt. Suecia.

HOLMIÆ.

IMPENSIS DIRECT. LAURENTII SALVII,
1758.

Illustration 4. The title page of the first edition of Carl Linnaeus' *Systema Naturae* (1753) described Nature in Three Kingdoms (Regna Tria) with a preliminary taxonomy of four parts: Classes, Ordines, Genera, Species.

Linnaeus' most significant innovation was a full-fledged development of botanical description commenced in *Systema Naturae* (1735) with his most comprehensive treatment occurring in the tenth edition (1758) and considerably enhanced in the twelfth edition (1766-1768). In the expansive style of early books, Linnaeus' title page of the early edition already displays his four-part organization—*Classes, Ordines, Genera, and Specie*—the foundation of a classification system, or taxonomy, now universally adopted. In practice, Linnaeus adopted a two-part identification system now known as *binomial nomenclature*. As Paoli Rossi (2000, 175) remarks, in Linnaeus' settled binomial nomenclature, two terms contain "an astounding wealth of information. . . . the first defines its genus and the second its species, distinguishing it from all others of the same genus.

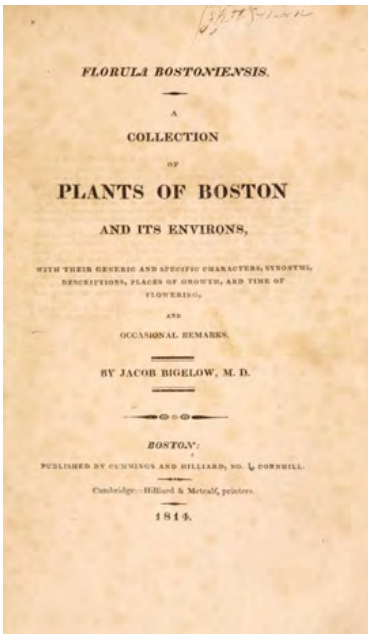
. . . The identification of a species is not simply the identification of differences but also the recognition of similarities to others of the same genus."

In the fully developed system, the sequence proceeding from the *specific* (aptly named "species") to the *general* expands Linnaeus' four levels to seven: *Species, Genus, Family, Order, Class, Phylum, and Kingdom*. Thus in identifying an oak tree—let's say *Quercus alba*, white oak of Eastern North America—*alba* (white) signifies one of 600 species belonging to the genus *Quercus* (oak) which is part of the family *Fagaceae* of the order *Fagales,* one class of *Magnoliopsida*, of the phylum *Anthophyta* of the kingdom *Plantae*. While most of the intermediate terms are unfamiliar, the final term identifies an oak tree as part of a broad category of Plants. In similar fashion, in the familiar designation of modern humans, *Homo sapiens*, our species *sapiens* is one of several extinct species *(erectus, habilis, neanderthalis)* in the genus *Homo*, which is part of the family *Hominidae* within the order *Primates*, part of the class *Mammalia* which belongs to the phylum *Coradata* within the kingdom *Animalia*—once again a recognizable category. In Linnaeus' nomenclature, these two kingdoms, *Plantae* and *Animalia*, marked the limit of classification in the eighteenth century. Lynn Margulis' *Five Kingdoms* (1982) has added three more: *Monera, Protoctista*, and *Fungi*.

In 1750, fourteen years after the publication of his *Fundamenta Botanica* (1736), Linnaeus expanded its thirty-six pages to a 364-page book he called *Philosophia Botanica*, with eleven illustration plates. Stearn (1992, 35) defines it as "the first textbook of descriptive systematic botany and botanical Latin." Its influence is evident in translations and expanded illustrated versions that soon appeared in England, France, and Germany. Meanwhile, with the generation of new knowledge, new vocabulary was needed, and Latin became the source. But classical Latin, despite its extensive linguistic richness, could not support the linguistic needs of new learning. It was here that a new kind of Latin was developed: vocabulary conforming to the structure of Latin linguistic prefixes, suffixes, and roots was created.

By the nineteenth century, binomial nomenclature and a supporting Latin vocabulary of plant stems, leaves, blossoms, and colors was developed enough that plants could be observed and identified without supporting illustrations. This is hard for us to imagine today because we rely on the extensively illustrated Peterson or Smithsonian field guides. Early plant observers were evidently refined observers. Jacob Bigelow's 1814 *Florula Bostoniensis* (Flowers of Boston) became the working handbook for Henry David Thoreau (1817-1862), who studied plants, flowers, and trees throughout his and his brother's excursion narrated in *A Week on the Concord and Merrimack Rivers* (1849), his two-year life in the woods recorded in *Walden* (1854), and three expeditions combined in *Cape Cod* (1865) His botanical knowledge is evident in posthumous works where we find comprehensive lists in Linnaeus' binomial form as appendixes to *The Maine Woods* (1864) and his much delayed "lost manuscript" recovered and published as *Wild Fruits* (2000). After twelve years of work, the painter John James Audubon published his life's work, 435 paintings titled *The Birds of America* (1839). Every illustration carries both the common name and the Linnaean scientific name.

In a context far removed from Linnaeus' Sweden, Thoreau's New England, or the broader canvas of Audubon's America, the *Greens Bayou Wetlands Mitigation Bank* (2006) provides an inventory of species on 1,450 acres of wildland preserve in Houston, Texas. Here we find *Hyla cinerea* (green tree frog) among 14 amphibians; *Procyon lotar* (raccoon) among 15 mammals; *Micropterus salmoides* (largemouth bass) among 22 fish species; 15 reptiles, including the American alligator, copperhead snake, and Texas coral snake; 70 invertebrates such as bees, beetles, ants, and butterfly species; and over 450 species of vegetation—a total of 550 species of flora and fauna identified by both Linnaean binomial nomenclature and common English names. Such exhaustive inventories are most



FLORULA BOSTONIENSIS.

A

COLLECTION

OF

PLANTS OF BOSTON

AND ITS ENVIRONS,

WITH THEIR GENERIC AND SPECIFIC CHARACTERS, SYNONYMS, DESCRIPTIONS, PLACES OF GROWTH, AND TIME OF FLOWERING,

AND

OCCASIONAL REMARKS.

BY JACOB BIGELOW, M. D.

BOSTON:

PUBLISHED BY CUMMINGS AND HILLIARD, NO. 4, CORNHILL.

Cambridge—Hilliard & Metcalf, printers.

1814.

Illustration 5. Jacob Bigelow's *Flurola Bostoniensis* (1814) was used by Henry David Thoreau (1817-1862), a self-taught student of botanical species wherever he traveled. In addition to lists of species appended to The Maine Woods, Thoreau's twenty-volume Journal includes copious notes on plant species in Linnaean form—including dates for flower blooming recorded over many years. Comparison with today's blooming dates which are occurring several days earlier has provided evidence for global warming.

often found on limited tracts set aside for study as well as preservation. Selective inventories have been compiled for the carefully gathered trees and plans of The Royal Botanic Gardens, Kew, in London (Utteridge and Bramley 2016) and the Singapore Botanic Gardens (Sim 2017)—preserved species dating to the days of the British Empire. Wildflowers attract our attention more than purely green plants. Consequently, a wildflower emphasis is found in plant inventories of extensive wildland regions in the United States: the Florida Everglades (Hammer 2015), the Sierra Nevada Mountains explored by John Muir (Wiess 2013, Wenk 2015), the Great Smoky Mountains National Park (Stupka 1964), and most other national and state parks. Oceanographic inventories of coral and sea creatures lie behind the creation of undersea preserves such as the northwest Hawaiian seamount chain (Fenner 2005, Hoover, 2010). Such Linnaean inventories turn up from distant regions of diverse linguistic backgrounds, Southeast Asia, for instance: *Mangrove Forests of the Malay Peninsula* (Watson 1928); *Fruits of Bali* (Eiseman 1988); *Birds of the Philippines* (Kennedy 2000); and *Field Guide to the Reptiles of Thailand* (Chan-ard 2015).

An innovative modification of Latin is evident in Linnaeus' 1737 *Flora Lapponica* (Flowers of Lapland), the result of five months of travel in Lapland. The title provides a Latinized name for Lapland and stands as an early regional field guide to flowers. His 1744 *Flora Svecica* (Flora of Sweden) provided the same for Sweden. Latinized geographical names continue to appear in the species position in *Fulica americana* (American Coot), *Quiscalus mexicanus* (Great-tailed Grackle), *Melospiza georgiana* (Swamp Sparrow), and *Sylviagus floridanus* (Eastern Cottontail)—generally indicating where a specific species was first identified. Peking Man, found near the capital of China in the 1920s, was originally called *Sinanthropus pekinensis* which incorporates Latinized versions of "China" (*Sina*) and the anglicized "Peking" (Beijing). This hasty designation has become entangled with the Multiregional Evolution Hypothesis (MEH) in opposition to the Recent Out of Africa Hypothesis (ROAH) for modern humans, with continuing Chinese reticence and criticism of the ROAH (Wu 2004) and belief in an Asian origin and Chinese evolution from *Sinathropus pekinensis* rather than an *africanus* ancestry. However, recognition of Peking Man as a descendant of the African *Homo erectus* species has superseded the MEH.

Another revealing innovation is found in Linnaeus' 1738 *Hortus Cliffortianus* (Clifford's Garden), written in Holland while Linnaeus was a guest of the wealthy banker, George Clifford, governor of the East India Company, was an enthusiastic botanist who had developed a large herbarium. The naming of species for discoverers is another innovation of botanical Latin. During the British stewardship of Indonesia, Sir Stamford Raffles (1781-1826) served as Lieutenant Governor of Java (1811-1815), later Bencoolen in Sumatra (1817-1822). Famous for founding Singapore, he is also the famous for a drink, the Singapore Sling (a gin-based cocktail), invented in the Raffles Hotel. During an expedition in Sumatra, he and Joseph

Arnold discovered a giant parasitic plant whose name now celebrates both discoverers: *Rafflesia arnoldii*. The renowned and widely published entomologist, Edward O. Wilson, noted for his study of ants is honored in several ant species: *Wilsonia megagastrosa, Wilsonia lianoingensis*, and others.

Latin in the service of botany has been the most fully articulated, thanks to the exhaustive work of William T. Stearn (1911-2001), known for scores of publications, including *Dictionary of Plant Names* (1972) and *Flower Artists of Kew* (1990). His magnum opus, *Botanical Latin*, subtitled *History, Grammar, Syntax, Terminology and Vocabulary*, has gone through four editions (1966, 1973, 1982, 1992), multiple reprintings, and translation; it is renowned among botanists worldwide.

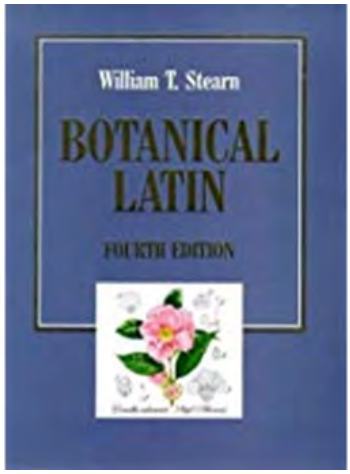


Illustration 6. William T. Stearn's *Botanical Latin* includes the basics of Latin conjugation, declension, grammar, terminology, and binomial nomenclature.

Interestingly, once botanical Latin was securely established in the eighteenth century, it subsequently spread well beyond biology. Chemical elements, most of which were isolated later, thus have classical etymologies indicating roughly equal origins from Greek and Latin. Element names from the Greek often derive from Greek deities or mythological figures—Helium (*Helios*), Iridium (*Iris*), Niobium (*Niobe*), Plutonium (*Pluto*), Promethium (*Prometheus*), Selenium (*Selene*), Tantalum (*Tantolos*)—with their endings routinely Latinized. Elements from Latin sometimes honor deities—Mercury (*Mercurius*), Cerium (*Ceres*), Neptunium (*Neptune*); more often they preserve Latin names for substances or qualities—Calcium (*calx*), Carbon (*carbo*), Copper (*cyprum*), Tellurium (*tellus*), Silicon (*silicis*). When new chemical elements are named to honor eminent historical figures, they are regularly provided with Latin endings: Copernicium (Copernicus), Curium (Marie Curie), Mendelevium (Dmitri Mendeleyev), Fermium (Enrico Fermi), Rutherfordium (Ernest Rutherford), Einsteinium (Albert Einstein), and Nobelium (Alfred Nobel).

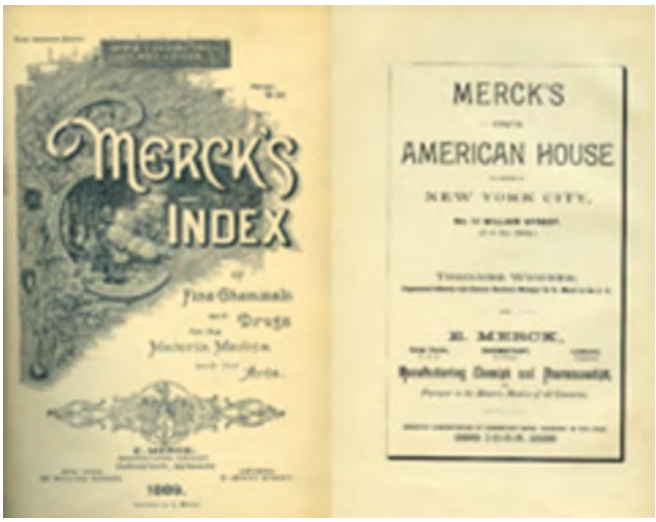


Illustration 7. The first edition of *Merck's Index*, published in 1889. This encyclopedic tome is now in its 15th edition.

Elements in their raw form, particularly metallic elements, are of value for human use in many ways, well illustrated by Aluminum, Iron, Copper, Gold, Silver, and Tin. In combination, they have numerous industrial and technological applications. However, *The Merck Index*, first published 129 years ago, now in its 15th edition, extends chemistry into medicine and pharmaceuticals. Recent editions which are subtitled *An Encyclopedia of Chemicals, Drugs, and Biologicals,* include more than 10,000 entries. Many of them are simple compounds, some are organic extracts. Listings, even if they contain three or more elements, typically imitate the binomial nominclature of Linnaean botanical taxonomy. Manganese Chloride has two

components (Cl_2Mn); Sucrose Octaacetate contains three ($C_{28}H_{38}O_{19}$), Aluminum Ethoxide contains four ($C_6H_{15}AlO_3$), Mecysteine Hydrochloride contains five ($C_4H_{10}ClNO_2S$), Pyridinium Chlorochromate contains six ($C_5H_5ClCrNO_3$). These and most other chemicals are most often referred to by their English names; for instance, iron sulphate and potassium nitrate; but when these are incorporated into chemical descriptions, they are Latinized—*ferri sulphas*, *kalii nitras*. There is, indeed, much to learn if one is to navigate this vast Latinized landscape. The rumor of my high school years that students heading for medical studies should take Latin is no longer supported by high school curricula; medical students now typically enroll in quick-take courses in "medical Latin."

English as the most widely spoken language in the world has been exceptionally receptive to scientific Latin. To a large extent this is the result of the many more general Latin words that have been preserved in English so easily that an educated reader hardly distinguishes them as foreign. Thus, we run across familiar Latin terms in a variety of general contexts: *ad hoc, a priori, argumentum ad hominin, de facto, deus ex machina, ipso facto, magnum opus, modus operandi, non sequitur, per se, quid pro quo, reducto ad absurdum,* and *terra firma*. Philosophers are known by a Latin phrase—Descartes by *cogito ergo sum*, Locke by *tabula rasa,* Freud by *ego* and *id*. Academics still title a list of their credentials as *curriculum vitae*. John Dryden published a poem called *Annus Mirabilis* to celebrate the survival of London in 1666 following the Great London Fire. The term has been applied to 1543, the year Copernicus released his heliocentric theory; 1776, the year of American Independence; 1905, the year Einstein published his General theory of Relativity; and dozens of other years of significance in the lives of the famous. When Queen Elizabeth II spoke at the end of 1992, a year of royal family scandals, divorces, and the devastating fire at Windsor Castle, she evoked a Latin term, *Annus horribilis*.

Undoubtedly, Cicero, Virgil, and Lucretius would be astonished to discover that their language has survived and expanded over two millennia and is now the only truly universal language. In its penetration into the scientific community, it surpasses even English. Unaware of the stature of their language in later cultures, Roman writers would be puzzled by books with Latin titles written in an unrecognizable language: the three-volume tome by Alfred North Whitehead and Bertrand Russell, *Principa Mathematica* (1910), and Ludwig Wittgenstein's translated *Tractatus Logico-Philosophicus* (1921), both written in English. From another perspective, today's college students documenting their essays are equally puzzled by the purpose of Latin fossils like *et al*, *loc cit,* and *op cit*.

The history of Latin in science, literature, and general culture reveals a penetration of this ancient language far more extensive than we usually recognized. A comprehensive exploration and inventory of its extensive applications, as Stearn's 546-page *Botanical Latin* or the 1818-page *Merck Index* well illustrate, might require as many volumes as an encyclopedia. In this connection, we are reminded of one of the most influential works of many volumes, published between 1768-1771 during Linnaeus' lifetime—the most important work of general knowledge in English; interestingly, its title preserves the Linnaean genus-species structure of botanical Latin: *Encyclopedia Britannica*.

Latin is useful as a scientific and technical language because it is a written rather than spoken language and is therefore immune to vocal anomalies, vowel changes, consonant variations, and colloquial modification. Vocabulary additions and inventions occur, but the roots and elements utilized in the addition of new terms are fixed. No one speaks *Latinus Scientificus*, but scientists in every corner of the world find permanent coordinates of meaning in a structure formalized more than two centuries ago. It is pervasive, so much so that it has an influence well beyond what may have been intended. Various European literary works have been translated into Latin: the Italian *Divina Comoedia* (Divine Comedy), Spanish *Dominus Quixotus a Manica* (Don Quixote), Portuguese *Lusiadae* (Lusiads),

German *Werther Iuvenis Quae Passis Sit* (Sorrows of Young Werther), and the English novels *Rebilius Cruso* (Robinson Crusoe), and *Superbia et Odium* (Pride and Prejudice). Translation of novels into Latin in the twentieth century has virtually disappeared; a notable exception is the Latin translation of George Orwell's 1944 novel, *Fundus Animalium* (Animal Farm), an anachronistic oddity.

Yet the vitality of Latin lives on, even while it has almost disappeared from high school and college curricula. The translation of fairy tales and children's books provides an entertaining and humorous indicator of Latin's prestige and vitality.

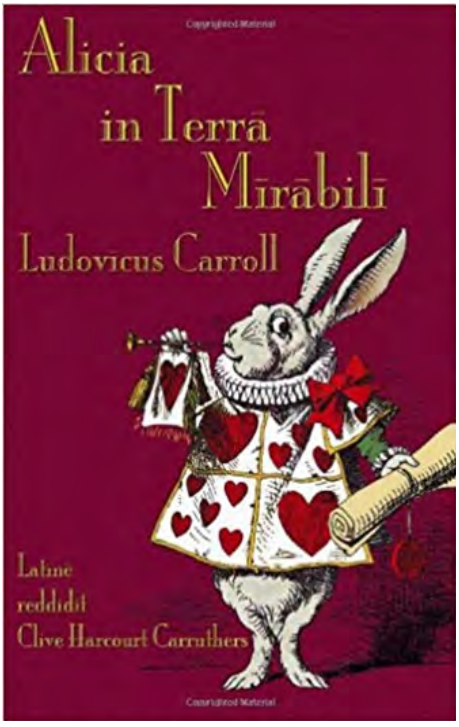


Illustration 8. Clive Harcourt Carruthers' Latin "reddidit" (translation) of *Alice in Wonderland* includes a Latin rendition of the original author's pseudonym, Lewis Carrol. Etymologically, Ludovicus is a Latinized version of the German name Hluwig, which renders into English as Louis or Lewis. Carrol's real name was Charles Lutwidge Dodgson, his middle name being the original of Ludovicus—a convenient illustration of the tangles of vocaculary transfer.

This includes such classics as *Alicia in Terra Mirabili* (Alice in Wonderland), *Insula Thesauraria* (Treasure Island), *Pericia Thomae Sawyer* (Adventures of Tom Sawyer), *Beata Illa Nox* (The Night Before Christmas), *Fabula De Petro Cuniculo* (The Tale of Peter Rabbit), *Winnie Ille Pu* (Winnie the Pooh), *Hobbitus Ille* (The Hobbit), *Tela Charlottae* (Charlotte's *Web*), *Cattus Petasatus* (*The Cat in the Hat*), *Virent Ova! Virent Perna!* (*Green Eggs and Ham*), *Arbor Alma* (The Giving Tree), *Ubi Fera Sunt* (Where the Wild Things Are), and *Quomodo Invidiosulus Nomine Grinchus Christi Natalem Abrogaverit* (How the Grinch Stole Christmas).

The effect is an entertaining placement of children's books alongside the greatest scholarly works of the Western world by Galileo, Newton, and Wittgenstein. But there seems to be a serious side to this anachronism. Getting children started in Latin aligns rather well with the current American Association for the Advancement of Science (AAAS) efforts through *Next Generation Science Standards* (2011) to motivate massive numbers of students to undertake advanced study of the sciences.

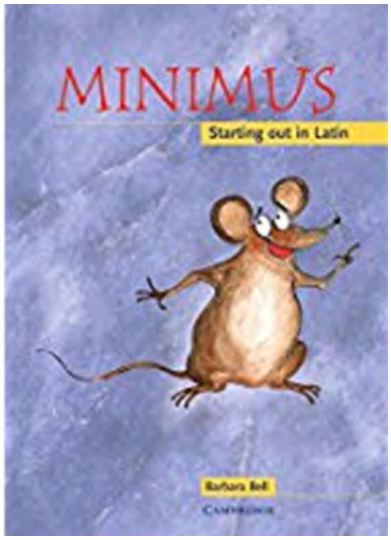


Illustration 9. Barbara Bell's *Minimus* (2000) is the first of a series that includes an audio CD and two spiral-bound Teacher's Resource Books (2000, 2004 from Cambridge University Press.

The materials are available to interest children in Latin as a foundation for subsequent mastery of scientific Latin. Resources are extensive: Barbara Bell's *Minimus Pupil's Book: Starting Out in Latin* (2000), the follow up *Mininus Secundus* (2004), an associated *Latin Activity Book* (2005), and a *Minimus Audio CD* (2006) provide accessible approaches. All carry the

impressive imprimatur of Cambridge University Press. Aaron Larsen draws on the now-outdated but nostalgic idea of the "primer" in his *Latin for Children: Primer A* and *Primer B* (2003) supported by a *Primer A DVD* (2006)—with options of "classical or ecclesiastical pronunciation".

Meanwhile, as fossils of ancient human ancestors keep turning up, the Linnean system of binomial nomenclature remains the system to which all discoveries must submit. Raymond Hart (1925) began it when he applied the term *Australopithecus africanus* ("Southern ape of Africa") to a primitive skull found near Taung, South Africa. Donald Johanson added *Australopithecus afarensis* ("Southern ape-man of Afar) to his 1974 discovery of "Lucy," at Afar. Since then, the ancestral lineage of Latinized ancestors has grown at an accelerating pace. A 1975 fossil discovery of fossils in close association with an advanced lithic tool worksite has led to *Homo ergaster* ("Worker Man"). A fully bipedal human discovered in 1991 in Georgia is named *Homo erectus.* European fossil discoveries in the 1990s of a species regarded as a predecessor or ancestor of later European humans are termed *Homo antecessor*. A 2014 discovery of pigmy-size humans on the Indonesian island of Flores has been designated *Homo floresiensis*. Most of these illustrate the Latinization of discovery locations or associated artifacts. Occasionally an oddity occurs. *Homo naladi* refers to a 2013 discovery of hominid fossils in the Rising Star Cave system of South Africa. *Naladi* means "star" in the Sotho-Tswana languages; interestingly this species designation escaped Latinization because it already resembled a Latin masculine adjective.

Despite the sophistication of Linnean binomial nomenclature, specimens turn up that resist classification. This has occurred with extinct species of plants, various animals, a number of birds, even bacteria where taxonomic description leaves questions or specialist controversies develop; such specimens remain in a taxonomic limbo. In a seminal paper, S. C. Matthews (1972, 714) discussed the occasional need for "open nomenclature," necessitated by uncertainty of classification: "*Incertae familiae* (Family uncertain), *Incerti subordinis* (Suborder uncertain), *Incerti ordinis* (Order uncertain), *Incerti sedis* (Class uncertain)." This catch-all term for taxonomic puzzles gets periodic usage: in a discussion of ancient fossils from Iowa, Richard Arnold Davis (1975) refers to their "uncertain affinity." Graham J. Bird (2007) provides another example in a crustacean located in the deep trenches off the coasts of the Kamchatka Peninsula and Japan, designating it as "Family *Incertae sedis*." Sometimes removal of a puzzling specimen from "uncertain placement" is effected by the creation of a new Order, as happened with the California condor; in such cases, the specimen may be designated *Species inquirenda*, meaning its identification is doubtful and requires further investigation. The terms *Incertae sedis* ("Uncertain placement") and *Species inquirenda* ("Requiring additional investigation") illustrate the momentum of scientific Latin in providing descriptors even for biological specimens that momentarily defy placement within the standard Linnaean system. Within the *Homo* genus, we have an example in the recent discovery of a finger bone and molar in Denisova Cave in southern Russia. DNA sequencing has shown prehistoric mating of the Denisova Cave people with Neanderthals and markers reveal genetic penetration into Island Southeast Asia and Melanesia. But the relationship between Neanderthals, the Denisova Cave people, and the presumptive *Homo erectus* migrants out of Africa one to two million years ago, leaves precise taxonomy so far uncertain—a prime example within the hominid line of *Incertae sedis*. This is one situation when scientists are willing to resort to a popular nomenclature rather than forcing an uncertain Linnaean placement. To date, these newly discovered hominids are called, simply, *Denisovans,* just as their compatible cousins with whom they mated have for years been called, simply, *Neanderthals*.

Acknowledgment

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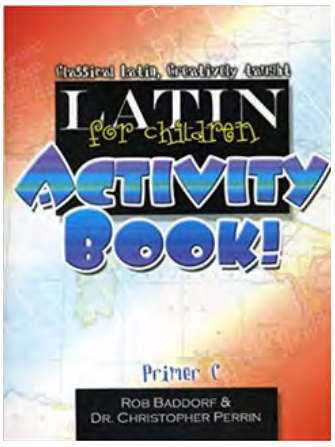

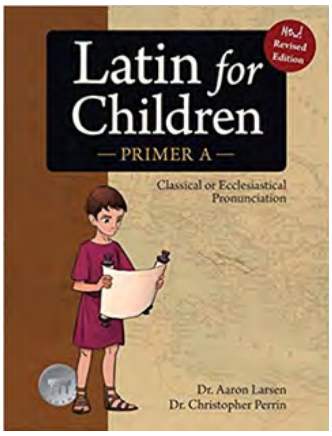

Illustration 10. Arron Lewis has produced a series—*Latin for Children: Primer A* and *Primer B* (2003) with a Latin for Children Activity Book, with support from a Primer A DVD (2006)

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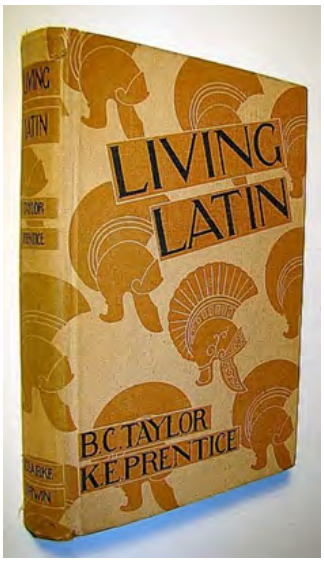

Illustration 11. B. C. Taylor and K. E. Prentice, *Living Latin* (Toronto: Clarke-Irwin & Company, 1956) was the most widely used Latin Textbook in Canada until its publisher was purchased by Thomas Nelson Publishing in 2002.

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Latinus Scientificus: A História e a Cultura do Latim Científico

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Resumo

O inglês é a primeira língua de 330 a 360 milhões de pessoas, e o triplo desse número de pessoas tem o inglês como segunda língua. Com aproximadamente 1,5 bilhão de falantes, é a língua mais amplamente falada no planeta, embora não seja universal; muitas regiões são carentes de falantes do inglês. Por outro lado, uma língua com poucos falantes contemporâneos, mas de uso extenso é o Latinus Scientificus (latim científico) – uma versão modernizada do latim clássico de dois mil anos atrás, de Cesar, Cícero, Horácio, Tito Lívio, Ovídio e Virgílio. Mantido vivo pela igreja católica, o latim evoluiu para as línguas românicas (francês, italiano, português, romeno e espanhol) e influenciou todas as outras línguas europeias, incluindo sua influência na língua inglesa em diferentes momentos. Enquanto isso, o latim clássico permaneceu como a língua do conhecimento nas mãos de teólogos, humanistas e filósofos, até o século dezoito. Naquele momento, pelas mãos de Carl Linnaeus, a terminologia latina foi sistematicamente desenvolvida para as descrições da botânica, e daí adaptada para a zoologia, a química, a antropologia e a medicina. Enquanto o latim falado e escrito está agora confinado ao círculo interno da igreja de Roma e seus documentos oficiais, o latim científico tornou-se a língua universal e precisa da taxonomia científica e suas descrições. A latinização de nomes pessoais e de lugares revela o latim como uma língua ainda em desenvolvimento. A influência do latim como a língua do conhecimento e da ciência levou a uma influência mais ampla na literatura e na cultura geral.

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No ano de 393 da era cristã, chegaram ao fim na Grécia, depois de onze séculos, os Jogos Olímpicos, que datavam pelo menos do ano de 776 a.c. Após uma geração, no ano de 410, Roma foi invadida pelos visigodos. O último imperador romano, Flavius Romulus Augustus (cujo nome, ironicamente inclui o lendário fundador de Roma e o seu primeiro e mais renomado imperador) foi deposto no ano de 476, depois de apenas 10 meses, trazendo ao fim, efetivamente, uma civilização que, pelo que se sabe, tivera início mais de doze séculos antes. Dado esse aparente fim do império romano, fico de certa forma atônito ao lembrar que 1483 anos após a queda de Roma, no ano de 1959, me graduei na *high school* (ensino médio) com quatro anos de estudo do latim. Nosso livro-texto de gramática chamava-se *Living Latin* (Latim Vivo, 1956), uma piada entre a garotada de 15 anos: nós normalmente nos referíamos às nossas aulas de latim 'morto.' Meu livro-texto de grego, *First Greek Book* (Primeiro Livro de Grego, 1937), de White, escapou de tal chacota.

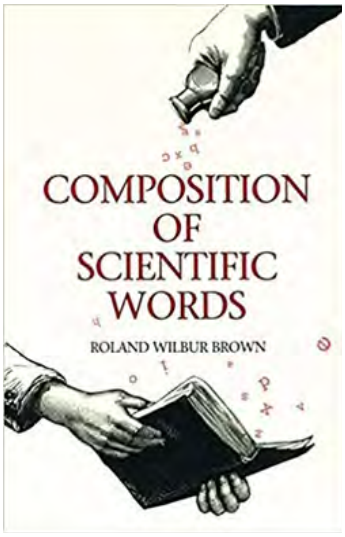
Naqueles dias, circulava um boato de que qualquer interessado em cursar a faculdade de medicina precisava do ensino médio com ênfase em latim, pois os médicos usavam o idioma nas suas prescrições. Eu não ia fazer medicina; terminei cursando estudos de língua e literatura, onde o conhecimento de raízes e sufixos latinos e gregos foi usado continuamente para descobrir os sentidos subjacentes às palavras inglesas. Meu diploma de bacharel da universidade de Toronto foi escrito em latim; alguns anos depois, meus diplomas de mestre e de doutor foram escritos em inglês – um sinal, talvez, da diminuição de prestígio dos estudos clássicos. Ainda assim, muito frequentemente somos lembrados de que o latim ainda está em circulação. Em *T-Rex and the Crater of Doom* (T-Rex e a cratera

do julgamento, 1997), o geologista Walter Alvarez intitulou o seu segundo capítulo *Ex Libro Lapidum Historia Mundi* sem, devemos acrescentar, sentir a necessidade de oferecer uma tradução: de rochas, a história do mundo. Mais tarde (2015), ele usou o latim novamente para subtítulo de um artigo:"ler a história escrita em rochas," em tradução livre, um talento que está na base de praticamente todos os textos que Alvarez escreveu. Para leitores não familiarizados com o latim, *T-Rex* é uma abreviação de *Tyrannosaurus rex*, o tirano rei dos lagartos, um nome que oferece uma introdução a este artigo.

Embora a língua falada tenha desaparecido gradualmente, metamorfoseando-se pelo sul da Europa em línguas que dela descenderam, a língua latina continua conosco. Tendo início em algum lugar na nebulosa história de Roma – tradicionalmente fundada no século oito a.c – o latim desenvolveu um vocabulário, poder e talento artístico que resultaram em notável tradição histórica, filosófica e literária. O latim poderia ter desaparecido com o império romano, mas ao invés disso sobreviveu e desenvolveu-se, adaptando-se a novos usos, e finalmente foi transformado no latim científico, *latinus scientificus*. Este artigo rastreia essa evolução, que foi tecida por toda a história da civilização ocidental, a ascensão da ciência e da cultura moderna. É uma evolução compreendida em fragmentos, principalmente pelos linguistas, mas tem seu lugar na história do pensamento, na cultura ocidental e na grande história.

O latim taxionômico teve como pioneiro e desenvolvedor, Carl Linnaeus (1707-1778). Hoje em dia, um latim modernizado e muito expandido é língua global da ciência – especificamente a origem da terminologia na biologia, incluindo tanto a botânica quanto a zoologia. Usando-se a nomenclatura *Linnaeana* binomial, 1,2 mihão de espécies de animais e de plantas, terrestres e marinhas foram nomeadas, de um total estimado de 8,7 milhões, o que significa que aproximadamente 86% das espécies terrestres e 91% das marinhas ainda precisam ser nomeadas (Mora, 2011). Estimativas de tempo e de custo para completar esse trabalho preveem centenas de anos e bilhões de dólares. Coletivamente, completar esse inventário científico pode ser o mais extenso projeto em qualquer língua, sem final à vista se o objetivo for nomear e classificar todos os seres vivos: a estimativa para as espécies de micróbios, por exemplo, varia de cem bilhões a um trilhão. O uso do latim e do grego dominam a formulação da terminologia científica; não há outras fontes para os que descrevem a ciência. Mas a criação de palavras científicas não é simplesmente uma questão de empréstimo aleatório; desenvolveu-se num processo linguístico sistemático.

Ilustração 1. O livro de Roland Wilbur Brown, *Composition of Scientific Words* (Composição de palavras científicas), com 882 páginas, oferece indicações do processo de criação de palavras da ciência e a extensão da terminologia científica desenvolvida a partir do latim e do grego.



A história de como o latim sobreviveu ao fim do império romano para se tornar o meio para esse vasto empreendimento constitui uma história cultural de grande interesse, que inclui sua extensão para outras ciências: antropologia, química, geologia e medicina. O latim, contendo empréstimos do grego, foi uma língua que se desenvolveu por toda a era do império romano (753 a.c-476 da era cristã), mas o latim clássico que os estudiosos de eras posteriores admiraram e copiaram data do período central, de 100 a.c ao ano 50 da era cristã. Durante o renascimento europeu, os estudiosos idealizaram o latim clássico e os escritos daquela era. O livro de Julio Cesar, *De Bello Gallicus* (em *inglês On the War in Gaul*, ou *Na guerra em Gália*) é simples e impressionantemente claro; como o estilo de Hemingway, em inglês. As obras *De Natura Deorum* de Cícero (em inglês *On the Nature of the Gods*, ou *Sobre a natureza dos deuses*) e a *História de Roma* de

Tito Lívio, em vários volumes, oferecem o padrão de excelência para a prosa clássica. Na poesia, as *Odes* de Horácio, a *Eneida* de Virgílio, as *Metamorfoses* de Ovídio e *Da natureza das coisas*, de Lucrécio, definem o poder artístico da língua latina. Na era imperial tardia, o latim perdeu um pouco em expressão e poder, e ficou conhecido como latim vulgar, *Latinus vulgare,* que é melhor compreendido como a língua falada pelos soldados romanos, pelos colonizadores e pelos povos conquistados, particularmente na Europa austral e ocidental. Isolado da escrita, que estabiliza a forma linguística, e influenciada por idiomas nativos mais antigos, o latim vulgar rapidamente se desenvolveu em línguas separadas, conhecidas hoje como línguas românicas: francês, italiano, português, romeno e espanhol – este último com o segundo maior número de falantes no mundo, depois do inglês. As características particulares do latim clássico – declinações nominais, conjugações verbais, verbos em final de sentença com flexão que altera o significado – em grande parte desapareceram nessas línguas. A ordem de palavras substantivo-verbo-objeto com o uso extensivo de preposições tornou-se a chave principal para o significado.

À parte dessas línguas, a influência do latim vulgar é evidente nos empréstimos linguísticos de quase todas as línguas europeias: albanês, tcheco, dinamarquês, norueguês, polonês, russo, eslovaco, sueco e ucraniano. Essa influência do vocabulário do latim vulgar, se não de seu talento artístico, data de sua adoção como a língua sagrada pela igreja católica. A conversão do imperador Constantino no ano de 312 da era cristã efetivamente definiu o cristianismo como a religião oficial do império romano um século e meio antes de sua queda, dando autoridade aos escritos cristãos por toda a Europa. Os mais antigos evangelhos do novo testamento foram compostos em latim antigo, *Vetis Latina*, mas no ano de 382, o papa Damásio contratou Jerônimo para fazer uma tradução completa para o latim vulgar, que é chamada hoje de *Versio Vulgata*, a versão comumente usada, abreviada para 'a vulgata', tão amplamente reconhecida e que foi finalmente confirmada como a bíblia oficial da igreja católica no Concílio de Trento (1545-1563). Durante os primeiros quinze séculos da era cristã, a continuidade do latim nas línguas românicas e o seu uso pela igreja fez dele a língua mais influente na Europa.

O próprio latim descende de línguas mais antigas, genericamente agrupadas como 'itálicas;' a maioria das quais, como a etrusca, extintas há muito tempo. Traçar sua origem mais recente é praticamente impossível, pois palavras faladas são efêmeras: desaparecem no ar, e a língua escrita se estende por não mais do que 5000 anos passados. Foi um feito engenhoso que tenhamos reconstruído a matriz das línguas itálicas, e na verdade, de dezenas de outros ramos, o hipotético indo-europeu, que se estima tenha sido falado entre 6000 e 8000 anos atrás, em algum local na região do Mar Negro.

As raízes do indo-europeu original podem ser reconstruídas a partir do vocabulário de línguas indo-europeias vivas e de modificações de sons conhecidos para se chegar a um vocabulário indo-europeu provisório. Isso não quer dizer que reconheçamos imediatamente cada língua descendente do indo-europeu; à primeira vista, as línguas germânicas não sugerem uma afinidade com o latim. Com vários milênios de evolução isolada, os ramos germânico e itálico tornaram-se mutuamente ininteligíveis nos primeiros séculos da era cristã, quando podemos identificar uma palavra latina que tenha entrado furtivamente no alemão como uma presença estrangeira. Foi a partir daí que o latim primeiro começou a influenciar o inglês.

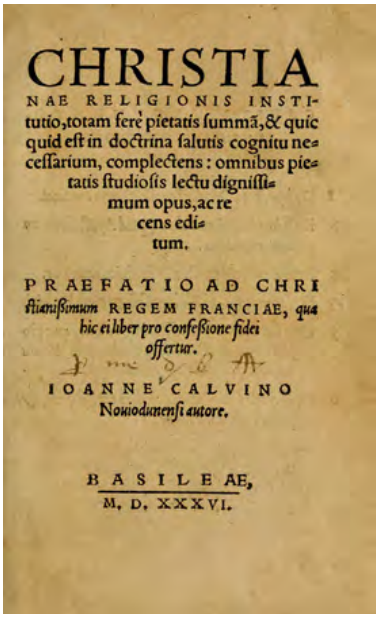
Esse momento começou na era imperial, logo após a deificação de Augustus (27 a.c) com o vocabulário latino se infiltrando no germânico ocidental no continente e depois levado para a Grã-Bretanha pelos anglos, saxões e jutos. Aproximadamente 175 palavras latinas, que eram empréstimos do latim ao germânico ocidental sobreviveram à perda no continente e à obsolescência ou extinção na Inglaterra e se tornaram incorporadas ao inglês antigo (Serjeantson, 1935, 271-277). Uma segunda influência ocorreu em seguida à chamada dos militares romanos da Inglaterra no ano de 410 da era cristã. Entre essa data e a conquista normanda no ano de 1066, outros 500 empréstimos linguísticos do latim reconhecíveis hoje

adentraram o inglês antigo (Serjeantson, 277-288). Um grupo substancial de palavras religiosas em inglês se originaram com a transferência do cristianismo diretamente para a Grã-Bretanha: as palavras latinas *apostolus, credo, crucem, discipulus* e *martyr* sobreviveram como *apostle (apóstolo), creed (credo, crença), crucifix (crucifixo), disciple (discípulo) e martyr (mártir).*

Seguindo o que os linguistas puristas Thomas Algeo e John Piles (2005, 124) chamaram de "a grande catástrofe da conquista normanda," uma terceira onda de influência latina ocorreu por meio do francês normando, a língua de uma recém-instalada monarquia e aristocracia imposta às classes trabalhadoras da Grã-Bretanha feudal. Do século 11 ao 14, milhares de palavras latinas foram adicionadas ao inglês por meio do francês normando, notadamente em temas como religião, leis e vida privilegiada. A ciência praticamente não se desenvolveu na idade média; portanto, as palavras científicas do latim (algumas vezes originárias do grego) em inglês, ficavam restritas a termos simples de astronomia e geografia (*comet* – cometa, *equator* – equador, *circumference* – circunferência), nomes de plantas (*asparagus* – aspargo, *delphiniums* – esporinha, *juniper* – zimbro, *lilies* lírios, – *roses* – rosas, *violets* – violetas), animais (asp - víbora, locust - gafanhoto) e minerais (copper – cobre, onyx – ônix). O quarto momento de influência se deu nos séculos 15 e 16, quando um interesse renovado na cultura e aprendizagem clássica levou a numerosas adições de palavras formadas por raízes latinas. Tipicamente, essas adições foram de natureza geral: *area, innuendo, censos, curriculum, impetus, radius* (Serjeantson 264-265).

Em algum momento tardio no período do inglês antigo, os sons vocálicos começaram a abrandar, o que se acelerou depois com a influência do francês normando. A velar surda herdada da matriz da língua germânica perdeu intensidade, suavizando a pronúncia de várias consoantes. Essas mudanças, juntamente com a infiltração do vocabulário latino, mudaram o inglês de uma língua germânica para uma posição intermediária entre os ramos germânico e itálico do indo-europeu original. James Lovelock (1988, 17) observou que "a guerra tribal entre normandos e saxões perdurou muito: o erudito medieval, sabendo onde se encontravam o poder e a preferência, escolheu apoiar o sistema normando vitorioso e manter o latim como seu idioma." O latim para os eruditos, e o descendente normando do latim para o povo: isso fez o inglês ainda mais aberto às influências do latim do que a maioria das outras línguas europeias, com adição massiva de raízes de origem latina na era do humanismo renascentista e a ascensão da ciência. Melvin Bragg (2003, 109-120) caracterizou esse período como "um renascimento de palavras." Muitas adições latinas ao inglês não modificaram a sua ortografia; o fato de que muitas dessas (*bacteria, corona, fungus, opus, strata* e *virus*) serem consideradas hoje como palavras da língua inglesa revela o quanto o inglês tornou-se compatível para as adições latinas.

A influência do latim em outras línguas europeias é evidente embora não com tanta penetração. Como observado, o seu meio foi principalmente os textos religiosos. Por todo o período do domínio da igreja católica, o latim foi a língua das crenças, teologia, e textos religiosos de referência, como *Civitas Dei* (*City of God*, ou cidade de Deus) de Santo Agostinho, *Consolatio Philosophia* (*Consolation of Philosophy*, ou a consolação da filosofia) de Boetius e *Summa*


CHRISTIA
NAE RELIGIONIS INSTI-
tutio, totam fere pietatis summã, & quic
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PRAEFATIO AD CHRI
stianissimum REGEM FRANCIAE, qua
hic ei liber pro confessione fidei
offertur.
IOANNE CALVINO
Noviodunensi autore.
BASILEAE,
M. D. XXXVI.

Ilustração 2. *Christianae Religionis Institutio* (1536) de John Calvino, traduzida para o inglês como *Institutes of the Christian Religion* (1559), se tornou a obra definidora da religião protestante, incluindo os imigrantes puritanos das colônias americanas. A divisão das palavras do título, Christia/nae and Insti/tutio podem indicar limitações de tamanho de fontes disponíveis.

Theologica (*Complete Theology*, ou Teologia Completa) de São Tomás de Aquino, e continuou para al[em da igreja católica com o *Institutio Christianae Religionis* (*Institutes of Christian Religion*, ou institutos da religião cristã) de Calvino, quando a reforma protestante redefiniu as fundações da autoridade cristã.

A influência do latim no período medieval dificilmente pode ser exagerada, como deixa clara a documentação massiva em *European Literature and the Latin Middle Ages* (*Literatura europeia e a Idade M*édia latina), de Robert Curtius, publicada em 1948.

No Renascimento, a influência latina cresceu e tornou-se o meio para variados textos laicos. Em 1509, Desiderius Erasmus (1466-1536) publicou sua sátira *Stultitiae Laus* or *Moriae Encomium* (*In Praise of Folly*, ou *Elogio da Loucura*). Em 1516, Thomas More publicou sua sátira política *Utopia* (*No place*, ou *lugar algum*); embora esse título derive do grego, a obra foi escrita em latim. Um dos mais antigos romances escritos em latim, *Somnium* (*The Dream*, ou *O sonho*, 1608) de Johannes Kepler é reconhecido como ficção científica. Nos séculos 16 e 17, as obras antigas de ciências foram publicadas em latim. Em seu leito de morte em 1543, o polonês Copernicus lançou o seu *De Revolutionibus Orbium Cœlestium* (*On the Revolution of Heavenly Orbs*, ou *Sobre a revolução das esferas celestes*) que estabeleceu sua teoria heliocêntrica do sistema solar. Em 1610 o italiano Galileo reapresentou a teoria em *Siderius Nuncius* (*The Sidereal Messenger*, ou *O mensageiro sideral*). Em 1620 o ensaísta e filósofo britânico Francis Bacon apresentou os princípios da observação e da dedução, em *Novum Organum Scientiarum* (*New Instrument of Science*, ou *Novo meio da ciência*). O médico dinamarquês Nicholas Steno, realocado na Itália, confrontou o mistério dos fósseis animais encrustados em pedra no *De Solido intra Solidum* (*On a Solid inside a solid*, ou *Sobre um sólido dentro de um sólido*); em 1641 o filósofo Descartes completou *Meditationes de Prima Philosophia* (*Meditations on First Philosophy*, ou *Meditações sobre a primeira filosofia*), apresentando uma nova abordagem para as certezas filosóficas; *Ethica*, a obra máxima do filósofo português Baruch Spinoza surge em 1677; e o matemático britânico Isaac Newton estabeleceu os princípios do cálculo *em Principia Mathematica* (1687).

Ilustração 3. *Siderius Nuncius* (1608) de Galileo, traduzido como *The Starry Messenger* (*O mensageiro estrelado*) em 1610, apresentou a teoria heliocêntrica do universo, que o levou à inquérito em Roma, onde foi forçado a renunciar à sua teoria e a cumprir prisão domiciliar nos 8 últimos anos de sua vida.


SIDEREVS
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PERSPICILLI
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QVATVOR PLANETIS
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diem cognitos, nouissimè Author deprehendit primus; atque
MEDICEA SIDERA
NVNCVPANDOS DECREVIT.
VENETIIS, Apud Thomam Baglionum. M DC X.
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filósofo português Baruch Spinoza surge em 1677; e o matemático britânico Isaac Newton estabeleceu os princípios do cálculo *em Principia Mathematica* (1687).

A influência mais drástica do latim nas ciências foi nas descrições da biologia. Descrições detalhadas de plantas originadas milênios antes por um discípulo de Aristóteles, Theophrastus de Eresos (370-285 ac), cujo *De Causis Plantarum* (*On the Origin of Plants*, ou *Sobre a origem das plantas*) e *De Historia Plantarum* (*On the History of plants,* ou *Sobre a história das plantas*) sobreviveram. Suas deduções, junto às de outros numerosos escritores gregos e latinos, foram consultados por Plínio, o Velho (23-79 da era cristã). No desenvolvimento do latim como uma língua de descrições para a botânica, destaca-se a influência da obra de Plínio, *Historia Naturalis* (*Natural History,* ou *História natural*) que teve 190 edições latinas entre 1469 e 1799. Plínio adotou palavras latinas de maneira metafórica, e, portanto, forneceu poucos termos familiares da botânica – corona, pistillum, pollen, e muitos outros, reconhecidos apenas por botânicos profissionais. A influência de Plínio é vista no texto de 1601, *Rariorum Plantarum Historia* (*History of Rare Plants,* ou *Historia das plantas raras*) de Cariolus Clusius (1526-1609).

O uso mais extenso do latim para descrições botânicas no período pré-iluminista veio do botânico inglês John Ray (1627-1705) cuja obra de 3000 páginas, *Historia Plantarum*, dividida em três fólios imensos (1686-1704), descreveu 18000 espécies. O projeto foi ambicioso, mas as ilustrações que o autor planejou nunca foram incluídas, por falta de apoio financeiro. Além disso, o inventário enciclopédico de plantas de Ray não foi guiado por um sistema de classificação mais importante; de fato, como Paoli Rossi (2000, 179) observa, "Ray não acreditou [...] que a natureza pudesse estar geométrica e simetricamente organizada." Embora vasto, aquele foi o último inventário de plantas não guiado por algum tipo de sistema organizado. Enquanto isso, Joseph Pitton de Tournefort (1656-1708), um botânico francês, publicou em 1696 *Elements de Botanique* (*Elementos da botânica*), no Jardin des Plantes em Paris, e depois o republicou em latim como *Institutiones Rei Herbariae* (1700), em cuja introdução explicou o seu sistema de classificação baseado inteiramente em gêneros, com distinções traçadas a partir das diferenças morfológicas da corola, que adorna a parte reprodutiva das flores. Usando essa metodologia restrita, Tournefort descreveu mais de 10000 espécies classificadas em quase 700 tipos. Embora não tão abrangente quanto a *História das plantas* de Ray, como aponta Julius von Sachs (1890, 78), as ilustrações notáveis de Tournefort, entalhadas em placas de cobre, junto a descrições felizes tornou suas obras populares e influentes no século dezoito, até serem substituídas, na metade do século, pela obra de Carl Linnaeus.

O desenvolvimento que levou a descrição botânica para além de um mero inventário, teve lugar com a revolução linguística de Linnaeus, que dispôs os parâmetros para a descrição e anotação científica que estabeleceu o latim como a língua universal da ciência. Ele poderia ter escolhido escrever em sueco, mas isso teria certamente reforçado a tendência de separação de vocabulário para a ciência nas numerosas línguas vernáculas da Europa e de outros lugares. A influência de Linnaeus reside primeiro na variedade de tratados em latim produzidos entre 1736 e 1753; *Fundameta Botanica* (*Botanical fundamentals*, ou *Fundamentos da botânica*), *Genera Plantarum* (*Origin of Plants,* ou *Origem das plantas*), *Philosophia Botanica* (*The Science of Botany*, ou *A ciência da botânica*), e *Species Plantarum* (*Plant Species,* ou *Espécies de plantas*). Sua cobertura enciclopédica em latim estabeleceu essas obras como padrão para cientistas de toda a Europa poderem consultar, o que realmente ocorreu. Em segundo lugar, Linnaeus utilizou termos disponíveis, usados anteriormente em obras desde Theophrastus e Plínio, mantendo-se fiel às definições lexicais estabelecidas. Como William T. Stearns (1992, 34-35) coloca, "ele selecionou das palavras clássicas convertidas em termos técnicos por seus predecessores aquelas que pareciam aptas, agradáveis e não ambíguas." A terceira contribuição de Linnaeus foi a adoção de palavras latinas para o uso da botânica, sem levar em consideração seus significados clássicos originais. Um exemplo instrutivo em sua publicação de 1736, *Fundamenta Botanica* (*Fundamentals of Botany*, ou *Fundamentos da botânica*) é a 'corola' – "uma pequena coroa ou grinalda" no uso clássico – que ele adotou especificamente para nomear as pétalas atraentes e salientes que circundam os órgãos sexuais das flores. A esse uso diverso do significado lexical, Richard Robinson (1950) chamou de 'definição

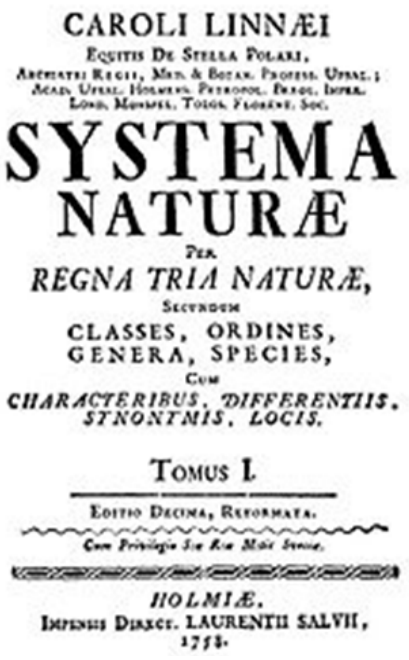

CAROLI LINNÆI
EQUITIS DE STELLA POLARI,
ARCHIATRI REGII, MED. & BOTAN. PROFESS. UPSAL.;
ACAD. UPSAL. HOLMENS. PETROPOL. BEROL. IMPER.
LOND. MONSPEL. TOLOS. FLORENT. SOC.
SYSTEMA
NATURÆ
PER
REGNA TRIA NATURÆ,
SECUNDUM
CLASSES, ORDINES,
GENERA, SPECIES,
CUM
CHARACTERIBUS, DIFFERENTIIS,
SYNONYMIS, LOCIS.
TOMUS I.
EDITIO DECIMA, REFORMATA.
Cum Privilegio Sac. Reg. Maj. Sveciæ.
HOLMIÆ,
IMPENSIS DIRECT. LAURENTII SALVII,
1758.

Ilustração 4. A página de título da primeira edição de *Systema Naturae* (1753) de Linnaeus descreve a natureza em três reinos: (*Regna Tria*) com uma taxonomia preliminar de quatro partes: classes, ordens, gêneros e espécies.

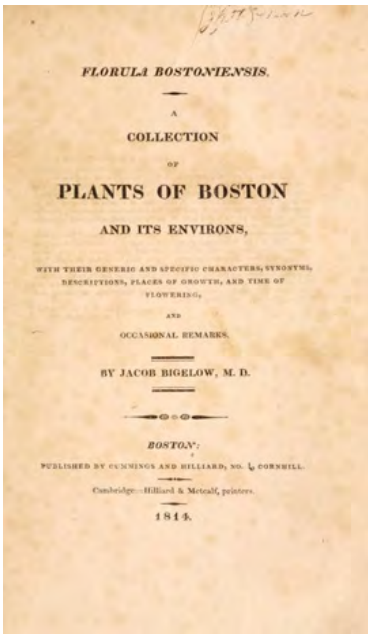
estipulativa,'uma destilação, criativa e arbitrária, de novos significados para o vocabulário clássico. Tal terminologia traz o sabor do latim clássico para novos usos, embora tal definição estipulativa tenha ocorrido também em muitos outros campos e praticamente não pode ser evitada na história da ciência.

A mais significativa inovação de Linnaeus foi um desenvolvimento completo das descrições da botânica iniciadas em *Systema Naturae* (1735) com a abordagem mais abrangente ocorrida na décima edição (1758) e consideravelmente aprimorada na décima-segunda edição (1766-1768). No estilo extenso dos primeiros livros, a página de título da primeira edição de Linnaeus já exibia sua organização em quatro partes – classes, ordens, gêneros e espécies – a fundação de um sistema de classificação, ou taxonomia, hoje adotada universalmente. Na prática, Linnaeus estabeleceu um sistema de identificação em duas partes, agora conhecido como nomenclatura binária. Como Paoli Rossi (2000, 175) observa, na nomenclatura binomial de Linnaeus, dois termos contém "uma impressionante riqueza de informações [...] o primeiro define o gênero e o segundo a espécie, distinguindo o ser de todos os outros do mesmo gênero. A identificação de uma espécie não é simplesmente a identificação das diferenças, mas também o reconhecimento das similaridades de outros do mesmo gênero."

No sistema totalmente desenvolvido, o processo de sequência do específico (apropriadamente chamado de "espécie") para o geral expande os quatro níveis de Linnaeus para sete: espécie, género, família, ordem, classe, filo e reino. Assim, na identificação de uma árvore de carvalho — digamos *Quercus alba*, carvalho branco do leste da América do Norte — alba (branca) significa uma das 600 espécies pertencentes ao gênero *Quercus* (carvalho), que faz parte da família *Fagaceae* da ordem *Fagales*, uma classe de *Magnoliopsida,* do filo *Anthophyta* do reino *Plantae*. Enquanto a maioria dos termos intermediários não são familiares, o termo final identifica uma árvore de carvalho como parte de uma vasta categoria de plantas. De maneira semelhante, na designação familiar dos humanos modernos, *Homo sapiens*, nossa espécie *sapiens* é uma das várias espécies extintas (*habilis, erectus, neanderthalis*) no gênero *Homo*, que faz parte da família *Hominidae* dentro da ordem *Primates*, parte da classe *Mammalia*, que pertence ao filo *Coradata* dentro do reino *Animalia* — mais uma vez uma categoria reconhecível. Na nomenclatura de Linnaeus, esses dois reinos, *Plantae* e *Animalia*, marcaram o limite de classificação no século XVIII. Os cinco reinos de Lynn Margulis (1982) tiveram o acréscimo de mais três: Monera, Protista e Fungi.

Em 1750, quatorze anos após a publicação do seu *Fundamenta Botanica* (1736), Linnaeus expandiu suas trinta e seis páginas para um livro de 364 páginas que ele chamou *Philosophia Botanica*, com onze placas de ilustração. Stearn (1992, 35) define-o como "o primeiro livro de sistemática descritiva botânica latim botânico". Sua influência é evidente em traduções e versões expandidas ilustradas, que logo apareceram na Inglaterra, França e Alemanha. Entretanto, com a geração de novos conhecimentos, um novo vocabulário era necessário, e o latim tornou-se a fonte. Mas o latim clássico, apesar de sua extensa riqueza linguística, não atendia as necessidades linguísticas do novo conhecimento. Foi aqui que um novo tipo de latim foi desenvolvido: um vocabulário em conformidade com a estrutura linguística de prefixos, sufixos e raízes latinas foi criado.

No século XIX, a nomenclatura binomial e um vocabulário latino de caules de plantas, folhas, flores e cores foi desenvolvido o suficiente para que as plantas pudessem ser observadas e identificadas sem ilustrações de apoio. É difícil para nós hoje imaginarmos essa situação, porque contamos com os guias de campo de Peterson e Smith, amplamente ilustrados. Os primeiros observadores de plantas foram evidentemente, observadores refinados. A obra de 1814, *Florula Bostoniensis* (Flores de Boston), de Jacob Bigelow, tornou-se o livro de trabalho para Henry David Thoreau (1817-1862), que estudou as plantas, flores e árvores ao longo da excursão dele e do irmão, narrada em *A Week on the Concord and Merrimark Rivers* (*Uma semana nos rios Concord e Merrimack*), de 1849, seus dois anos vivendo na floresta, registrado em *Walden* (1854) e três expedições combinadas em *Cape Cod* (1865). Seu conhecimento


FLORULA BOSTONIENSIS.

A

COLLECTION

OF

PLANTS OF BOSTON

AND ITS ENVIRONS,

WITH THEIR GENERIC AND SPECIFIC CHARACTERS, SYNONYMS, DESCRIPTIONS, PLACES OF GROWTH, AND TIME OF FLOWERING,

AND

OCCASIONAL REMARKS.

BY JACOB BIGELOW, M. D.

BOSTON:

PUBLISHED BY CUMMINGS AND HILLIARD, NO. 4, CORNHILL.

Cambridge:—Hilliard & Metcalf, printers.

1814.

Ilustração 5. A obra *Flurola Bostoniensis* de Jacob Bigelow (1814) foi usada por Henry David Thoreau (1817-1862), um estudante autodidata de espécies botânicas para onde viajasse. Além de listas de espécies apensadas ao *The Maine Woods*, o diário de vinte volumes de Thoreau inclui anotações sobre espécies de plantas na nomenclatura de Linnaeus — incluindo registros de plantas florescendo ao longo de muitos anos. A comparação com as datas de floração de hoje, ocorrendo vários dias mais cedo, forneceu evidências para a constatação do aquecimento global.

de botânica é evidente nas obras póstumas onde encontramos listas completas na forma binomial de Linnaeus como apêndices a *The Maine Woods*, 1864 (*Os bosques do Maine*) e em seu tardio "manuscrito perdido", recuperado e publicado como *Wild Fruits* (*Frutos silvestres*) em 2000. Depois de doze anos de trabalho, o pintor John James Audubon publicou o trabalho de sua vida, 435 pinturas intituladas *The Birds of America* (*Os* pássaros da América) em 1839. Cada ilustração traz o nome comum e o nome científico de acordo com a nomenclatura de Linnaeus.

Em um contexto muito distante da Suécia de Linnaeus, da Nova Inglaterra de Thoreau ou do contexto maior da América de Audubon, o Banco de Mitigação de Áreas Verdes Pantanosas (2006) fornece um inventário das espécies em 1450 hectares de reserva florestal, em Houston, Texas. Aqui encontramos o *Hyla cinerea* (sapo verde) entre 14 anfíbios; *Procyon lotar* (guaxinim) entre 15 mamíferos; *Micropterus salmoides* (achigã) entre 22 espécies de peixes; 15 répteis, incluindo o jacaré americano, a cobra cabeça-de-cobre e a cobra-coral do Texas; 70 invertebrados, como espécies de abelhas, besouros, formigas e borboletas; e mais de 450 espécies de vegetação — um total de 550 espécies de flora e fauna identificadas pela nomenclatura binomial de Linnaeus e nomes comuns em inglês.

Tais inventários exaustivos são mais frequentemente encontrados em trechos limitados de terra separados para estudo, bem como para preservação. Inventários seletivos foram compilados para as árvores e plantas cuidadosamente recolhidos nos jardins londrinos, *The Royal Botanic Gardens* e *Kew* (Utteridge e Bramley, 2016) e os jardins botânicos de Singapura (Sim, 2017) preservou espécies que datam dos dias do Império britânico. Flores silvestres atraem nossa atenção mais do que plantas puramente verdes, por essa razão, há uma ênfase nas flores silvestres nos inventários de plantas de extensas regiões nos Estados Unidos: *Everglades* na Flórida (Hammer, 2015), as montanhas de *Sierra Nevada* exploradas por John Muir (Wiess, 2013, Wenk 2015), o Parque Nacional das *Great Smoky Mountains* (Stupka, 1964) e a maioria dos outros parques nacionais e estaduais. Inventários oceanográficos de corais e criaturas do mar encontram-se por trás da criação de reservas submarinas, tais como o noroeste da cadeia de montanhas submarinas havaianas (Fenner, 2005, Hoover, 2010). Tais inventários de Linnaeus aparecem de regiões distantes com diversas origens linguísticas, do sudeste da Ásia, por exemplo: *Florestas de mangue da Península Malaia* (Watson, 1928); *Frutos de Bali* (Eiseman, 1988); *Aves das Filipinas* (Kennedy, 2000); e *o Guia de campo para os répteis da Tailândia* (Chanard 2015).

Uma inovadora modificação do latim é evidente em *Flora Lapponica* (*Flores da Lapônia*) de 1737, de Linnaeus, resultado de cinco meses de viagem à Lapônia. O título fornece um nome latinizado para 'Lapônia'e destaca-se como um guia de campo regional para flores. O seu *Svecica Flora* (*Flora da Suécia*), de 1744, ofereceu o mesmo para a Suécia. Topônimos latinizados continuam a aparecer na posição da espécie, como em *Fulica americana* (galinha d'água americana), *Quiscalus mexicanus* (graúna de rabo grande), *Melospiza georgiana* (pardal do pântano), and *Sylviagus floridanus* (coelho-de-cauda-de-algodão do leste) — geralmente indicando

onde foi identificada uma determinada espécie. O Homem de Pequim, por exemplo, encontrado perto da capital da China na década de 1920, foi originalmente chamado *Sinanthropus pekinensis*, que incorpora as versões latinizadas de China (Sina) e a anglicizada Peking (Pequim). Essa designação precipitada ficou emaranhada com a *Multiregional Evolution Hypothesis* (MEH), ou hipótese da evolução multregional, em oposição a *Recent Out of Africa Hypothesis,* (ROAH), ou modelo fora da África para os humanos modernos, com a permanente reticência chinesa e crítica ao ROAH (Wu, 2004) e a crença em uma origem asiática e evolução chinesa do *Sinathropus pekinensis,* ao invés de uma ascendência africana. No entanto, o reconhecimento do Homem de Pequim como um descendente da espécie africana *Homo erectus* tem substituído o MEH.

Outra inovação reveladora é encontrada em *Hortus Cliffortianus* (*Jardim de Clifford*), de 1738, escrito na Holanda, enquanto Linnaeus era um convidado do rico banqueiro George Clifford, governador da Companhia das Índias Orientais, e um botânico entusiasmado, que desenvolveu um grande herbário. A nomeação de espécies com o nome de seus descobridores é outra inovação do latim usado na botânica. Durante a administração britânica da Indonésia, Sir Stamford Raffles (1781-1826) serviu como tenente governador de Java (1811-1815), mais tarde Bencoolen, em Sumatra (1817-1822). Famoso por fundar Cingapura, ele é famoso também por um drinque, o *Singapore Sling* (um coquetel preparado com gim), inventado no Hotel Raffles. Durante uma expedição em Sumatra, ele e Joseph Arnold descobriram uma planta parasitária gigante cujo nome hoje celebra ambos os descobridores: *Rafflesia arnoldii*. O renomado e largamente publicado entomologista, Edward O. Wilson, reconhecido pelo seu estudo sobre formigas é homenageado em várias espécies de formigas: *Wilsonia megagastrosa*, *Wilsonia lianoingensis* e outras.

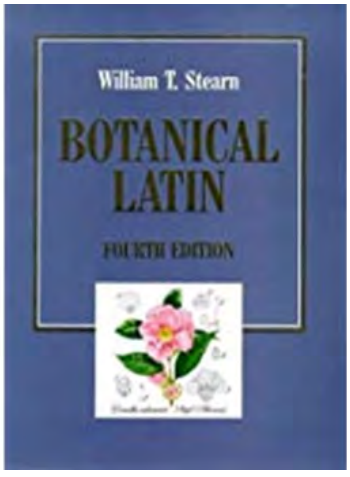


Ilustração 6. A obra *Latim Botânico*, de William T. Stearn inclui as regras básicas da conjugação latina, declinações, gramática, terminologia e nomenclatura binomial.

O latim a serviço da botânica tem sido o mais completamente articulado, graças ao exaustivo trabalho de William T. Stearn (1911-2001), conhecido por dezenas de publicações, incluindo o *Dicionário de nomes de plantas* (1972) e *Os artistas florais de Kew* (1990). Sua obra máxima, *Latin Botânico*, subintitulado *história, gramática, sintaxe, terminologia e vocabulário*, passou por quatro edições (1966, 1973, 1982, 1992), múltiplas reimpressões e traduções e é reconhecido entre os botânicos de todo o mundo.

Curiosamente, o latim para a botânica, que foi firmemente estabelecido no século XVIII, posteriormente espalhou-se bem além da biologia. Elementos químicos, a maioria dos quais isolados mais tarde, tem etimologias clássicas indicando origens mais ou menos iguais do grego e do latim. Nomes de elementos do grego muitas vezes derivam de divindades gregas ou figuras mitológicas — hélio (Helios), irídio (Iris), nióbio (Niobe), plutônio (Plutão), promécio (Prometheus), selênio (Selene), tântalo (Tantolos) — com suas terminações rotineiramente latinalizadas. Elementos do latim às vezes homenageiam divindades — mercúrio (Mercurius), cério (Ceres), neptúnio (Netuno); mais frequentemente preservam nomes latinos para substâncias ou qualidades — cálcio (calx), carbono (carbo), cobre (cyprum), telúrio (tellus), silício (silicis). Quando novos elementos químicos são nomeados para homenagear eminentes figuras históricas, são fornecidos regularmente com terminações latinas: Copernício (Copernicus) cúrio (Marie Curie), mendelévio (Dmitri Mendeleyev), férmio (Enrico Fermi), Rutherfórdio (Ernest Rutherford), einstênio (Albert Einstein) e nobélio (Alfred Nobel).

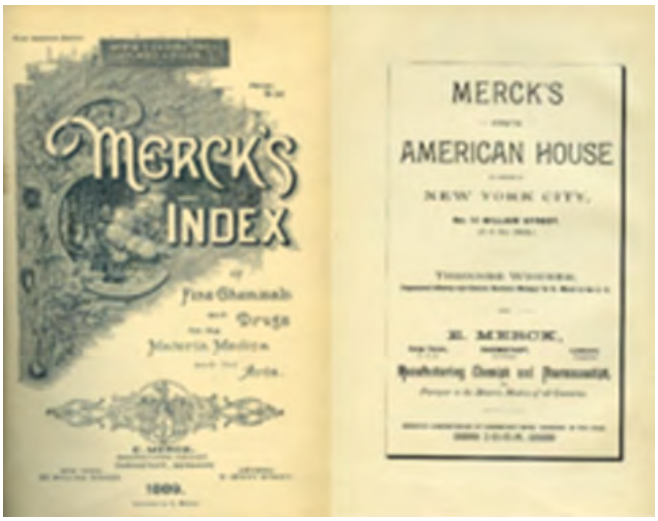


Ilustração 7. A primeira edição do Índice de Merck, publicado em 1889. Esse tomo enciclopédico está agora na sua 15a edição.

Elementos em sua forma bruta, particularmente os metálicos, são de valor para o uso humano em muitos aspectos, como bem ilustrado no uso de alumínio, ferro, cobre, ouro, prata e estanho. Em combinação, eles têm numerosas aplicações industriais e tecnológicas. No entanto, o Índice de Merck, publicado pela primeira vez há 129 anos, agora em sua 15ª edição, estende os elementos químicos para remédios e produtos farmacêuticos. Edições mais recentes, que são subintituladas "uma enciclopédia de produtos químicos, drogas e substâncias biológicas", incluem mais de 10.000 entradas. Muitos deles são compostos simples, alguns extratos orgânicos. As listas, mesmo contendo três ou mais elementos, normalmente imitam a nomenclatura binomial da taxonomia botânica de Linnaeus. O cloreto de manganês tem dois componentes (Cl_2Mn); o octaacetato de sacarose contém três ($C_{28}H_{38}O_{19}$), o etóxido de alumínio quatro ($C_6H_{15}AlO_3$), o cloridrato de mecisteína cinco ($C_4H_{10}ClNO_2S$), o clorocromato de piridíneo seis ($C_5H_5ClCrNO_3$). Esses e outros produtos químicos são mais frequentemente referidos por seus nomes comuns; por exemplo, sulfato de ferro e nitrato de potássio; mas quando são incorporados em descrições químicas, são latinizados — *ferri sulphas, kalii nitras*. Há, de fato, muito a saber ao se navegar esta vasta paisagem latinizada. O boato dos meus anos de ensino médio que estudantes indo para a faculdade de medicina devem aprender latim não é mais apoiado pelos currículos do ensino médio; estudantes de medicina agora normalmente se matriculam em cursos rápidos de "latim médico."

A língua inglesa, como a mais extensamente falada no mundo tem sido excepcionalmente receptiva ao latim científico. Em grande medida, este é o resultado das várias palavras latinas mais gerais que foram preservadas em inglês tão facilmente que um leitor letrado mal distingue-as como estrangeiras. Assim, podemos nos deparar com termos latinos familiares em uma variedade de contextos: *ad hoc, a priori, argumentum ad hominídeo, de facto, deus ex-machina, ipso facto, magnum opus, modus operandi, non sequitur, per se, quid pro quo, reducto ad absurdum* e *terra firma*. Filósofos são conhecidos por uma frase em latim — Descartes por *cogito ergo sum*, Locke por tabula rasa, Freud pelo *ego* e *id*. Acadêmicos ainda intitulam uma lista de suas credenciais como *curriculum vitae*. John Dryden publicou um poema chamado *Annus Mirabilis* para comemorar a sobrevivência de Londres em 1666, após o grande incêndio de Londres. O termo foi aplicado aos anos de 1543, quando Copernicus lançou sua teoria heliocêntrica; 1776, ano da independência dos Estados Unidos; 1905, o ano em que Einstein publicou sua teoria geral da relatividade; e dezenas de outros anos de significado na vida dos famosos. Quando a rainha Elizabeth II falou em finais de 1992, um ano de escândalos da família real, divórcios e o devastador incêndio no Castelo de Windsor, ela evocou um termo latino, *Annus horribilis*.

Sem dúvida, Cícero, Virgílio e Lucrécio ficariam surpresos ao descobrir que sua língua sobreviveu e expandiu-se por mais de dois milênios e é agora a única língua verdadeiramente universal. Em sua penetração na comunidade científica, supera até mesmo o inglês. Não conscientes da estatura de seu idioma em culturas mais tardias, escritores romanos ficariam intrigados com livros de títulos latinos

escritos numa língua irreconhecível: o tomo de três volumes *Principia Mathematica* (1910), de Alfred North Whitehead e Bertrand Russell e o *Tractatus Logico-Philosophicus* (1921), traduzido por Ludwig Wittgenstein, ambos em inglês. De outra perspectiva, estudantes universitários de hoje, documentando seus trabalhos ficam igualmente intrigados com a finalidade de fósseis latinos, como *op. cit., loc cit* e *et al*.

A história do latim na ciência, literatura e cultura geral revela uma penetração desta antiga língua muito mais extensa do que é geralmente reconhecida. Uma exploração abrangente e um inventário de suas aplicações extensas, como nas 546 páginas do *Latim para a botânica* de Stearn ou nas 1818 páginas do índice de Merck bem ilustram, podem exigir muitos volumes como uma enciclopédia. Nesta conexão, somos lembrados de uma das mais influentes obras de muitos volumes, publicados entre 1768-1771, durante a vida de Linnaeus — o mais importante trabalho de conhecimento geral em inglês; curiosamente, seu título preserva a estrutura gênero-espécie do latim para a botânica de Linnaeus: a *Encyclopedia Britannica*.

O latimé útil como linguagem científica e técnica, pois é uma língua escrita ao invés de falada e, portanto, é imune a anomalias vocais, alterações de vogal, variações de consoantes e modificação coloquial. Invenções e adições de vocabulário ocorrem, mas as raízes e elementos utilizados na adição de novos termos são fixos. Ninguém fala *Latinus Scientificus*, mas cientistas em todos os cantos do mundo encontram coordenadas permanentes de significado em uma estrutura formalizada há mais de dois séculos. É tão dominante, que tem influência para bem além do que foi destinado. Várias obras literárias europeias foram traduzidas para o latim: o italiano *Divina Comoedia* (A d*ivina comédia*), o espanhol *Dominus Quixotus a Manica* (*Dom Quixote),* o português *Lusiadae* (*Os Lusíadas*), o alemão *Werther Iuvenis Quae Passis sit* (*Os sofrimentos do jovem Werther*), e os romances ingleses *Rebilius Cruso* (*Robinson Crusoé*) e *Superbia et Odium* (*Orgulho e preconceito*). A tradução de romances para o latim no século XX praticamente desapareceu; uma exceção notável é a tradução em latim do romance de George Orwell 1944, *Fundus Animalium* (*Animal Farm*), uma esquisitice anacrônica.

A vitalidade do latim ainda vive, mesmo tendo quase desaparecido dos currículos do ensino médio e da faculdade. A tradução de contos de fadas e livros infantis fornece um indicador divertido e bem-humorado do prestígio do latim e de sua vitalidade.

Isso inclui clássicos como *Alicia in Terra Mirabili* (Alice no país das maravilhas), *Insula Thesauraria* (ilha do tesouro), *Pericia Thomae Sawyer* (aventuras de Tom Sawyer), *Beata Illa Nox* (a véspera de natal), *Fabula De Petro Cuniculo* (o conto de Peter Rabbit) , *Winnie Ille Pu* (Winnie o Pooh), *Hobbitus Ille* (Hobbit), *Tela Charlottae* (a teia de Charlotte), *Cattus Petasatus* (o gato no chapéu), *Virent ova! Virent Perna!* (ovos verdes e presunto), *Arbor Alma* (a árvore doadora), Ubi Fera Sunt (onde as coisas selvagens estão) *e Quomodo Invidiosulus Nomine Grinchus Christi Natalem Abrogaverit* (como Grinch roubou o Natal).

O efeito é um posicionamento interessante de

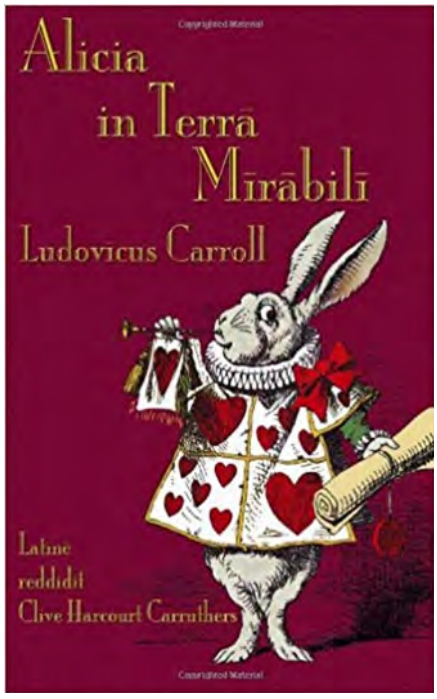


Ilustração 8. A *reddidit* (tradução) latina de Clive Harcourt Carruthers para *Alice no país das maravilhas* inclui uma versão latina do pseudônimo do autor original, Lewis Carrol. Etimologicamente, Ludovicus é uma versão latinizada do nome alemão Hluwig, que se processa em inglês como Louis ou Lewis. O nome verdadeiro de Carrol era Charles Lutwidge Dodgson, seu nome do meio sendo o original de Ludovicus — uma ilustração conveniente dos emaranhados da transferência de vocabulário.

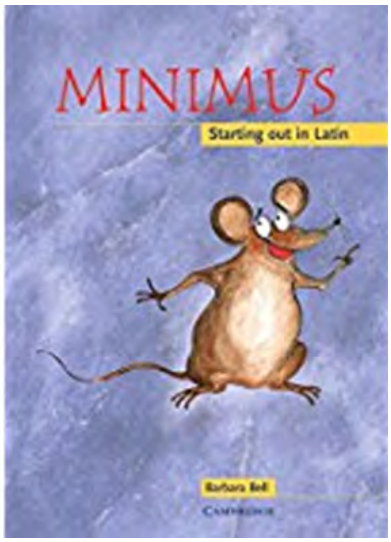


Ilustração 9. *Minimus* (2000), de Barbara Bell é o primeiro de uma série que inclui um CD de áudio e dois livros em espiral de recursos didáticos para o professor (2000, 2004 da Cambridge University Press).

livros infantis, juntamente com as maiores obras acadêmicas do mundo ocidental, de Galileu, Newton e Wittgenstein. Mas parece haver um lado sério neste anacronismo. Iniciar crianças no latim alinha-se muito bem com a atual American Association for the Advancement of Science (AAAS - associação americana para o avanço dos esforços da ciência) através das normas para a ciência na próxima geração (2011) para motivar um número maciço de estudantes a assumir o estudo avançado das ciências.

Os materiais estão disponíveis para despertar o interesse das crianças pelo latim como base para o posterior domínio do latim científico. Os recursos são extensos: Minimus livro do aluno: começando no latim (2000) de Barbara Bell, o livro seguinte Minimus Secundus (2004), um livro de atividades de latim associado ao primeiro (2005) e um CD de áudio Minimus (2006) fornecem abordagens acessíveis. Todos trazem o selo oficial de aprovação da Cambridge University Press. Aaron Larsen traz a ideia agora desatualizada, mas nostálgica da cartilha em seu latim para crianças: Cartilha A e Cartilha B (2003), apoiados por um DVD da Cartilha A (2006) — com opções de "pronúncia clássica ou eclesiástica".

Entretanto, como fósseis de ancestrais humanos continuam aparecendo, o sistema de nomenclatura binomial de Linnaeus permanece o sistema ao qual todas as descobertas obedecem. Raymond Hart (1925) começou quando aplicou o termo *Australopithecus africanus* (macaco do Sul da África) para um crânio primitivo encontrado perto de Taung, na África do Sul. Donald Johanson adicionou *Australopithecus afarensis* (homem-macaco de Afar) à descoberta de "Lucy", em 1974 em Afar. Desde então, a linhagem ancestral dos antepassados latinizada tem crescido a um ritmo acelerado. Uma descoberta de fósseis em 1975 em estreita associação com uma ferramenta de lítio avançada em um canteiro de obras levou ao *Homo ergaster* (homem trabalhador). Um humano totalmente bípede, descoberto em 1991 na Geórgia é chamado de *Homo erectus*. Descobertas fósseis europeias na década de 1990 de uma espécie considerada como um antecessor ou ancestral dos humanos europeus são denominados *Homo antecessor*. A descoberta de 2014 de humanos com tamanho de pigmeus na ilha Indonésia de Flores foi designada *Homo floresiensis*. A maioria desses exemplos ilustram a latinização dos locais de descoberta ou de artefatos a ela associados. Ocasionalmente ocorre uma esquisitice. *Homo naledi* refere-se a uma descoberta de 2013 de fósseis hominídeos no sistema Rising Star Cave da África do Sul. Naledi significa "estrela" nas línguas Sotho-Tswana; curiosamente esta designação da espécie escapou da latinização porque já se assemelhava a um adjetivo masculino em latim.

Apesar da sofisticação da nomenclatura binomial de Linnaeus, alguns espécimes surgem e resistem à classificação. Isto ocorreu com espécies extintas de plantas, vários animais, certo número de aves, e até mesmo bactérias, em que a descrição taxonômica deixa questões, ou controvérsias entre especialistas se desenvolvem; esses espécimes permanecem no limbo taxonômico. Em um trabalho seminal, S. C. Matthews (1972, 714) discutiu a necessidade ocasional de uma "nomenclatura aberta", ditada pela incerteza da classificação: "*Incertae familiae* (família incerta), *Incerti subordinis* (Subordem incerta), Incerti ordinis (*ordem incerta*), Incerti sedis (classe incerta)." Este termo abrangente para quebra-cabeças taxonômicos pode ser usado periodicamente: em uma discussão sobre antigos fósseis de Iowa, Richard Arnold Davis (1975) refere-se a sua "afinidade incerta". Graham J. Bird (2007) fornece outro exemplo, de um crustáceo

localizado nas trincheiras profundas da costa da Península de Kamchatka e do Japão, designando-a como "Família Incertae sedis." Às vezes, a remoção de um espécime de "classificação incerta" é efetivada através da criação de uma nova ordem, como aconteceu com o condor da Califórnia; em tais casos, a amostra pode ser designada espécie *inquirenda*, ou seja, sua identificação é duvidosa e requer mais investigação. Os termos *Incertae sedis* ("posicionamento incerto") e *Species inquirenda* ("que requerem investigação adicional") ilustram a dinâmica do latim científico em fornecer descritores mesmo para espécimes biológicas que momentaneamente desafiam a colocação dentro do sistema padrão de Linnaeus. Dentro do gênero *Homo*, temos um exemplo na recente descoberta de um osso de dedo e um molar na caverna Denisova, no sul da Rússia. O sequenciamento de DNA mostrou o acasalamento pré-histórico do povo da caverna Denisova com neandertais e marcadores revelam penetração genética na ilha a sudeste da Ásia e da Melanésia. Mas a relação entre os Neandertais, o povo da caverna Denisova e os migrantes presumidos *Homo erectus* da África aproximadamente há 1 ou 2 milhões de anos, deixa taxonomia precisa até agora, incerta — um exemplo dentro da linha dos hominídeos de *Incertae sedis*. Esta é uma situação em que os cientistas estão dispostos a recorrer a uma nomenclatura popular, ao invés de forçar um posicionamento incerto no sistema de Linnaeus. Até agora, esses hominídeos recentemente descobertos, são chamados simplesmente, *Denisovans,* assim como seus primos compatíveis, com os quais eles acasalaram, foram chamados, por muitos anos, simplesmente, Neandertais.

Agradecimentos

Eu gostaria de agradecer ao revisor anônimo, um estudante autodidata de latim, que fez uma leitura minuciosa, observações úteis e sugestões específicas para a melhoria deste trabalho.

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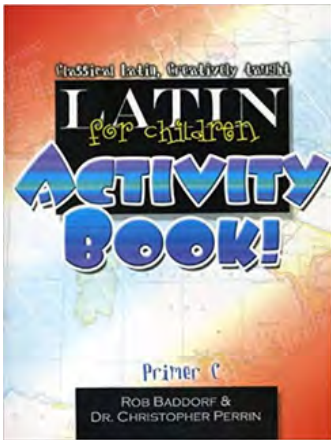

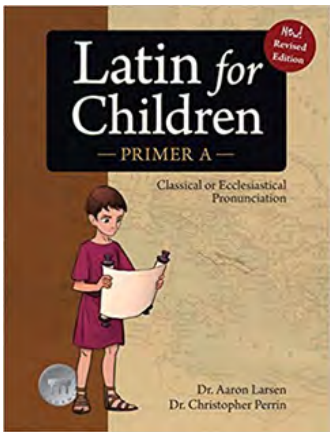

Illustration 10. Arron Lewis has produced a series—Latin for Children: Primer A and Primer B (2003) with a Latin for Children Activity Book, with support from a Primer A DVD (2006)

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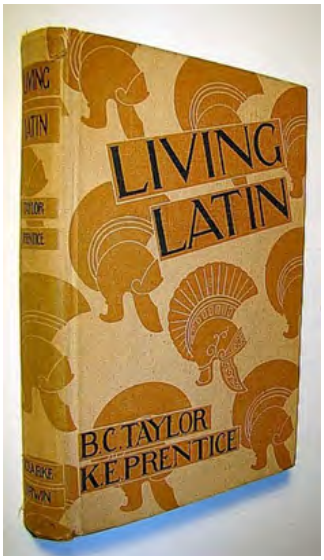

Illustration 11. B. C. Taylor and K. E. Prentice, Living Latin (Toronto: Clarke-Irwin & Company, 1956) was the most widely used Latin Textbook in Canada until its publisher was purchased by Thomas Nelson Publishing in 2002.

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Reading Alberto Caeiro's Poems with Anthropocene Eyes

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Abstract
The term "Anthropocene" proposed by Crutzen and Stoermer in 2000 names a new geological epoch, that endows humans with geological agency. The advent and acceptance of this new geological epoch begs the revision of Modernity's cherished concepts and the reframing of the so-called modern constitution, the Great Divide, as conceived by Bruno Latour. Modernity's wall, the one that separates humans and non-humans, shows its cracks in the Anthropocene. Literature, however, long ago, had anticipated the need for rethinking our relationship with Nature, especially with regards to the subject/object dichotomy. Alberto Caeiro, Fernando Pessoa's heteronym, claims that Nature had been neglected by all poets and thinkers, as he is the first poet to have noticed it. The present article aims at, therefore, reading Caeiro's poems with Anthropocene eyes so that the subject/object dichotomy, one of the pillars of Modernity, can be better investigated.

Key words: Anthropocene, Modernity, Subject, Object, Nature.

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"What words or tongue of Seraph can suffice, or heart of man suffice to comprehend?" (*Paradise Lost*, BK. VII, 113-14), Raphael asks himself, acknowledging the burden of the task at hand: warning Adam and Eve about Lucifer. Raphael's questions then reveal the disparity between two realms, namely that of man and that of celestial beings. How could he, an angel, speaking a celestial language that differed from that of man's disclose the creation of the world and the existence of Paradise to unfit ears? How could the father of mankind be able to comprehend events so distant from his daily life? Events unheard of, such as the war in Paradise? Two different realms, languages, constitutions.

When Raphael perceives Adam's curiosity, his tendency to look for God's traces on Earth, as if there were a correspondence between the visible and the invisible realms, he adds: "But Knowledge is as food, and need no less/ Her Temperance over Appetite, to know/ In measure what the mind may well contain/ Oppresses else with Surfet, and soon turns/ Wisdom to Folly, as Nourishment to Winde" Paradise Lost (BK. VII, 116-20). The comparison between Knowledge and food once more leads to the main problem: human constitution. Human understanding is limited, circumscribed by its constitution. That which is ungraspable, unimaginable, or even inexplicable stems from human limitation. There is a certain kind of knowledge, though, which may be humanly acceptable: in Raphael's terms, what the mind can contain. The mind, thus, as well as the stomach, is likened to a container, since its physical capacity is at play. The limitations are physical, constitutional. Surpassing the limit, trying to know more than the mind could physically sustain would mean turning "Wisdom to Folly". What's more, not only does the word "contain" emphasize the physical limitations of the mind, but also its control qualities. Humanly fit knowledge is the one the mind can control. It is no wonder, then, that Raphael is allowed to answer some of Adam and Eve's questions but with a condition: "I have receav'd, to answer thy desire/ Of Knowledge within bounds" Paradise Lost (BK. VII, 119-20). Limits, limitations, bounds: the world before the fall was a limited world,

it was living "within a circle or behind a line", as Stanley Cavell would say (CAVELL, 1988, p. 49).

After listening attentively to Raphael's narration, Adam summarizes his teachings:

> How fully hast thou satisfi'd mee, pure
> Intelligence of Heav'n, Angel serene,
> And freed from intricacies, taught to live,
> The easiest way, nor with perplexing thoughts
> To interrupt the sweet of Life, from which
> God hath bid dwell farr off all anxious cares,
> And not to molest us, unless we our selves
> Seek them with wandring thoughts, and
> notions vaine.
> But apte the Mind or Fancie is to roave
> Uncheckt, and of her roaving is no end;
> Till warn'd, or by experience taught, she learn
> That not to know at large of things remote
> From use, obscure or suttle, but to know
> That which before us lies in daily life,
> Is the prime Wisdom, what is more, is fume,
> Or emptiness, or fond impertinence,
> And renders us in things that most concerne
> Unpractis'd, unprepar'd, and still to seek
> Paradise Lost(BK. VIII.180-97)

The prime wisdom would thus be not letting the mind rove, by not allowing it to entertain itself with matters far from reach. A human mind should stay away from intricacies or from things remote by adhering to what laid before it in daily life. Interestingly enough, Raphael's words point to the need to abstain from imagining worlds that could not be seen, to abstain from trying to find similarities between the visible and the invisible domains. The limits, limitations, bounds also meant that there were different worlds: Eden and Paradise, visible and invisible, human and divine that did not correspond to one another. Therefore, there is a separation hence from what happens above and what happens below. How far from the medieval world are we!

Catherine Martin in *Ruins of Allegory: Paradise Lost and the Metamorphosis of Epic Convention* studies how *Paradise Lost* departs from both the epic tradition as well from the normative allegory practiced by Dante and Spenser. The author studies Milton's epic from Benjamin's perspective, that is, from the perspective of the baroque allegory. While normative allegory's structure would be that of the synecdoche – a part representing the whole, which would result in the search of universals from natural correspondences; in *Paradise Lost* the allegory stems from a more contingent rhetoric figure: the metonym. "what if Earth / Be but the shaddow of Heav'n, and things therein / Each to other like, more then on earth is thought?" Paradise Lost (BK. V, 574-76), the question *what if* inscribes the relationship between Heaven and Earth in the domain of uncertainty. What if one is the shadow of the other? What if it is not? How does one ascertain the rules that govern such relationship? One cannot. Besides, the relationship, that of being the shadow, inhibits the search for correspondences, analogies. The part does not represent the whole anymore, the relationship between part and whole is more contingent than thought, above and below are contingently separated.

Throughout his narration Raphael is pretty clear about his objectives: to show Adam and Eve how to avoid being expelled from Eden. This meant respecting the boundaries, accepting human's constitution, coming to terms with the fact that what is humanly acceptable is within bounds. In other words, living in Eden was living behind a line. What if they crossed that line? Then they would turn "Wisdom to Folly". Because crossing the line would mean the realization that Eden was not the world, that there was an elsewhere, it would mean being exposed to "the vulnerability of knowledge" (CAVELL, 1988, p. 49). Prior knowledge would not be sufficient to account for this new world beyond the line:

> The irony here, then is that this rationalist age of renewed certitude in philosophy, science and religion is actually the beginning of a greater age of doubt that prophetic poets like

> Milton (as well as anti-Cartesian philosophers like Pascal) could begin to foresee in advance (MARTIN, 1998, p. 5).

Raphael knowingly or not exposes both the conditions for certainty and its frailty. Certainty was therefore conditioned by the need of separation. As long as human and divine realms remained separated and the explosion of correspondences was restrained, as long as men lived behind the line, mankind could live in the Eden of clear and distinct ideas. Reaching for the unconditioned, however, would result in Wisdom turning to Folly.

Catherine Martin's assertion that *Paradise Lost* entailed a departure from normative allegory's tradition unveils its different world view. Not that of correspondences anymore, or in Foucault's terms, not a world where words and things coincided, not a world, therefore, imbued with divine signs, traces ready to be deciphered; but one that demanded separation – between the humans and the divine, between words and things, and what else?

Paradise Lost was written on the onset of Modernity, a time when not only Descartes' clear and distinct ideas were shaping the conception of knowledge but also when his *cogito* was paving the way for what Hegel would later call subjectivity, the principle that governed Modernity. Even though, as Bruno Latour states in *We have never been modern*, there are as many thinkers as versions of Modernity, they all converge in one aspect – that of the passage of time (LATOUR, 1993, p.10). Modernity entailed a new regime, a rupture, a revolution in time. Wasn't it what Hegel meant when he conceived the modern times? Whose principle differed from that of pre-moderns'? In the sense that it was ruled by freedom and reflection? No wonder does human history seem to have one thread: "freedom has been the most important motif of written accounts of human history of these two hundred and fifty years" (CHAKRABARTY, 2009, p. 208). As if the history of men were an account of mankind's increasing freedom along the years, as if each new modern epoch would break away from traditions, freeing itself from the restraints of past times."time's irreversible arrow" (LATOUR, 1993, p. 10), leading towards progress, freeing mankind from obscurantism and the mishmash of worlds?

Modernity, nonetheless, is far from being defined by the advent of humanism or even by the sciences. Its strengths and weaknesses derive, however, from what characterizes the modern constitution, that is, the Great Divide. In Latour's terms, the Great Divide is the separation between natural and social worlds, between human and non-humans. While the pre-moderns had conceived the world by means of hybrids, acknowledging their existence and limiting their proliferation; the moderns, on the other hand, as their opponents as the creators of a new paradigm that would, eventually, be the model to be established worldwide, didn't conceive the world from the same perspective. In this sense, the medieval world, the world of analogies, of the correspondences between what happens above and what happens below; world, thus, where the divine trace could be sought, where words were things, gives rise to a different kind of allegory, that of Benjamin's, that promulgates for the arbitrariness of the sign: the coincidence between visible and invisible, between words and things was no longer possible. Benjamin's allegory reveals that the relationship between things and words was arbitrary, granted and never essential. Modern constitution, therefore, advocates for the separation of worlds. The advent of humanism was, though, asymmetrical, insofar as it did not result in the creation of non-humanism that, following the lines of modern constitution's logics would be its contemporary. This, however, begs the question: what would be the limit of such separation?

In the beginning of his essay, Bruno Latour anticipates the argument to be pursued: the proliferation of hybrids throughout modernity, the fact that modern constitution, actually, allows and even enables the same proliferation that it was supposed to restrain. The daily articles that open the essay seem to set the tone for

the issue to be developed: the biological had entered the political field, the separation between humans and non-humans was just a fallacy concealed by means of purification and mediation. Humans and non-humans had never been apart, then, as hybridization always took place, especially during the so-called modern times. That is, we have neveractually been modern. According to Latour, the separation between humans and non-humans, Society and Nature, or even between subject and object was what characterized our conception of modernity. Wasn't it Hegel who understood that subjectivity was the principle that governed the modern times? Wasn't it Kant who claimed that the thing-in-itself was beyond the limits of our understanding? Or even Heidegger, later, that stated that science was not able to think the Being? Latour would say that all these philosophical thoughts revolved around the same problem: the irreconcilable separation between humans and non-humans. So I ask, does being modern mean living behind a line or within a circle? Behind the line that separated humans and non-humans? What if the line was crossed? Would Wisdom be turned into Folly?

I am the first poet to remember that Nature exists, says Alberto Caeiro, Fernando Pessoa's heteronym[1]. Curiously, Caeiro's originality resided in claiming that a stone was nothing but a stone or that a flower should be understood as it was: a flower and nothing else. Alberto Caeiro, the master of Pessoa's heteronyms, whose poems were clearly distinct even from that of Pessoa's orthonym, both in style and themes, the complicated bucolic poet, was Pessoa's most complete depersonalization. Pessoa's heteronyms aligned with his poetic thoughts, that is, his understanding that poetry, that of the highest value, at least, should tend towards the dramatic. In one of his most famous theoretical texts, the Portuguese poet ranked the lyric poetry according to its dramatic quality. Some first-degree lyric poetry would be the least dramatic type, according to Pessoa, since the verses and the poet's feelings would coincide; poetry would, then, be just the expression of a poet's feelings. Needless to say that this poetry should be regarded as some low-rank poetry, having no or little poetic value. Shakespeare was, on the other hand, highly valued, because his dramatic poetry, his tendency towards depersonalization, the creation of worlds and moods other than his own, should be the assessment criterion for all high-rank lyric poetry. But what if *Hamlet* was deprived of its action and dialogues? Deprived of the possibility of being enacted, of being a play? What would remain? Pessoa hints that quite possibly this is how his heteronyms should be understood, as the "drama-in-people" they were: verses that begged for the erasure of the poet (as not having been written by Pessoa), being mere signatures, as they were not Pessoa's poems, but Álvaro de Campos', Alberto Caeiro's, Ricardo Reis' and many others'. A universe peopled with as many poets as depersonalization would allow. *Hamlet* without action, dialogues. *Hamlet* that could not be enacted, that is, deprived of its theatrical features; in other words, drama, drama-in-people, heteronyms.

Caeiro claims to be the greatest poet of all time, since he is the only one to have made an amazing discovery: that Nature exists. By setting himself apart from a tradition of poets, Caeiro seems to be establishing a new paradigm. The other heteronyms do not contradict such an assumption, and by calling Caeiro master, Reis, Campos and even Pessoa seem to agree that Caeiro's poems break away from a certain kind of tradition. But which one? Caeiro is "Greeker than the Greeks"[2], says Reis and goes on to read his poems from the perspective of the paganism. Caeiro is the paganism, not some theory about a bygone

1 Sou mesmo o primeiro poeta a lembrar de que a Natureza existe. Os outros poetas têm cantado a Natureza subordinando-a a eles, como se eles fossem Deus; eu canto a Natureza subordinando-me a ela, porque nada me indica que sou superior a ela, visto que ela me inclui, que eu nasço dela e que (CAEIRO/PESSOA, 2005, p. 180).

2 "mais grego que os gregos" (REIS/PESSOA, 1998, p. 112)

belief, but the embodiment of a pagan worldview or existence, he adds. From Ricardo Reis' perspective, thus, Caeiro's poems, due to their total or absolute objectivity, disrupt Christianity tradition. Caeiro, nonetheless, never mentions the word paganism, he never theorizes, he just writes his natural poems as naturally as possible. But what kind of Nature is this one that he discovers?

Other poets submit Nature to their verses, as if they were Gods, Caeiro would say. He intends to invert this dynamic by submitting himself to Nature, subjugating himself to it, since there is nothing that proves he is, in fact, superior to it. Nature includes him. He comes from Nature. And by doing so, Caeiro is able to become another: a plant or any other natural thing.[3] He opens himself to different modes of feelings, or different sensations. By allowing himself to think with his eyes or with his ears, by being subjected to Nature, a plethora of sensations is made available and all his body is filled with sensations, modes of feelings, or metaphysics, as opposed to only one. [4] And he can become the trees, the flowers, or even the movement of the wings of a butterfly. Caeiro's absolute or total objectivity, however, is threatened by the presence of thoughts. The poet knows that in order to become others in this eternal movement of depersonalization, in order to allow different metaphysics to take hold of his bodily sensations he needs to inhibit the act of thinking. Thinking would mean giving up on the possibility of seeing the world as it is – just the world – without any prior conception, without any framework. Suspending the act of thinking enabled his original perceptions, as if he were seeing, touching, feeling for the very first time. And, without the interference of thoughts, the experience was always an original one, always like the very first time, insofar as nothing in Nature was alike. There aren't two trees which are exactly the same, each one is unique, adds Caeiro, to the point that calling them trees seems harmful to the way we could apprehend the world. Language, therefore, damages our experience of the world as it tends to conceal differences. Even though there aren't two trees, or two rocks, or two birds that are exactly the same, our language, or our use of it, makes it seem so. The experience of language did not coincide with how he experienced the world. It was just language, incapable of grasping the complexities of Nature. Language was about language and not the world, as thinking was about the act of thinking and said nothing about the world itself. So was the thing-in-itself out of reach, as Kant had claimed? Are we still behind the line – the one that divided humans and non-humans? Is this still being modern?

Caeiro's absolute objectivity entailed the suppression of the subject. Suspending the act of thinking means thereby accessing other modes of knowledge rather than thoughts, rather than reason. A kind of knowledge the mind could not contain? For sure, something the mind could not control, as the mind wouldn't be the center of the experience anymore. Interestingly enough, acknowledging the non-human world, crossing the line, allowing for other types of experiences, would make Caeiro embody the paganism, being Greeker than the Greeks, positioning himself before the Great Divide. Even so Caeiro is the master of other modernist heteronyms. Caeiro is Fernando Pessoa's master, the greatest modernist Portuguese poet. The one, according to Massaud Moisés, to revolutionize Portuguese literature, modernize it. By being pagan? By forgetting "time's irreversible arrow"?

José Gil would say Caeiro's poems, even though apparently simple at first, are not an appeal to some past way of existence, quite the opposite, they result from the construction and the destruction of the European civilizations, from the experience of the war. As if all the past had been metamorphosed into

3 "...a capacidade única de Caeiro de tornar-se outro, tornar-se planta, tornar-se coisa natural. A nãorelação torna possível não uma relação de união, mas um processo de devir."(GIL, 1999, p. 28)

4 E os meus pensamentos são todos sensações. Penso com os olhos e com os ouvidos E com as mãos e os pés E com o nariz e a boca (CAEIRO/PESSOA, 2005, p. 34)

the original view they portray, one that could only be due to the experience of Modernity. The seemingly naive perception of the world presented in his poems conceal their critical view.[5] They conceal, I must add, that Modernity's wall had some cracks.

The term proposed in 2000 to name a new geological era by Paul Crutzen and Eugene Stoermer also reveals its alignment with Latour's thought: that the separation between human and non-human worlds was nothing but a fallacy. Crutzen and Stoermer proposed the term "Anthropocene" for a new era and dated it back to "James Watt's 1784 patent on the double-acting steam engine" (MENELY & TAYLOR, 2017, p.3). That is, this very first version of the Anthropocene tells the story of the unintended consequences of human actions. A technological innovation by means of revolutionizing our mode of existence would then result in a catastrophic outcome. So far, however, consensus has not been reached regarding the beginning of this new geological era. 1784 or the postwar Great Acceleration, each date means the telling of a different narrative concerning the Anthropos and the consequences of their actions, from the perspective of agriculture, inventions, industrialization, capitalism and so on. All these narratives, nonetheless, have something in common: they present a new framework to conceive the human, one that shatters our claims and beliefs about Modernity and its founding concepts and conceptions.

First of all, "The idea behind the term "Anthropocene" is that we have entered a new epoch in Earth's geological history, one characterized by the advent of the human species as a geological force" (SCRANTON, 2015, p. 17). For the very first time human beings are endowed with geological agency, which has two different implications that converge. One, being a geological force means that human beings are being regarded as a species. On an individual level no human has geological agency, which is one of the great paradoxes of facing the reality of climate change: what one does on an individual level has no or little effect in grappling with climate change. However, what each individual does matter. The second implication is that regarding humans as a geological force means that there is a non-human aspect to humans. Species or force, either way, the advent of the Anthropocene begs the revision of the idea of being human, inasmuch as we are no longer only human-human, but there is a non-human aspect to being human capable of altering the course of the planet, bringing about its total destruction.

> This nonhuman, forcelike mode of existence of the human tells us that we are no longer simply a form of life that is endowed with a sense of ontology. Humans have a sense of ontic belonging. That is undeniable. We used that knowledge in developing both anticolonial (Fanon) and postcolonial criticism (Bhabha). But in becoming a geophysical force on the planet, we have also developed a form of collective existence that has no ontological dimension. Our thinking about ourselves now stretches our capacity for interpretive understanding. We need nonontological ways of thinking the human. (CHAKBRABARTY, 2012, p. 13)

Ironically, the intensification of The Great Divide

5 A obra de Caeiro encontra-se com o olhar do primeiro homem, mas após a construção e a destruição das civilizações que se sucederam na Europa. Não houve que aprender e desaprender: ela é o resultado espontâneo de todo esse processo, reencontrando a visão da infância e da aurora da humanidade como se todos os olhares adultos da história se tivessem nela naturalmente metabolizado- ou seja, aprendidos e desaprendidos. Daí o peso crítico dessa poesia, o seu efeito revolucionário sobre os espíritos que dela se aproximam e por ela se deixarem impregnar; daí o facto de Caeiro ser capaz de escutar e compreender as mais finas sutilezas do pensamento especulativo (embora seja radicalmente distante dele. Como se houvesse um pensamento infantil a ser usado- também- pelos adultos). (GIL, 1999, p. 18).

that characterizes modernity, the separation between humans and non-humans, or even between subject and object. In other words, the intensification of subjectivity, the principle governing Modernity, led to the realization that both worlds were, in fact, intertwined. Human history and natural history are more enmeshed than Modernity had envisioned.

We are going through a contemporary crisis, from the historical standpoint. According to Dipesh Chakrabarty in the article *The Climate of History: Four Theses,* the humanistic distinction between human and natural history hadcollapsed. If Collingwood could conceive history as being distinguished from nature and Croce could claim that there was no world other than that of the humans', that is, the non-human world didn't deserve or didn't have any historiography; this point of view cannot be sustained when the non-human world is no longer immutable. The tsunamis, earthquakes, tornados, nature not subjugated by human subjectivity anymore (and this way not under control) reveal that human history cannot be understood or studied without its counterpart: natural history or non-human history. "The wall of separation between natural and human histories that was erected in early modernity and reinforced in the nineteenth century as the human sciences and their disciplines consolidated themselves has some serious and long-running cracks in it"(CHAKRABARTY, 2012, p. 10). We have crossed the line, it seems.

The Anthropocene, as the unintended consequences of human actions, draws our attention to the interconnectedness of all life forms (MORTON, 2018, p. 36). If our modern assumptions, then, led to the seemingly uncontrollable crisis we are living in, one to bring about mass destruction, there is an urgent need to reconsider our thoughts on the so-called modern constitution. If our belief in "time's irreversible arrow" led to a catachronistic temporality, as Aravamudan would say, that is, to the experience of Enlightenment's reversibility (apocalyptic nightmares); a serious revision of human's relationship to the world around is begged. For 12,000 years, man have thought to have been "on top of things, outside of things or beyond things, able to look down and decide exactly what to do" (MORTON, 2018, p. 25); rephrasing Timothy Morton: subjectivity was the measure of all things. But, then, wasn't it Hegel's claim? That subjectivity shaped modernity? Wasn't it also what Latour said? That the advent of humanism was asymmetrical, since the non-human world was forgotten? However, *the repressed returns, and with a vengeance.*

Timothy Morton's adherence to object-oriented ontology and its claims that nothing can be accessed in its entirety and that thought is, by no means, the best access mode to things, is grounded in its usefulness in the age we are living in:

> One way is that it doesn't make thinking, in particular human thinking, into a special kind of access mode that truly gets at what a thing is. OOO tries to let go of anthropocentrism, which holds that humans are the center of meaning and power (and so on). This might be useful in an era during which we need to at least recognize the importance of other lifeforms. (MORTON, 2018, xli)

Caeiro's and Timothy Morton's ideas, though decades apart, point to the need to reconceive the role of thinking, which is synonymous with the role of men. The mind that can control, the humanly acceptable knowledge, the one that subjugates the world under conceptions, prevents the apprehension of other life forms. "What matters isn't exactly what you think but how you think"(MORTON, 2018, p. 25). Going beyond the line that divides humans and non-humans is necessary to; at least, acknowledge the existence of this other world, not anthropocentrically-centered. Aravamudan would criticize Timothy Morton's Buddhist-like attitude, one that advocates that being ecological does not necessarily mean activism, but refers to relating to a non-human being for no reason at all (MORTON, 2018, p. 59):"By caring for strangers as well as plutonium (presumably we would caress the

former but use radiation protection gloves to handle the latter) we might show a Levinasian commitment to radical alterity."(ARAVAMUDAN, 2013, p. 16). But wasn't that Latour's question? Where are the Lévinases of the animals? – he questions why because neither human nor non-human worlds could be understood, as long as humanism was still conceived as being opposed to the object (LATOUR, p. 136). One must go beyond the dichotomy, then.

What if we were not kept anthropocentrically safe in our assumptions and theories? What if Lévinas' hospitality could encompass the non-human world as well? And Heidegger's full-on, rich world could be granted to all life-forms, instead of just to humans? And Cavell's acknowledgment could refer to anything else other than other minds? What if theories that brought to surface modernity's frailties could be extrapolated to encompass the non-human world? Would we turn Wisdom into Folly?

One would be "Greeker than the Greeks", Ricardo Reis would probably answer. One would be the master of the "drama-in-people", insofar as the verses would embody the concept of depersonalization. It is no wonder then that after Caeiro's "apparition", Fernando Pessoa wrote down *Chuva Oblíqua*, almost as an attempt to make sure he could go back to being the poet he was, to make sure he hadn't lost his voice, style, way of thinking. Caeiro discovered Nature and in doing so he disclosed one of the greatest problems that would concern us living during the Anthropocene: the relationship between subject and object, the subjugation of the latter by the former and the need for depersonalization, i.e, the suppression of the subject.

Interestingly enough, Pessoa's "drama-in-people", the way by which he would revolutionize Portuguese Literature. By breaking away from the emotional tradition that had shaped Portuguese lyric poetry since its beginning, meant his depersonalization. That is, his conception of poetry would collide with any idea concerning a genius subject. In other words, the intensification of subjectivity, through its guiding principles of freedom and reflection, resulted in the experience of alterity. His famous verse "*O que em mim sente 'stá pensando*", that in a free translation would read as: that which in me feels is thinking, connected feeling with thought, meaning that a thought of a feeling corresponded to the feeling itself. There was nothing that separated feelings from thoughts, since feelings were also a mode of thinking. A poet, therefore, by combining feelings and thoughts, would have a multitude of modes of feelings available. This way, Pessoa could become Caeiro or others, by means of combining feelings and thoughts, by means of letting go of his own subjectivity. Thinking like another was feeling like another. No wonder would Pessoa criticize any attempt to explain his poems, heteronyms, pseudo-heteronyms by resorting to his biography. If there was any trace of himself in his poems, or any trace of his personal story or opinions that meant that he had failed as a poet. Modern poetry for him signified the erasure of the person, the subject. It is understandable why Caeiro is the master. He is the one to embody the extreme depersonalization experience, the confrontation with the ultimate otherness: that of nature. Not only does Caeiro acknowledge nature, but he is by it transformed. His and nature's history are intertwined. He lives in the mishmash of worlds.

At the end of the article *The Catachronism of Climate Change*, Srinivas Aravamudan, after identifying speculative materialism and object-oriented ontology as a wave of post-Heideggerian climate change philosophy, that abandons "humanist subjectivism for a democracy of the objects or "an alien phenomenology"" (ARAVAMUDAN, 2013, p. 18), states that: "What began as catachronism, the burdensome experience of "living in the end times," could morph into the birth of many brave new worlds populated by those that come after the subject (...)" (ARAVAMUDAN, 2013, p.21). One cannot help wondering if this "after the subject" does not have a history, one to be traced back to the beginning of the twentieth century, when the idea of the subject was being questioned by modernist literature.

The relevance of the aesthetic experience lies,

according to Timothy Morton, in shaping our experience in the Anthropocene, especially because any aesthetic experience means caring for what is non-human. An artwork poses the question of the solidarity with what is non-human, being the artwork ecological or not. Besides, the experience of beauty in itself is not subject-driven: "This is because beauty just happens, without our ego cooking it up. The experience of beauty itself is an entity that isn't me. This means that the experience has an intrinsic weirdness to it (MORTON, 2018, p. 65). What happens when a not subject-driven experience is mediated by another not subject-driven experience? A real ecological experience? One can only wonder.

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Lendo os poemas de Alberto Caeiro com olhos antropocênicos

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Resumo: O termo "Antropoceno" proposto por Crutzen e Stoemer em 2000 não apenas nomeia uma nova época geológica, como também dota os humanos de agência geológica. O advento e a aceitação dessa nova época geológica pede a revisão dos conceitos da modernidade e do reenquadramento da assim chamada constituição moderna, a grande Divisão, nos termos de Bruno Latour. O muro da modernidade, aquele que separa humanos e não-humanos, revela suas rachaduras no Antropoceno. A literatura, no entanto, há muito, já havia antecipado a necessidade de repensar nossa relação com a natureza, especialmente no que tange à dicotomia sujeito/objeto. Alberto Caeiro, heterônimo pessoano, afirma ter sido a natureza negligenciada por todos os poetas e pensadores, sendo ele o primeiro a notá-la. O presente artigo busca, assim, ler os poemas de Caeiro com olhos antropocênicos para que a dicotomia sujeito/objeto, um dos pilares da modernidade, possa ser investigada.

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"What words or tongue of Seraph can suffice, or heart of man suffice to comprehend?" Paradise Lost (BK. VII, 113-14), Rafael se pergunta, reconhecendo o peso de sua tarefa: alertar Adão e Eva sobre Lúcifer. As perguntas de Rafael, assim, relevam a disparidade entre duas esferas, nomeadamente aquela dos homens e a dos seres celestiais. Como poderia ele, sendo um anjo, falando uma língua que diferia da dos homens, revelar a criação do mundo e a existência no Paraíso a ouvidos não preparados para tal? Como poderia o pai da humanidade compreender eventos tão distantes de sua vida cotidiana? Eventos inéditos, tais como a guerra no Paraíso? Dois âmbitos distintos, línguas, constituições.

Quando Rafael percebe a curiosidade de Adão, sua tendência a procurar rastros divinos na Terra, como se houvesse uma correspondência entre as instâncias visíveis e invisíveis, ele afirma: "But Knowledge is as food, and need no less/ Her Temperance over Appetite, to know/ In measure what the mind may well contain/ Oppresses else with Surfet, and soon turns/ Wisdom to Folly, as Nourishment to Winde" Paradise Lost (BK. VII, 116-20). A comparação entre conhecimento e comida mais uma vez aponta para o problema principal: a constituição humana. A compreensão humana é, portanto, limitada, circunscrita pela sua constituição. Aquilo que é incompreensível, inimaginável, ou até mesmo inexplicável provém da limitação humana. Há certo tipo de conhecimento, no entanto, que pode ser humanamente aceitável, e que pode, nos termos de Rafael, ser contido pela mente. A mente, assim como o estômago, é comparada a um recipiente, já que é a sua capacidade física que está em jogo. Os limites, limitações são físicos, constitucionais. Ultrapassar o limite, tentar saber mais do que a mente pode fisicamente suportar seria transformar Sabedoria em Tolice. Ademais, a palavra "conter" não enfatiza apenas as limitações físicas da mente, como também sua capacidade de controle. O conhecimento humanamente apropriado é aquele que a mente pode controlar. Não é de se admirar, então, que a Rafael é permitido responder as perguntas de Adão e Eva sob uma condição: "I have receav'd, to answer thy desire/ Of Knowledge within bounds" Paradise Lost (BK. VII,

119-20). Limites, limitações, fronteiras: o mundo antes da queda era um mundo limitado, implicava viver "within a circle or behind a line", como diria Stanley Cavell (CAVELL, 1988, p. 49).

Adão, portanto, após ouvir à narração de Rafael atentamente, resume seus ensinamentos:

> How fully hast thou satisfi'd mee, pure
> Intelligence of Heav'n, Angel serene,
> And freed from intricacies, taught to live,
> The easiest way, nor with perplexing
> thoughts
> To interrupt the sweet of Life, from which
> God hath bid dwell farr off all anxious
> cares,
> And not to molest us, unless we our selves
> Seek them with wandring thoughts, and
> notions vaine.
> But apte the Mind or Fancie is to roave
> Uncheckt, and of her roaving is no end;
> Till warn'd, or by experience taught, she
> learn
> That not to know at large of things remote
> From use, obscure or suttle, but to know
> That which before us lies in daily life,
> Is the prime Wisdom, what is more, is fume,
> Or emptiness, or fond impertinence,
> And renders us in things that most concerne
> Unpractis'd, unprepar'd, and still to seek
> Paradise Lost(BK. VIII.180-97)

A grande sabedoria seria, assim, não deixar a mente vaguear, não deixá-la se ocupar com questões fora de alcance. A mente humana deveria se manter distante de complexidades, de coisas remotas ao se ater ao que estaria diante de si, na vida diária. Curiosamente, as palavras de Rafael apontam para a necessidade de evitar imaginar mundos que não poderiam ser vistos, evitar buscar similaridades entre as instâncias visíveis e invisíveis. Os limites, limitações, fronteiras também implicavam que havia mundos distintos: Éden e Paraíso, visível e invisível, humano e divino, sem que houvesse correspondências entre eles. Há uma separação entre o que acontece em cima e embaixo. Quão distante estamos do mundo medieval!

Catherine Martin em *Ruins of Allegory: Paradise Lost and the Metamorphosis of Epic Convention* estuda como *Paradise Lost* abandona tanto a tradição épica quanto a alegoria normativa praticada por Dante e Spenser. A autora estuda a épica de Milton a partir da perspectiva de Benjamin, ou seja, da perspectiva da alegoria barroca. Enquanto a estrutura da alegoria normativa seria aquela da sinédoque – a parte representando o todo, que resultaria na busca de universais a partir de correspondências naturais, em *Paradise Lost* a alegoria deriva de uma figura retórica mais contingente: a metonímia. "what if Earth / Be but the shaddow of Heav'n, and things therein / Each to other like, more then on earth is thought?" Paradise Lost (BK. V, 574-76), a pergunta *e se* circunscreve a relação entre o Paraíso e a Terra no âmbito da incerteza. E se um for a sombra do outro? E se não for? Como verificar as regras que governam tal relação? Não podemos. Ademais, a relação - ser sombra - inibe a busca por correspondências, analogias. A parte não mais representa o todo, a relação entre parte e todo é mais contingente que imaginada. O em cima e o abaixo estão contingentemente separados.

Ao longo de sua narração Rafael é bem claro acerca de seus propósitos: mostrar a Adão e Eva como evitar serem expulsos do paraíso ao respeitarem os limites, a constituição humana, ao aceitarem que o que é humanamente aceito é limitado. Em outras palavras, viver no Éden implicava viver atrás de uma linha. E se a linha fosse ultrapassada? Então transformariam "Sabedoria em Tolice". Mas como assim? Ultrapassar a linha significaria a percepção de que o Éden não era o mundo, de que havia algo mais, significaria ser exposto à vulnerabilidade do conhecimento (CAVELL, 1988, p. 49). O conhecimento prévio não seria suficiente para dar conta do novo mundo além da linha:

> The irony here, then is that this rationalist
> age of renewed certitude in philosophy,
> science and religion is actually the
> beginning of a greater age of doubt that
> prophetic poets like Milton (as well as anti-

> Cartesian philosophers like Pascal) could begin to foresee in advance (MARTIN, 1998, p. 5).

Rafael, assim, conscientemente ou não, expõe tanto as condições para a certeza quanto suas fraquezas. A certeza estava, dessa maneira, condicionada pela necessidade de separação. Enquanto as esferas divinas e humanas fossem mantidas separadas e a explosão de correspondências controlada, enquanto os homens vivessem atrás da linha, a humanidade poderia viver no Éden das ideias claras e distintas. Buscar pelo incondicionado, entretanto, resultaria na Sabedoria ser transformada em Tolice.

A afirmação de Catherine Martin de que *Paradise Lost* se afastaria da tradição da alegoria normativa revela sua diferente visão de mundo. Não mais aquele das correspondências, ou nos termos de Foucault, não mais um mundo onde palavras e coisas coincidiam; um mundo, portanto, não mais imbuído de traços divinos prontos a serem decifrados; e sim um que demandava separação – entre os humanos e o divino, entre palavras e coisas e que mais?

Paradise Lost foi escrito no início da modernidade, momento no qual não somente as ideias claras e distintas de Descartes modelavam a concepção sobre o conhecimento, como também o seu *cogito* abria caminho para aquilo que Hegel, mais tarde, chamaria de subjetividade, o princípio que governava a modernidade. Embora haja tantos pensadores como versões da modernidade, como afirma Bruno Latour em *We have never been modern,* todos convergiriam em um aspecto – no da passagem do tempo (LATOUR, 1993, p.10). A modernidade implicava um novo regime, uma ruptura, uma revolução no tempo. Não fora exatamente isso que Hegel tinha em mente quando concebeu os tempos modernos? Cujo princípio diferia daquele dos pré-modernos? Na medida em que era governado pela liberdade e pela reflexão? Não é de se admirar que a história humana pareça ter um fio condutor: "freedom has been the most important motif of written accounts of human history of these two hundred and fifty years" (CHAKRABARTY, 2009, p. 208). Como se a história dos homens fosse um relato do aumento da liberdade da humanidade ao longo dos anos, como se cada nova época moderna rompesse com tradições ao se libertar das limitações do passado. "time's irreversible arrow" (LATOUR, 1993, p. 10), levando ao progresso, libertando a humanidade do obscurantismo e da mistura de mundos?

A modernidade, no entanto, está longe de ser definida pelo advento do humanismo ou mesmo pelas ciências. Sua força e fraqueza deriva daquilo que caracteriza a constituição moderna, ou seja, a Grande Divisão, nos termos de Latour: a separação entre os mundos naturais e sociais, entre humanos e não-humanos. Enquanto os pré-modernos concebiam o mundo a partir de híbridos, reconhecendo sua existência e limitando sua proliferação; os modernos, por outro lado, enquanto seus opositores, ao romper com a mistura dos mundos; enquanto criadores de um novo paradigma que iria, eventualmente, ser o modelo a ser estabelecido no mundo inteiro, não concebiam o mundo a partir da mesma perspectiva. Nesse sentido, o mundo medieval, o mundo das analogias, das correspondências entre o que ocorre em cima e abaixo; mundo, portanto, onde o traço divino poderia ser procurado, onde as palavras eram as coisas, cede lugar a um tipo diferente de analogia, aquela de Benjamin, que promulga pela arbitrariedade do signo: a coincidência entre o visível e o invisível, entre palavras e coisas não era mais possível. A alegoria benjaminiana revela que a relação entre palavras e coisas era arbitrária, concedida e nunca essencial. A constituição moderna, portanto, advoga pela separação de mundos. O advento do humanismo fora, no entanto, assimétrico, uma vez que não resultou na criação do não-humanismo que, seguindo a lógica da constituição moderna, seria seu contemporâneo. Uma pergunta, no entanto, perdura: qual seria o limite de tal separação?

No começo de seu ensaio, Bruno Latour antecipa o argumento a ser perseguido: a proliferação dos híbridos ao longo da modernidade, o fato de a constituição moderna, na realidade, permitir e até mesmo favorecer a mesma proliferação que deveria

conter. As notícias que abrem o ensaio parecem dar o tom do tópico a ser desenvolvido: o biológico entrara no campo político, a separação entre humanos e não-humanos fora apenas uma falácia escamoteada por meios de purificação e mediação. Humanos e não-humanos nunca estiveram separados, então, já que a hibridização sempre ocorreu, especialmente durante os assim chamados tempos modernos. Ou seja, nós, na realidade, nunca fomos modernos. De acordo com Latour, a separação entre humanos e não-humanos, Sociedade e Natureza, ou até entre sujeito e objeto fora o que caracterizara nossa concepção de modernidade. Não fora Hegel quem entendeu que a subjetividade era o princípio que regia os tempos modernos? Não fora Kant que afirmara que a coisa-em-si estaria fora do escopo de nosso entendimento? Ou até mesmo Heidegger, mais tarde, que afirmou que a ciência não era capaz de pensar o Ser? Todos esses pensamentos filosóficos revolveriam em torno do mesmo problema, diria Latour: a separação inconciliável entre humanos e não-humanos. Então ser moderno, pergunto, significaria viver atrás de uma linha, ou dentro de um círculo? Atrás da linha que separava humanos e não-humanos? E se a linha fosse ultrapassada? Transformaríamos Sabedoria em Tolice?

"Sou mesmo o primeiro poeta a lembrar de que a Natureza existe" (CAEIRO/PESSOA, 2005, p. 180), diz Alberto Caeiro, heterônimo de Fernando Pessoa. Curiosamente, a originalidade de Caeiro reside em afirmar que uma pedra é nada mais que uma pedra ou que uma flor deve ser apreendida enquanto flor e nada mais. Alberto Caeiro, o mestre dos heterônimos de Fernando Pessoa, cujos poemas eram claramente distintos até mesmo da produção ortonímica de Pessoa, tanto em estilo quanto em temas; o complicado poeta bucólico, foi a mais completa despersonalização pessoana. O processo heteronímico pessoano encontra repercussão em seus pensamentos poéticos, ou melhor, no seu entendimento de que a poesia, aquela de mais alto valor, pelo menos, deveria tender ao dramático. Em um de seus textos teóricos mais importantes, o poeta português classificou a poesia lírica de acordo com suas qualidades dramáticas. A poesia lírica de primeiro grau seria o tipo menos dramático, de acordo com Pessoa, uma vez que os versos coincidiriam com os sentimentos do poeta; a poesia seria, então, mera expressão dos sentimentos do poeta. Desnecessário dizer que essa poesia teria pouco valor poético. Shakespeare seria, por outro lado, altamente valorizado, já que sua poesia dramática, sua tendência à despersonalização, a criação de mundos e humores distintos dos seus, deveria ser o critério de avaliação de toda poesia lírica de alto valor. Mas e se, pergunto, *Hamlet* fosse privado de ação e diálogos? Privado da possibilidade de ser encenado, de ser uma peça? O que restaria? Pessoa sugere que muito possivelmente essa deveria ser a forma como seus heterônimos deveriam ser entendidos, como o "drama em gente" que eram: versos que pediriam pelo apagamento do poeta (não tendo sido escritos por Pessoa), sendo meras assinaturas, uma vez que não eram poemas de Pessoa, e sim de Álvaro de Campos, Alberto Caeiro, Ricardo Reis e de muitos outros. Um universo povoado com tantos poetas quanto a despersonalização permitiria. *Hamlet* sem ação, diálogos. *Hamlet* que não poderia ser encenado, ou seja, privado de ser teatro; em outras palavras, drama, drama em gente, heterônimos.

Caeiro afirma ser o maior poeta de todos os tempos, já que foi o único a fazer uma descoberta extraordinária: que a Natureza existe. Ao se separar de uma tradição de poetas, Caeiro parece estabelecer um novo paradigma. Os outros heterônimos não contradizem tal assunção e, ao chamarem Caeiro de mestre, Reis, Campos e até mesmo Pessoa, parecem concordar que os poemas de Caeiro rompem com certo tipo de tradição. Mas com qual? Caeiro é "mais grego que os gregos" (REIS/PESSOA, 1998, p. 112), diz Ricardo Reis e lê os poemas de Caeiro a partir da perspectiva do paganismo. Caeiro é o paganismo, não uma teoria acerca de uma crença passada, mas sim a encarnação de uma existência ou visão de mundo pagã. Da perspectiva de Ricardo Reis, os poemas de Caeiro, assim, por conta do total e absoluto objetivismo, rompem com a tradição cristã. Caeiro, entretanto, nunca menciona a palavra

paganismo. Ele nunca teoriza, apenas escreve seus poemas naturais de forma mais natural possível. Mas que tipo de Natureza é essa que ele descobre?

Outros poetas submetem a Natureza aos seus versos, como seu fossem deuses, Caeiro diria. Ele pretende inverter tal lógica ao se submeter à Natureza, subjugar-se a ela, já que não há nada que prove que ele é, de fato, superior. A Natureza o inclui. Ele vem dela. Ao fazê-lo, ao se submeter a ela, Caeiro pode se tornar outro: uma planta ou qualquer outra coisa natural: "...a capacidade única de Caeiro de tornar-se outro, tornar-se planta, tornar-se coisa natural. A não relação torna possível não uma relação de união, mas um processo de devir."(GIL, 1999, p. 28). Ele se abre a diferentes modos de sentimentos, ou diferentes sensações. Ao se permitir pensar com os olhos ou com os ouvidos, ao se submeter à Natureza, uma pletora de sensações se abre e todo o seu corpo é dominado por sensações, modos de sentir, ou metafísicas, ao invés de uma única: "E os meus pensamentos são todos sensações. Penso com os olhos e com os ouvidos E com as mãos e os pés E com o nariz e a boca" (CAEIRO/PESSOA, 2005, p. 34). E ele pode ser tornar as árvores, as flores ou até mesmo o movimento das asas de uma borboleta. A absoluta e total objetividade de Caeiro, entretanto, é ameaçada pela presença dos pensamentos. O poeta sabe que para se tornar outro nesse eterno movimento de despersonalização, para permitir diferentes metafísicas, ele precisa reprimir o ato de pensar. Pensar implicaria abrir mão da possibilidade de ver o mundo como é – apenas mundo – sem qualquer concepção a priori, sem qualquer enquadramento. Suspender o pensamento permite suas percepções originais, como se estivesse vendo, tocando, sentindo pela primeira vez. E, sem a interferência dos pensamentos, a experiência era sempre original, sempre como a primeira vez, uma vez que nada na Natureza era exatamente igual. Não há duas árvores exatamente iguais, cada qual é única, acrescenta Caeiro, de forma que chamá-las árvores interfere na forma como poderíamos apreender o mundo. A linguagem, portanto, prejudica a nossa experiência de mundo já que apaga as diferenças. Apesar de não existirem duas árvores, ou pedras, ou pássaros que sejam exatamente iguais, nossa linguagem, ou nosso uso dela, faz parecer o contrário. A experiência da linguagem não coincidia com como ele apreendia o mundo. Era apenas linguagem, incapaz de alcançar as complexidades da Natureza. A linguagem diz respeito à linguagem e não ao mundo, assim como pensar o mundo diz respeito ao ato de pensar e nada diz sobre o próprio mundo. Então a coisa-em-si estava fora de alcance? Como Kant havia afirmado? Estaríamos ainda atrás da linha – aquela que separaria humanos e não-humanos? Ainda sendo modernos?

A objetividade absoluta de Caeiro implicaria a supressão do sujeito. Suspender o ato de pensar, assim, significaria acessar outros modos de conhecimento distintos do pensamento, da razão. Um tipo de pensamento que a mente não poderia conter? Com certeza, algo que a mente não poderia controlar, já que a mente não seria mais o centro da experiência. Reconhecer o mundo não-humano, ultrapassar a linha, permitir outros tipos de experiência, fariam Caeiro encarnar o paganismo, ser mais grego que os gregos, posicionar-se antes da Grande Divisão. Mesmo assim, Caeiro é o mestre de outros heterônimos modernistas. Caeiro é o mestre de Fernando Pessoa, o grande poeta português modernista. Aquele, que de acordo com Massaud Moisés, revolucionaria a poesia portuguesa ao modernizá-la. Sendo pagão? Esquecendo "time's irreversible arrow"?

José Gil diria que os poemas de Caeiro, apesar da aparente simplicidade, não apelam a uma forma passada de existência, ao contrário, resultam da construção e desconstrução das civilizações europeias, da experiência da guerra. Como se todo o passado tivesse se metamorfoseado na visão original que revelam, uma que só poderia existir devido à experiência da Modernidade. A aparentemente percepção ingênua de mundo apresentada nos poemas encobre sua visão

crítica[1]. Encobre que o muro da Modernidade tinha rachaduras.

O termo proposto em 2000, por Paul Crutzen e Eugene Stoemer para nomear uma nova era geológica revela também o seu alinhamento com o pensamento de Latour: que a separação entre os mundos humano e não-humano fora apenas uma falácia.Crutzen e Stoemer propuseram o termo "Antropoceno" para determinar uma nova era e dataram seu início em 1784 "James Watt's 1784 patent on the double-acting steam engine" (MENELY & TAYLOR, 2017, p.3). Ou seja, a primeira versão do Antropoceno conta a história das consequências não intencionais das ações humanas. Uma inovação tecnológica, ao revolucionar nosso modo de existência, acaba por ter um resultado catastrófico. Até o presente momento, no entanto, não há consenso no que diz respeito ao início dessa nova era geológica. 1784 ou a Grande Aceleração pós-guerra, cada data implica contar uma diferente narrativa acerca dos *Antropos* e das consequências de suas ações, a partir da perspectiva da agricultura, invenções, industrialização, capitalismo e outros. Todas essas narrativas, entretanto, têm algo em comum: elas apresentam um novo enquadramento para conceber o humano, um que destrói nossas crenças e assunções acerca da Modernidade e seus conceitos fundamentais.

Em primeiro lugar,"The idea behind the term "Anthropocene" is that we have entered a new epoch in Earth's geological history, one characterized by the advent of the human species as a geological force" (SCRANTON, 2015, p. 17). Pela primeira vez os humanos são dotados de agência geológica, o que tem duas implicações que acabam por convergir. Primeiramente, ser uma força geológica significa que os humanos estão sendo considerados enquanto espécie. No nível individual nenhum humano possui agência geológica, que é um dos grandes paradoxos de lidar com a realidade da mudança climática: o que cada qual faz, no nível individual, tem pouco ou quase nenhum efeito ao lidar com a mudança climática. Entretanto, o que cada indivíduo faz importa. Em segundo lugar, conceber o humano enquanto força geológica implica que há um aspecto não-humano nos humanos. Espécie ou força, de qualquer forma, o advento do Antropoceno pede a revisão do conceito de humano, uma vez que não somos mais humanos-humanos, já que há um aspecto não-humano na humanidade capaz de alterar o curso do planeta e trazer a sua destruição total.

> This nonhuman, forcelike mode of existence of the human tells us that we are no longer simply a form of life that is endowed with a sense of ontology. Humans have a sense of ontic belonging. That is undeniable. We used that knowledge in developing both anticolonial (Fanon) and postcolonial criticism (Bhabha). But in becoming a geophysical force on the planet, we have also developed a form of collective existence that has no ontological dimension. Our thinking about ourselves now stretches our capacity for interpretive understanding. We need nonontological ways of thinking the human. (CHAKBRABARTY, 2012, p. 13)

Ironicamente, a intensificação da Grande Divisão que caracteriza a Modernidade, a separação entre humanos e não-humanos, ou até entre sujeito e objeto;

1 A obra de Caeiro encontra-se com o olhar do primeiro homem, mas após a construção e a destruição das civilizações que se sucederam na Europa. Não houve que aprender e desaprender: ela é o resultado espontâneo de todo esse processo, reencontrando a visão da infância e da aurora da humanidade como se todos os olhares adultos da história se tivessem nela naturalmente metabolizado- ou seja, aprendidos e desaprendidos. Daí o peso crítico dessa poesia, o seu efeito revolucionário sobre os espíritos que dela se aproximam e por ela se deixarem impregnar; daí o facto de Caeiro ser capaz de escutar e compreender as mais finas sutilezas do pensamento especulativo (embora seja radicalmente distante dele. Como se houvesse um pensamento infantil a ser usado- também- pelos adultos). (GIL, 1999, p. 18).

em outras palavras, a intensificação da subjetividade, princípio que governa a Modernidade, levou à percepção de que ambos mundos estavam, de fato, entrelaçados. A história humana e a história natural estavam mais enredadas do que a Modernidade havia imaginado.

Estamos vivendo uma crise contemporânea, da perspectiva histórica, diria Dipesh Chakrabarty no artigo *The Climate of History: Four Theses*, uma vez que a distinção humanística entre história humana e história natural desabou. Se Collingwood podia pensar a história como algo distinto da natureza, e Croce podia afirmar que não havia outra história a não ser a humana, ou seja, o mundo não-humano não mereceria ou não teria historiografia; tal ponto de vista não pode mais ser mantido quando o mundo não-humano não é mais imutável. Os tsunamis, terremotos, tornados, a natureza não mais subjugada pela subjetividade humana (e dessa forma não mais sob controle) revela que a história humana não mais pode ser entendida ou estudada sem seu par: a história natural, a história não-humana. "The wall of separation between natural and human histories that was erected in early modernity and reinforced in the nineteenth century as the human sciences and their disciplines consolidated themselves has some serious and long-running cracks in it"(CHAKRABARTY, 2012, p. 10). Parece que ultrapassamos a linha.

O Antropoceno, enquanto consequências não intencionais das ações humanas, chama a nossa atenção para a interconectividade de todas as formas de vida (MORTON, 2018, p. 36). Se as nossas assunções modernas, então, levaram à aparente crise incontrolável na qual nos encontramos, uma capaz de trazer destruição em massa, há a necessidade de reconsiderar nossos pensamentos acerca da assim chamada constituição moderna. Se nossa crença na "time's irreversible arrow" nos trouxe a temporalidade catacronística, como diria Aravamudan, ou melhor, nos trouxe a reversibilidade da experiência do Iluminismo (pesadelos apocalípticos); é necessária uma séria revisão da relação humana com o mundo. Por 12.000 anos, o homem se considerou "on top of things, outside of things or beyond things, able to look down and decide exactly what to do" (MORTON, 2018, p. 25); parafraseando Timothy Morton: a subjetividade foi a medida de tudo. Mas não fora exatamente o que Hegel afirmara? Que a subjetividade configurava a Modernidade? Não fora o que disse Latour? Que o advento do humanismo fora assimétrico, já que o mundo não-humano fora esquecido? Entretanto, *the repressed returns, and with a vengeance.*

A adesão de Timothy Morton à object-oriented ontology e sua afirmação de que nada pode ser acessado em sua completude e que o pensamento não é, de forma alguma, o melhor acesso às coisas, é fundamentada em sua utilidade no momento em que vivemos:

> One way is that it doesn't make thinking, in particular human thinking, into a special kind of access mode that truly gets at what a thing is. OOO tries to let go of anthropocentrism, which holds that humans are the center of meaning and power (and so on). This might be useful in an era during which we need to at least recognize the importance of other lifeforms. (MORTON, 2018, xli)

As ideias de Caeiro e de Timothy Morton, apesar de separadas por décadas, apontam para necessidade de reconsiderar o papel do pensamento, que se torna sinônimo ao papel do homem. A mente que pode controlar, o conhecimento humanamente aceitável, aquele que subjuga o mundo sob suas concepções, impede a apreensão de outras formas de vida. "What matters isn't exactly what you think but how you think" (MORTON, 2018, p. 25). Ultrapassar a linha que separa humanos e não-humanos é necessário para, pelo menos, reconhecer a existência desse outro mundo, não antropocêntrico. Aramavudan criticaria a atitude budista de Timothy Morton: "By caring for strangers as well as plutonium (presumably we would caress the former but use radiation protection gloves to handle the latter) we might show a Levinasian

commitment to radical alterity."(ARAVAMUDAN, 2013, p. 16). Mas não fora justamente essa a pergunta de Latour? Onde estariam os Levinás dos animais? – ele se pergunta, uma vez que nem o mundo humano nem o não-humano poderiam ser entendidos, enquanto o humanismo fosse ainda concebido enquanto oposição ao objeto (LATOUR, p. 136). Precisamos ir além da dicotomia, então.

E se não fôssemos mantidos antropocentricamente seguros em nossas concepções e teorias? E se a hospitalidade de Levinás pudesse englobar também o mundo não humano? E se o mundo rico e completo de Heidegger pudesse ser concedido a todas as formas de vida e não apenas à humana? E se o reconhecimento de Cavell pudesse se referir a algo além de outras mentes? E se as teorias que trouxeram as fragilidades da Modernidade à superfície pudessem ser extrapoladas para englobar o mundo não-humano? Transformaríamos Sabedoria em Tolice?

Seríamos mais gregos que os gregos, responderia Ricardo Reis. Seríamos o mestre do drama em gente, na medida em que os versos encarnariam a ideia de despersonalização. Não é de se admirar, portanto, que após a aparição de Caeiro, Fernando Pessoa tenha escrito *Chuva Oblíqua*, quase como uma tentativa de garantir que poderia voltar a ser o poeta que era, para garantir que não havia perdido sua voz, seu estilo, forma de pensar. Caeiro descobriu a Natureza e ao fazê-lo desvelou um dos grandes problemas que nos preocuparia ao viver no Antropoceno: a relação entre sujeito e objeto, a subjugação do último pelo primeiro e a necessidade da despersonalização, ou seja, a supressão do sujeito.

Assim, o drama em gente pessoano, a forma como revolucionaria a literatura portuguesa ao quebrar com a tradição emocional que configuraria a poesia lírica portuguesa desde seus primórdios, implicaria despersonalização. Ou seja, sua concepção acerca da poesia colidiria com qualquer ideia referente a um sujeito genial. Em outras palavras, a intensificação da subjetividade, a partir de seus princípios fundamentais de liberdade e reflexão, resultaram na experiência da alteridade. Seu famoso verso "*O que em mim sente 'stá pensando*" conecta pensamento com emoção, uma vez que o pensamento sobre uma emoção corresponderia à emoção. Não havia nada que separasse pensamento e emoção, já que emoções seriam também uma forma de pensamento. Um poeta, assim, ao combinar pensamento e emoção teria uma grande variedade de formas de emoção disponível. Desse modo, Pessoa pode tornar-se Caeiro ou outros, ao combinar pensamento e emoção, ao abrir mão de sua própria subjetividade. Pensar como outro era sentir como outro. Não é por menos que Pessoa critique qualquer tentativa de explicar seus poemas, heterônimos, pseudo-heterônimos ao recorrer a sua biografia. Se houvesse qualquer traço de si em seus poemas, qualquer traço de sua história pessoal ou opiniões significaria que havia falhado enquanto poeta. Poesia moderna, para ele, implicava o apagamento da pessoa, do sujeito. Assim é compreensível o porquê de ser Caeiro o mestre. Ele é aquele que encarna a experiência extrema de despersonalização, a confrontação com a alteridade maior: aquela da Natureza. Caeiro não apenas reconhece a Natureza como é por ela modificada. A sua história e a história da natureza estão interligadas. Ele vive na mistura dos mundos.

No final de seu artigo *The Catachronism of Climate Change*, Srinivas Aravamudan, após identificar o materialismo especulativo e a object-oriented ontology como uma onda de filosofia climática pós-heideggeriana, que abandona "humanist subjectivism for a democracy of the objects or "an alien phenomenology"" (ARAVAMUDAN, 2013, p. 18), afirma que: "What began as catachronism, the burdensome experience of "living in the end times," could morph into the birth of many brave new worlds populated by those that come after the subject (...)" (ARAVAMUDAN, 2013, p.21). Não podemos deixar de nos perguntar se "após o sujeito" não possui uma história, cujos primórdios não estariam no início do século XX, momento no qual a ideia de sujeito estava sendo questionada pela literatura modernista.

A relevância da experiência estética reside, de

acordo com Timothy Morton, em configurar nossa experiência no Antropoceno, especialmente porque qualquer experiência estética significa se preocupar com aquilo que é não-humano. Uma obra de arte postula a solidariedade com o não-humano, seja a obra ecológica ou não. Ademais, a experiência do belo é nela própria não induzida pelo sujeito: "This is because beauty just happens, without our ego cooking it up. The experience of beauty itself is an entity that isn't me. This means that the experience has an intrinsic weirdness to it" (MORTON, 2018, p. 65). O que acontece quando uma experiência não induzida pelo sujeito é mediada por outra experiência igualmente não induzida? Uma experiência realmente ecológica? Só podemos imaginar.

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Big History in the Ecuadorian Educational System: Theory, Practice, and Public Policies of Environmental Education

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Abstract
The main objective of this paper is to describe two eco-pedagogical experiences developed with the Environmental Education Program of Educator, using Big History as theoretical framework. A transdisciplinary methodology is used to integrate scientific knowledge with ancestral wisdom, in order to combine an ecology of epistemes. Hence, the study reflects about the intercultural, plurinational, and multiethnic nature of the Ecuadorian citizenship to understand the environmental practices of those ancient worldviews. As result, the article reflects about the theory, practice, and public policies of the Environmental Education Program 'Tierra de Todos' developed by the Ministry of Education in Ecuador. In harmony with the Ecuadorian's Constitution of 2008, that recognized the Rights of Nature, this program has been implemented in all the Ecuadorian Educational System to raise environmental awareness and to restore the ecosystems. This juridical framework is based in the Good Living, a philosophical and political worldview of kiwicha indigenous peoples of Andean Region, where human beings are interconnected with our planet Earth and the whole cosmos. As the main conclusion, the Environmental Education Program seeks to bio-literate citizens to face the complex civilizing challenges of the Anthropocene, by teaching how to feel-think-act in harmony with the co-evolutionary processes of nature.

Keywords
Anthropocene, Big History, Ecuador, Environmental Education, Global Change, Intercultural, Transdisciplinary.

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I. Introduction to the Anthropocene and the Global Change

In ecent years, the term 'Anthropocene' has become an important topic in scientific, philosophical, and academic debates. Scientists divide the history of our planet into epochs, we are currently living in the Holocene epoch, a name given to the post-glacial geological period of the past ten to twelve thousand years. However, there is a global debate questioning the huge ecological footprint left by humankind on the Earth (Wackernagel & Rees 1996). The biologist Eugene Stoermer and the Nobel winning chemist Paul Crutzen advanced the term 'Anthropocene' in 2000. It has since gained acceptance as a new geological period characterized by the influence of human behavior on Earth´s atmosphere. Using atmospheric carbon dioxide (CO_2) concentration as a simple indicator to track the pollution acceleration, many researchers have proven that our human activities have experienced a great explosion with significant consequences for Earth System functioning. According to Steffen, Crutzen, and McNeil (2007), the Anthropocene began around 1800 with the onset of industrialization, the central feature of which was the enormous expansion in the use of fossil fuels. The concept emphasizes the influence of humankind in global geology and ecology, where human actions have a drastic effect on the Earth System.

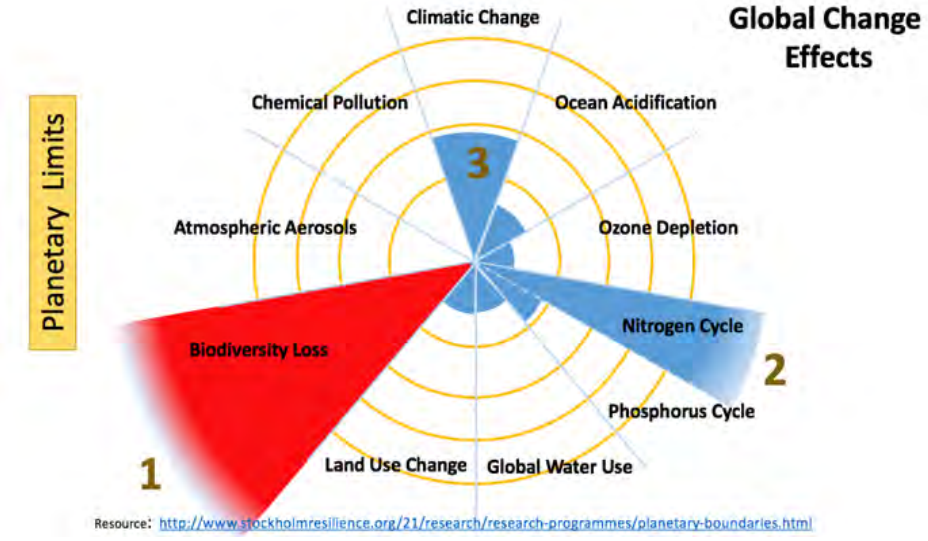


Figure 1. Global Change Effects. Resource: Stockholm Resilience.

As explained in Figure 1, the term global change refers to multidimensional changes on planetary scale that occur in the Earth System. This encompasses problems such as biodiversity loss, nitrogen cycle, climate change, phosphorus cycle, land use change, global water use, ocean acidification, ozone depletion, chemical pollution, atmospheric aerosols (among other inter-systemic and planetary problems concerning to environment, health, economy, energy, transportation, communication, urbanization, sea level rise, food, overfishing, and use of natural resources) (Bowman et al., 2009). As a whole, Earth acts as a meta-system constituted by bio-physical systems that interact with each other, giving place to the prevailing global environmental conditions. Solutions cannot be researched independently because all the socio-ecological problems of today's world are interdependent. Many Earth System scientists have concluded that humanity has harvest natural resources in a transcendental manner (Leff, 2002; Malo, 2015). Our socioeconomic systems conceive nature as an object that provides unlimited raw materials to industrial production models (Falconí 2014). According to Carson (1962), Schumacher (1973), and Kellert (2005), capitalism has transformed the ecosystems' geography around the globe, contributing to global change and leaving a huge ecological footprint (Wackernagel & Rees 1996).

As a result, the environmental activism began o emerge in nternational institutions in 1972, with the 'United Nations Conference on Human Environment' held in Stockholm. In 1977, the UNESCO and the UNEP organized the 'Intergovernmental Conference on Environmental Education' in Tbilisi (Georgia, URSS), to expand its political-educational scope. According to the Thilisi Final Report, "Environmental Education should help raise awareness of the economic, political and ecological interdependence of the modern world in order to accentuate the spirit of responsibility and solidarity among nations." (UNESCO, 1978, p.12). After the first stage of conceptualization, environmental education achieved important social and political commitments during the 1980s. The creation of the 'Commission on Environment and Development' in 1983 was a key event to develop a holistic vision on the environmental problems of our planet. After several years, the commission delivered its first report in 1987, with the title 'Our Common Future.' This document identified the ecological limits for economic growth in industrialized societies, establishing direct links between poverty reduction, gender equity, and redistribution of wealth with environmental conservation strategies. The document was the first to define the term 'sustainable development' as the process that "meets the needs of the present without compromising the needs of future generations" (United Nations, 1987).

The final recommendations of the Tbilisi Conference confirmed the inseparable link between the problems of civilization development and

environmental education. Although this definition of sustainable development is a bit vague and imprecise, environmental educators began to use it to expand a debate about planetary sustainability that still goes on today in formal and non-formal education (Arboleda & Paramo 2014; Teitelbaum 1978). Regional and international cooperation is a constant in the document to solve the planetary crisis that represents the ecological catastrophe created by humans. Experts recommended rethinking the industrial growth model based on the repudiation of gross domestic product (GDP) as a useful indicator to measure social progress (Stiglitz, Sen & Fitoussi 2010). Depending on those GDP economic-mercantile indicators, natural resources such as water, air or land, are not taken into account to measure social development (Neaman, Otto & Vinokur 2018). They are also obsolete because they exclude environmental health as an essential requirement for preservation, conservation, and proliferation of life (Riechmann & Tickner 2010).

Paradoxically, these natural resources are sacred in many ancestral views of indigenous people from all over the world. In many towns of *Abya Yala* (original name for Latin America), Mother Earth or Pachamama is conceived as a dynamic organism that is alive: rivers are its veins, mountains are its skin, forests and jungles are its fur, plants are spirits… According to some ancestral worldviews from the Andean Region, Nature provides biomimetic lessons in survival, resilience, and coevolution, as well as sophisticated diversification strategies that have been proven in a constant process of trial and error developed during 3.8 billion years. Then, designing regenerative cultures with the inherent wisdom of nature is the most efficient way to re-establish a creative fit between humanity and nature (Collado 2018).

For this reason, the Environmental Education Program 'Tierra de Todos,' developed by the Ministry of Education of Ecuador, has used the Big History as theoretical framework to raise awareness in the whole educational system. As historian David Christian (2010) proposed, the Big History integrates the history of the universe, Earth, and life along the history of mankind, in order to understand much better our socio-ecological reality. While science gives us light and specific data to many questions about our external physical cosmos, the ancestral wisdom allows us to explore our inner spirituality (free of religious dogmas). For example, the Kiwicha worldview uses medicinal and sacred plants to feel-think-act harmonically with our planet Earth, also known as *Pachamama* for these indigenous peoples. That is why the Environmental Education Program combines a transdisciplinary approach within scientific knowledge and ancestral wisdom to face the unsustainable challenges of our planet. Under this view, the 2008 Ecuadorian Constitution recognized Nature's Rights at the same legal status as Human Rights. This Constitution is a clear example of intercultural dialogue, where the epistemes of western modern science converged with ancestral wisdom of different ethnic peoples that make up the complexity of this Andean country (Acosta 2013; Tortosa 2009).

In this historical context, this article reflects about two eco-pedagogical experiences using Big History as theoretical framework in the Ecuadorian Educational System to raise environmental awareness. The Big History integrates an academic dialogue to unify the history of the cosmos, the history of our planet Earth, the history of life, and the humankind history (Christian 2010; Grinin, Korotayev & Rodrigue, 2011; Spier 2011). For this reason, the author explains two different educational experiences that used Big History to reinforce the Environmental Education Program in Ecuador: 1) as professor in the National University of Education (UNAE), in the subject 'Education, Science, and Good Living,' and 2) as special advisor of the Ministry of Education, with the implementation of green spaces in schools of Primary and Secondary Educational System. In sum, this article makes an introduction to the global change effects and the huge ecological footprint of the Anthropocene. Then, the paper analyzes the theory, practice, and public policies of the

Environmental Education Program. In addition, the multi-ethnic, plurinational, and intercultural nature of the Ecuadorian citizenship is described to understand the ecological consciousness and environmental practices of these ancient worldviews. Finally, it concludes with some reflections about how to regenerate our planet with environmental policies.

2. Big History in Ecuadorian Educational System: Theories and Practices in the Environmental Education Program

To speak about theories, practices, and public policies of Environmental Education in Ecuador is to emphasize that it is a pioneer country in the constitutional recognition of the Rights of Nature. It is the only country in the world that establishes nature as a subject of law. This legal advancement is a conquest of the indigenous peoples that, with their different ethnic groups and nationalities, has managed to capture their ancestral worldviews in the Constitution. According to political scientist Acosta (2013), 'Buen Vivir' (Good Living) is a political and philosophical proposal based on *Sumak Kawsay*, an ancestral Kichwa worldview that understands human beings as an integral and interdependent part of their social and natural environment. This worldview is also known as *Suma Qamaña* for the Aymara peoples of Bolivia, Peru, Chile, and Argentina (Tortosa 2009). Therefore, Good Living is the essence of Amerindian indigenous philosophy, which is characterized by its biocentric, intercultural, plurinational, and decolonial vision (Walsh 2009). This approach is present throughout the Ecuadorian Constitution of 2008 (Simon 2013), and in its' seventh chapter recognized Nature's rights as follows:

> **Art. 71**. - Nature or Pacha Mama, where life is reproduced and carried out, has the right to have its existence and the maintenance and regeneration of its life cycles, structure, functions and evolutionary processes fully respected. Every person, community, town or nationality may demand from the public authority the fulfillment of Nature's rights. To apply and interpret these rights, the principles established in the Constitution will be observed, as appropriate.
>
> **Art. 72**. - Nature has the right to restoration. This restoration will be independent of the obligation of the State and natural or legal persons to indemnify individuals and groups that depend on the affected natural systems. In cases of severe or permanent environmental impact, including those caused by the exploitation of non-renewable natural resources, the State will establish the most effective mechanisms to achieve restoration, and will adopt the appropriate measures to eliminate or mitigate the harmful environmental consequences.
>
> **Art. 73**. - The State will apply precautionary and restriction measures for activities that may lead to the extinction of species, destruction of ecosystems or the permanent alteration of natural cycles. The introduction of organisms and organic and inorganic material that can permanently alter the national genetic heritage is prohibited.
>
> **Art. 74**. - Individuals, communities and nationalities will have the right to benefit from the environment and the natural resources that allow the Good Living or *Sumak Kawsay*. The environmental services will not be susceptible of appropriation; its production, provision, use and exploitation will be regulated by the State (Asamblea Nacional 2008).

As a whole, the Constitution of 2008 designs the comprehensive exercise of state tutelage over the environment and the co-responsibility of citizens in its preservation, which must be articulated through a decentralized national system of environmental management. That is why public policies for the

restoration of nature are oriented towards inter-sectorial and participatory management of shared responsibility. Town halls are the guarantors of deploying (eco)efficient mechanisms in their respective management areas, but private industrial sectors must also assume their role in accordance with socio-environmental welfare. In this way, an inter-institutional governance is proposed that replaces the anthropocentric vision of the traditional economy, and it seeks to consolidate a biocentric conception that restores and regenerates ecosystems. In total, the Ministry of Environment of Ecuador (MAE, 2015) estimates that there are some 4,800 species (fish, amphibians, reptiles, birds, and mammals) throughout the country. That is why Ecuador is known as a 'mega-diverse' country.

Regarding its cultural diversity, Ecuador is characterized as a multi-ethnic, plurinational, and intercultural country, where different peoples coexist from a long time ago. According to data from the 2010 Census (INEC, 2010), the 13 million of inhabitants of Ecuador self-identify according to their customs and traditions in 45 ethnic groups distributed by coast, highland, amazon, and insular regions. Constitution's Article 1 reminds us that "Ecuador is a constitutional State of rights and justice, social, democratic, sovereign, independent, unitary, [multi-ethnic], intercultural, plurinational and secular. It is organized in the form of a republic and governs in a decentralized manner." This ethnic diversity is grouped into 14 nationalities and 20 cultural groups, who speak 14 languages throughout the territory (MCP, 2009). The flourishing of intercultural citizenship entails the overcoming of the historical exclusion imposed by coloniality (Mignolo 2001; Quijano 2000). In short, the will of the Constitution is national unity through the democratic and transdisciplinary recognition of multi-ethnic, plurinational, and intercultural richness (Walsh 2009). But what do the prefixes multi-, pluri-, inter-, and trans- mean in those social, political, cultural, and epistemic fields? According to Nicolescu's (2008) definitions, there are important differences:

Figure 2. Multi-ethnicity. Graphic by Javier Collado Ruano.

Multi-ethnicity: the multidisciplinary approach studies a research topic from several disciplines simultaneously, so it exceeds the disciplinary limits themselves, but its objective remains limited to the disciplinary research framework, since the disciplines cooperate in a mutual and cumulative way, but not interactive (Nicolescu 2008). The Constitution of Ecuador recognizes the multi-ethnic nature of its population, which means that there are 45 ethnic groups that adopt collaborative relationships with common objectives, but each one continues to maintain its own cultural, linguistic, historical, and artistic characteristics.

Pluri-nationality: the pluridisciplinary approach studies an object by several disciplines at the same time, located generally at the same hierarchical level. The pluridisciplinary approach goes beyond the disciplines through a disciplinary interaction or cooperation, where the own methods of each one are conserved, and whose purpose continues inscribed in the disciplinary research structure (Nicolescu 2008). The Constitution of Ecuador recognizes the plurinational nature

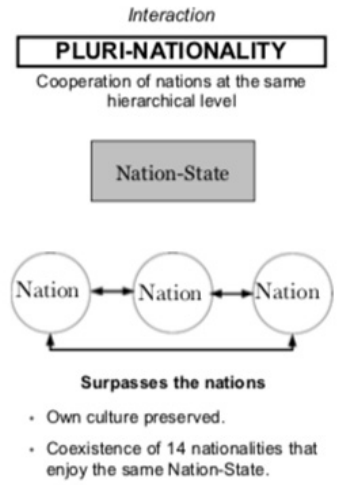


Figure 3. Pluri-nacionality. Graphic by Javier Collado Ruano.

of its population, which means that the Nation-State of Ecuador is composed for the coexistence of 14 nationalities that enjoy the same legal status. The plurinational approach surpasses the nationalities through an interaction or cooperation between the 14 nations, where each nation retains its geographical spaces, cultures, languages, values, and worldviews.

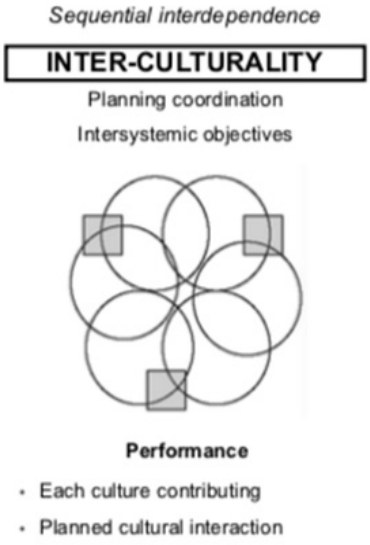


Figure 4. Inter-culturality. Graphic by Javier Collado Ruano.

Inter-culturality: the interdisciplinary approach studies an object of research through the prolonged and coordinated interaction between academic disciplines, leading to the integration of different discourses and the creation of a common conceptual framework and lexicon. The interdisciplinarity forms bridges between the cracks of the disciplinary structures, arriving to formulate a common methodology that transcends the interface of the epistemologies of different disciplines (Nicolescu 2008). The Constitution of Ecuador recognizes the intercultural nature of its population, which means that the 20 Ecuadorian cultures interact in a prolonged and coordinated manner, leading to the integration of different cultural discourses and the creation of a common legal framework. Interculturality forms bridges between cultural worldviews, leading to formulate an opening that transcends the interface of the epistemologies of different cultures.

Transdisciplinary: the transdisciplinary approach studies an object of research through the prolonged and coordinated interaction between the scientific knowledge of academic disciplines and the wisdom produced outside the academy (arts, spirituality, emotions, ancestral wisdom of indigenous peoples, mystical experiences and other dimensions historically forgotten by the sciences), in a process of reciprocal learning and without hierarchy. The transdisciplinarity develops a general axiomatics that crosses the essence of the disciplines, through an ecology of knowledge that is 'in, between and beyond the disciplines,' in order to achieve the unity of knowledge (Nicolescu 2008).

Figure 5. Trans-disciplinary. Own elaboration. Graphic by Javier Collado Ruano.

After some months of discussion, those definitions took shape and the multi-institutional Committee for the Environmental Education Program created strategies, (re)designed the curricula, and implemented actions in Primary and Secondary schools of Ecuador. Henceforth, two eco-pedagogical experiences are described to show how the Big History has been used as a theoretical framework to enrich theory, practice and public policies of Environmental Education.

3.1. Experience Teaching 'Education, Science, and Good Living' in the National University of Education (UNAE) of Ecuador

Those definitions to Ecuadorian realities were used during the 2018 course, in the subject 'Education,

Science, and Good Living,' with the students of 1st year of Education in Experimental Sciences of the National University of Education of Ecuador (UNAE). It was very important to contextualize all students into their complex reality to promote a transdisciplinary vision of Big History. This subject used Big History as theoretical framework to raise environmental awareness in the transversal axis of Environmental Education. During the entire academic year, the students used the flipped room methodology to research the main theories of various sciences. In each class, a couple students would explain to the others the main theories within cosmology, astrophysics, astronomy, classic and quantum physics, atmospheric chemistry, geology, biology, ecology, geography, anthropology, demography, sociology, theology, and so on. Pedagogical didactics reinforced their significant learning because they interlinked various epistemes in horizontal way - toward an ecology of knowledge (Santos 2010). In other words, by approaching the Big History from a transdisciplinary approach, students understood much better the interconnections of the humankind with the different levels of reality that co-exist in nature and in the cosmos (Collado 2016). The lessons combined scientific theories with mystical and spiritual experiences, very present in the rituals of shamanism with Ayahuasca and other sacred plants of the Andean region.

Another good example of this transdisciplinary learning of Big History was the visit to the Ingapirca Ruins, an archaeological complex wherein the largest and most ancient ruins in Ecuador can be found.. As the Inca Empire expanded into southern Ecuador, they met Cañari indigenous peoples in the early 16th century. After some confrontations, they decided to settle their differences and live together peacefully. The castle complex is of Cañari-Inca origin; however, its purpose remains unknown. During the visit to Ingapirca, the astronomer Vladimir Peña and the architect Pablo Jara explained to our students the links between astronomy, architecture, ancient cultures, and ancestral worldviews.

Photo 1. Archeological complex of Ingapirca. Photo by Javier Collado Ruano

Photo 2. Astrological observatory of Ingapirca. Own resource. Photo by Javier Collado Ruano.

This visit to Ingapirca was made during the commemoration of the World Environmental Education Day, on January 26th, 2019. The Ingapirca complex had long been settled by the Cañari and Inca cultures — the same cultures that built the elliptically shaped Temple of the Sun. This was used as atronomical observatory and the stones were carefully positioned in keeping with their beliefs and knowledge of the

Photo 3. Students of Education in Experimental Sciences visiting Ingapirca ruins.Photo by Javier Collado Ruano

cosmos. Some researches argue that the Temple of the Sun was positioned so that on the solstices, at exactly the right time of day, sunlight would fall through the center of the doorway of the small chamber at the top of the temple (Diaz 2013). As sun and moon worshipers, they built their monuments high in the mountains to be closed to their gods. Those ancient peoples had numerous ritual celebrations at the complex, using fermented drinks to consume during the festivals. This visit made clear to our students the relationship between astronomy, architecture, ancestral wisdom, indigenous worldviews, spirituality, and intercultural beliefs.

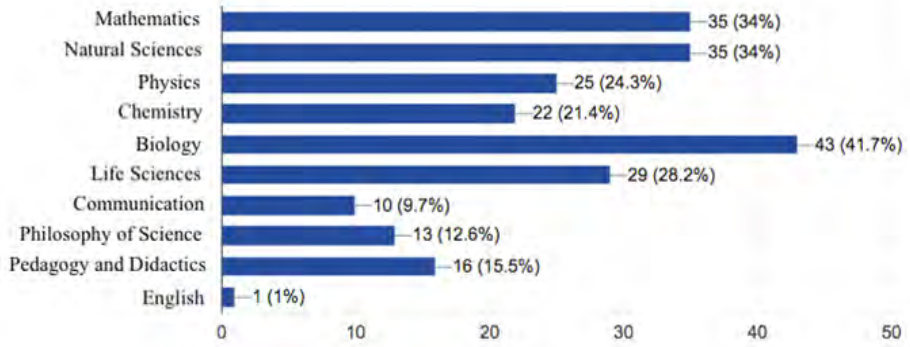
Moreover, Big History's scientific theoretical framework was enriched with ancesteral wisdom which provided better understanding of the multi-ethnic, plurinational, and intercultural complexity of Ecuador. This decolonial and transdisciplinary vision of history integrates and unifies diverse epistemes that are within, between, and beyond the scientific disciplines (Nicolescu 2008). That is, it includes ancestral wisdom, indigenous worldviews, spirituality, arts, emotions, mystical experiences, and other dimensions forgotten in the history of science, especially by the positivist approach. Important human dimensions were excluded because they cannot be measured or quantified by scientific instruments. Paradoxically, facing the challenges of global climate change means rescuing essential human dimensions to propose regenerative cultures and transform our relationship with nature and the whole cosmos. For this reason, my experience as professor in the subject 'Education, Science, and Good Living' has proven that Big History constitutes a perfect theoretical model to enrich the eco-pedagogical practices that Environmental Education Program requires.

In fact, a questionnaire was iven to all the students on the subject 'Education, Science, and Good Living,' a career within Education in Experimental Sciences. Here, they learn pedagogies and didactics about how to became teachers of Physics, Chemistry, Biology, and Mathematics in Primary and Secondary schools of Ecuador. The answers give us their opinion about this theoretical and methodological approach. In total,

103 students replied with the following highlights:

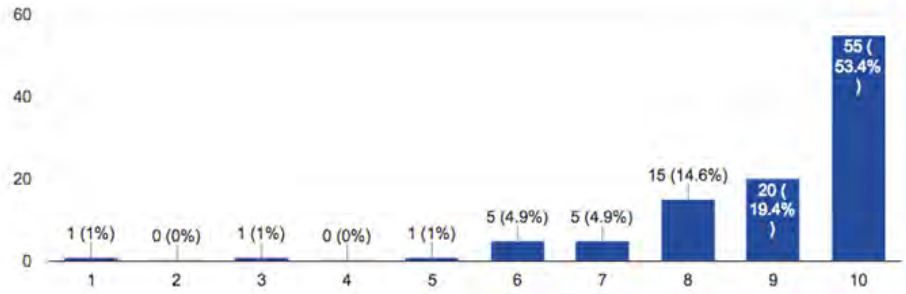
What science do you like most to learn in the UNAE?

103 responses



In your opinion, what is the level of importance that learning Big History has in your teacher training?

103 responses

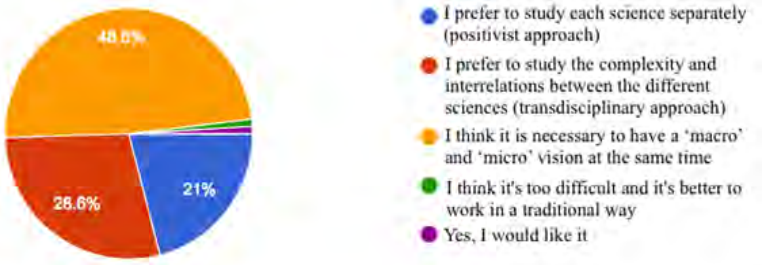


Would you like your university to create scientific and academic events that promote Big History?

103 responses

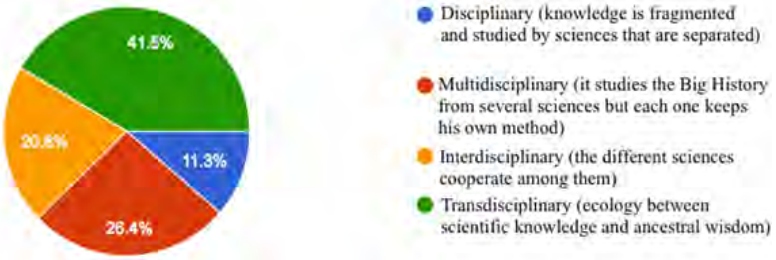
Would you like the teachers at your university to teach you Big History in your classes?

103 responses



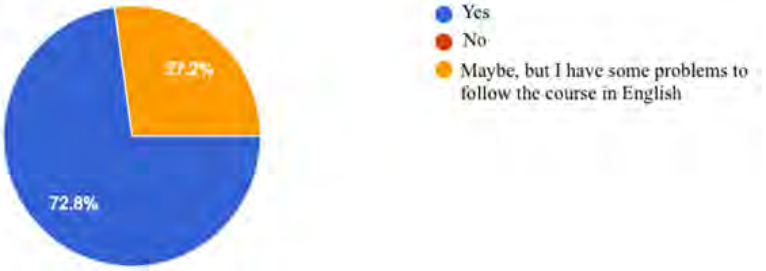
What epistemological approach do you think is most correct to teach Big History?

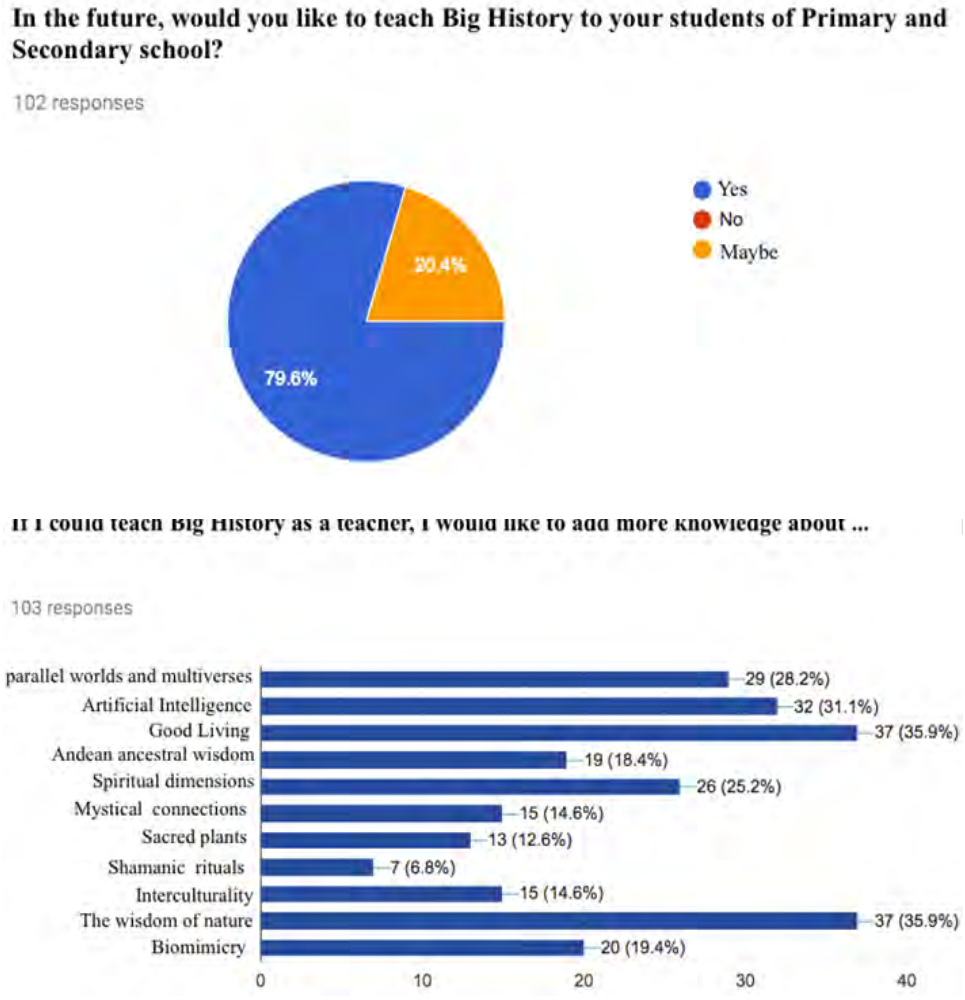
103 responses



Would you like to participate in the free online courses of Big History Project?

103 responses





According to the the questionnaire, given to 103 students, their greatest interest lies in studies of cosmology, neuorscience, ecology, and artificial intelligences. They really believe that Big History is very important in their training as future professors of Physics, Biology, Chemistry, and Mathematics. The students also think that our university should promote more academic events on Big History and their professors should teach with a 'macro' and 'micro' vision at the same time. The transdisciplinary approach (41.5%) is their prefer option to learn Big History, followed by the multidisciplinary (26.4%), interdisciplinary (20.8%), and disciplinary (11.3%) approach. They would like to study in the Big History Project, but they have some problems with the meaning s as expressed in English. Nearly 80% of the students would like to teach Big History in primary and secondary schools of Ecuador in the future. Additionally, they would like to gain knowledge about the Good Living philosoph, the wisdom of nature, artificial intelligence, parallel worlds and multiverses, spiritual dimensions, biomimicry, Andean ancestral wisdom, interculturality, mystical connections, sacred plants, and shamanic rituals. I argue here that a trans-disciplinary approach to Big History opens a dialogue with ancestral wisdom and intercultural knowledge of Ecuadorian communities. In the Andean region, respecting the ancient worldviews that harmonize

spiritual and cultural beliefs, has to be the cornerstone to building new scientific knowledge. Then, the decolonization of curricula with those dialogues is an essential process to integrate Big History in Ecuador, but also in many other countries of Latin America and beyond.

3.2. Experience as Special Advisor on Environmental Education of the Ministry of Education

From June 2017 until he present, I have had the privilege and the responsibility to act as special advisor of the Ministry of Education, where different specialists have worked together to develop the Environmental Education Program[1]in Primary and Secondary schools of Ecuador. The program is still in action and the axis of epistemic enunciation of those public environmental education policies has a marked intercultural and transdisciplinary character that includes and integrates scientific knowledge with ancient wisdom of indigenous people (Falconí 2017; Krainer 2012). In this way, the Ministry of Education of Ecuador, in collaboration with other national and international institutions, used a transdisciplinary approach that implies an inter-epistemological dialogue of ancestral worldviews with the natural sciences, social sciences, mathematics, arts, humanities, geosciences, and telecommunications. As shown in Figure 6, the transversalization of the environmental education axis is based on a multidimensional dialogue that germinates both the scientific knowledge and the indigenous wisdom.

According to this multidimensional approach of the Environmental Education, inspired by the Big History vision, my role as special advisor has been focused on three major actions: 1) provide a multidimensional scientific vision on the challenges that we face nowadays with the effects of global climate change, through bibliographic and documented data; 2) guide the educational discourse towards good eco-

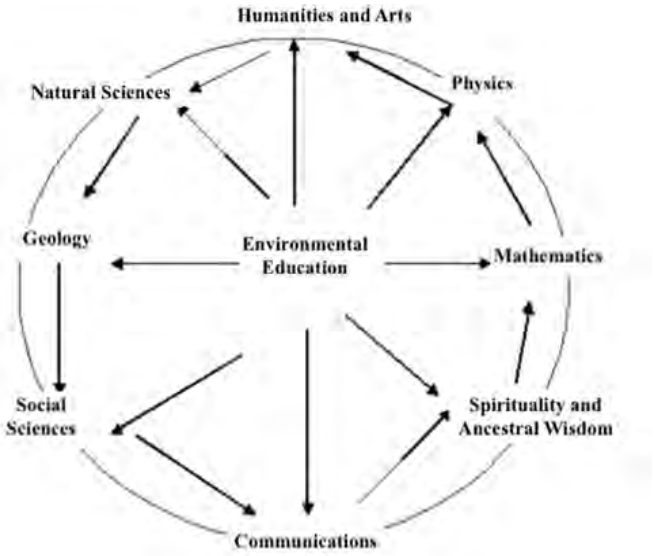


Figure 6. Transdisciplinary dialogue of Environmental Education. Source: Javier Collado Ruano.

pedagogical practices in order to create strategies to implement the Environmental Education Program; 3) create two online training courses for more than 165,000 teachers of primary and secondary schools that focuses on environmental quality, maritime awareness, and implementation of environmental projects in educational institutions. The online training program seeks to generate a domino effect in society through the transformation of their socio-environmental reality. Of course, those actions have been developed along with so many colleagues of the Ministry of Education, the Ministry of Environment, the Marine Institute, the Amazon University (IKIAM), and the National University of Education (UNAE). This committee typically holds a monthly meeting to discuss the various strategies, contents, and visions to be implemented at a multi-level scale. After all this time, many scientific articles, conferences, and movies have been made to disseminate the theories and practices of the Environmental Education Program.

In short, the Environmental Education Program combines the inside and outside dimensions of our human condition at the same hierarchical level.

1 To read more information visit: https://educacion.gob.ec/educacion-ambiental/

Photo 4. Environmental Education Committee along Minister of Education of Ecuador.
Photo by Javier Collado Ruano.

It means training one's self-awareness, our own spirituality; it means rescuing the ancestral indigenous wisdom and promoting many other rational, logical, perceptive, affective, emotional, rhetorical, poetic, epistemic, creative, artistic, cognitive, and philosophical dimensions of our human condition. By approaching the basics of environmental education in a transdisciplinary way, the teaching-learning processes are significantly enriched, as their training dimensions fertilize each other and lead to new ways of feeling-thinking-acting with Pachamama (Collado 2017). Rooting theoretically, methodologically, and pragmatically the transversalization of environmental education in the Ecuadorian Education System has involved a profound reflection on the theories and practices that have developed — in a multidimensional way — to promote the competencies, skills, and attitudes necessary to face the global change effects (MinEduc 2018a).

Furthermore, Minister Falconí (2017) reflects that we must bet on public policies of environmental education and ecological economy focused on the care of the Earth System and the transformation of the productive matrix (Wassily 1970). Here, the Big History vision helps us to understand the limits of biophysical regeneration of our planet, in order to transform the predatory economic system that guides our civilization. For this reason, facing the global change provoked by capitalism requires transgressing the failed theoretical model of sustainable development established by the academic discourse of technoscience (Leff 2002; Wallerstein 1997). According to Collado & Malo (2019, p. 339), "while the notion of sustainable development is focused on minimizing the negative impact of humans on the planet, the notion of regenerative development focuses on maximizing the positive impact of human beings on Earth." This regenerative approach represents a qualitative leap in our relations with nature, in harmony with the biocentric vision of restoration embodied in the Constitution of 2008. In this line of thought, (Orr 2002, Pauli 2015, Wahl 2016, and Müller 2018) argue that it is urgent to (re) design regenerative cultures to restore the nature and

to promote ecological economy and environmental education in public policies. Following this direction, the Equatorial Garden has been implemented in more than 10,000 schools in Ecuador (as described below) and is continuing to advance.

Equatorial Garden: Implementing TiNi's Methodology in Primary and Secondary Schools

The common denominator of many indigenous and ancestral worldviews is the spiritual and ecological conception that structures their social organizations, which are in harmony and respect with the different forms of life that co-exist in our Mother-Earth. Environmental consciousness is present in many worldviews of Amerindian indigenous people, who understand the sacred attribute of nature as a spiritual connection. Just as no one learns to swim out of water, no one learns to love nature without being in direct contact with it. For this reason, it is not possible to learn Environmental Education without a proper philosophy or methodology. In this direction, the Ministry of Education of Ecuador adopted the 'TiNi' methodology, created in the 90's by Peruvian educator Joaquin Leguía to promote environmental awareness. Nowadays, there are more than 10 countries around the world that have implemented the TiNi methodology. In 2012, the TiNi Methodology was recognized by UNESCO as a good education practice to raise environmental awareness. According to Leguía and Paredes (2016, p.24):

> TiNi is a space granted by adults to girls, boys and young people, from half a square meter of land, where with love, they *grow* life and biodiversity; and in the process they strengthen their knowledge, skills, values, and self-esteem to live in harmony with the environment.

With this educational vision of human training, the Ministry of Education of Ecuador recognized, in 2017, the TiNi methodology as a good educational practice and a fundamental eco-pedagogical resource for the transversalization of the environmental axis in the curricula of primary and secondary schools (MinEduc, 2017). The goal of this methodology is to put girls and boys in regular contact with nature from an emotional approach (Leguia & Paredes 2016). People from any country can implement the TiNi methodology regardless of their socio-economic or cultural situation, in a rural or urban area, in their schools, homes or communities. With this methodology, students can learn competences, skills and values for sustainable and regenerative management of natural resources. In this process to value nature, culture and identity they learn to develop feelings of affection for all forms of life (MinEduc, 2018b). It is a methodology focused on tackling global change through direct action-theory learning in the cultivation and restoration of ecosystems. In short, the TiNi methodology has shown that it can be very useful for environmental management, since it favors the care of ecosystems and develops multilevel actions among students and their communities.

The adaptation of the TiNi methodology to the Ecuadorian context is known as the *Equatorial Garden*, and was made within the public policies framework of the Environmental Education Program 'Tierra de Todos' of the Ministry of Education, in collaboration with other public and private institutions of national and international scopes. Here, the Big History theoretical framework is being introduced into schools by the teachers trained in the two online courses described above. The primary objective of Equatorial Garden is to strengthen environmental awareness and promote a regenerative culture throughout the educational community. Through a biocentric approach based on values, ethical orientation, altruism, innovation and education quality, the program seeks to integrate and transversalize environmental education at all school levels as a means to make the Ecuadorian citizens responsible for the social challenges of global change. In this direction, the Program is developed in three

areas:

1. Implementation of innovative pedagogical methodologies with an affective, playful, practical, intercultural, transdisciplinary, and holistic approach.

2. Strengthening the national curriculum with an environmental approach.

3. Good environmental practices in the education system.

In 2018, the National Education System of Ecuador had a total of 15,365 schools, including primary and secondary levels (MinEduc 2018b). This is a great challenge for the successful implementation of the Program. The Ecuadorian version of TiNi, like every plant transplanted to other lands, has shaped its own idiosyncrasy. The Good Living philosophy has been an important element to this adaptation. On September 2017, the Ministry of Education issued the guidelines for the implementation of this adapted methodology at national level. Just few months later, in June 2018 10,021 schools had inaugurated their own TiNi spaces. In total, more than 2.6 million students and 165,000 teachers benefit from the Equatorial Garden, which already has an extension of more than 1,000,000m^2 for environmental protection and the implementation of environmental education (MinEduc, 2018b). The 'Introductory Guide to TiNi's methodology' was created to explain the importance of respecting the particularities of each school, its territorial environment, and its cultural realities. Good practices of educative intervention are possible now, because teachers materialize the theoretical knowledge offered in classrooms, in a natural space, recognizing students as agents of change that shape their realities day by day with actions that benefit themselves, others and nature.

As a whole, the three action areas of the Program 'Tierra de Todos' have yielded successful and hopeful results. Although it is soon to bring more complete results, the indicators and evaluators of each line of action indicate that the Equatorial Garden has reported multiple benefits. This adaptation of the TiNi's methodology has created an inclusive environment that reinforces the interaction between students, teachers, family and community, generating collective environmental awareness. They all have a transdisciplinary dialogue between scientific theoretical knowledge and ancient community practices. Direct contact with nature has also brought benefits to the health of communities, whose teaching-learning processes have allowed the abstract (theory) to become concrete (practical), and the knowledge and skills acquired have one purpose: environmental care. In the coming years, we expect to obtain broader results that would allow us to better understand the impact of public policies implemented within the framework of the Environmental Education Program 'Tierra de Todos.'

Conclusions to (re)design regenerative cultures

Both of the eco-pedagogical experiences presented show that using Big History with a transdisciplinary approach in the Environmental Education Program of Educator has been a key factor to promote sustainable and regenerative development for the Earth System. Environmental Education cannot be just about transmitting values and knowledge, but is a creative, constructive and transformative act. Ecuadorian citizenship must learn to develop a continuous, self-conscious dialogue to *feel-think-act* with their emotional feelings, thoughts, and actions. In fact, sustainable and regenerative development is not only a quantifiable issue in economic terms, but also a human quality of feeling-thinking-acting in harmony with the Pachamama (Collado 2017). For this reason, it is urgent to reinforce public policies aimed at conservation, preservation, and remediation of ecosystems, in order to (re)design regenerative cultures that transform the current civilizatory direction.

As has been presented throughout this work, the public policies developed within the framework of

the Environmental Education Program 'Tierra de Todos' are aimed at the regenerative development of nature. The great asymmetry and economic inequality that globalization produces translates into planetary unsustainability and puts at risk the existence of future generations, especially in the so-called 'global South.' That is why it is essential to reflect about how to introduce Big History framework into the public policies on Environmental Education of Ecuador or on other countries. The Environmental Education Program of the Ministry of Education has a transdisciplinary vision in Ecuador, since ancestral wisdom enriches scientific theories with socio-environmental practices that have proven to be sustainable over time. With this vision rooted in public policies of Ecuadorian Educational System it is possible to deepen and improve the human-nature relationship by showing the different contexts, realities, interactions and processes. The partial results presented from the implementation of the program illustrate how necessary it is to continue working on teacher training, strengthening the quality and innovation of school's curriculum, and promoting good environmental practices.

With a biocentric, intercultural, and transdisciplinary vision, the Equatorial Garden is focused on the recovery of the community of life, preservation of a healthy biosphere and, moreover, conceives the Earth System as a sacred duty. According to the Good Living philosophy, the whole planet is an interconnected and indivisible entity. In other words, out planet is an intimately interrelated and interdependent meta-system that requires complex and systemic solutions to achieve sustainable and regenerative development. For this reason, environmental education is conceived in Ecuador as a lifelong process that it should not be confined solely to the school system curriculum, but should be extended to all areas of society. In the Ecuadorian context, environmental education is a transversal element of the curriculum at all schooling levels that includes a deep dialogue with communities where the educational institutions are located. The theory based on the Big History enriches the ancestral practices of environmental education of the communities, and the ancient environmental practices are enriched by the theoretical contributions of the Big History. The Environmental Education Program finds in the Big History theoretical framework a key element that contribute significantly to change the way in which Ecuadorian citizens understand their complex reality. In sum, the theories, practices, and public policies presented in this paper focus on the restoration of our planet. I hope this paper encourages readers to actively participate in the changes needed to save the planet. Are you ready? This article is a call for an active citizen participation to sow environmental conscience that derives in restoration actions of Mother Earth.

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Crater, Catastrophe, Contingency: An Improbable Journey and the Human Situation: A Review of Books by Walter Alvarez

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Walter Alvarez' big history of our planet and ourselves, *A Most Improbable Journey* (2017), begins with a 1991 expedition to Mexico with two other geologists to search for ejecta from the 110-mile-diameter Chicxulub crater recently found straddling the Yucatan Peninsula and Gulf of Mexico. This was a follow up episode in a decade-long – and by now well-known – story. It began when Alvarez presented his theory that a large asteroid had struck the Earth 65 million years ago, causing the extinction of the dinosaurs. His evidence was a mysterious centimeter-thick layer of clay located at the Cretaceous-Tertiary (K-T) boundary in the Apennine Mountains near the Medieval town of Gubbio. The mystery, however, was less in the clay itself, which was devoid of even microfossils, than in the dramatic change in fossil evidence from the Cretaceous layers below it to the newer Tertiary layers above. After discussion among associates and considerable puzzlement, analysis showed that it contained an unusual amount of iridium, an element rare on Earth but abundant in asteroids. No visible evidence of a local asteroid strike in Europe was known, thus leaving the location a mystery for a time. Eventually this iridium-rich clay was discovered at more than 100 sites around the world, wherever the K-T boundary was exposed. This led Alvarez to conclude that a city-sized asteroid 10 to 12 miles in diameter had struck the earth somewhere, causing a catastrophic disruption of planetary climate. Since the K-T boundary corresponded with the disappearance of numerous megafaunal species, Alvarez theorized that this hitherto unknown asteroid had brought down the dinosaurs that had dominated the Earth over the previous 200 million years, along with half the world's wildlife. Following its publication in *Science* (1980), his theory received a lukewarm, sometimes hostile, response in the geological community until the Chicxulub Crater was discovered a decade later and dated at 65 million years. In an almost perfect example of how science should work, his theory was followed by the discovery of evidence that confirmed it. Today the idea that an asteroid drove the dinosaurs to extinction has passed into popular knowledge, been repeated in causal conservations, and is taught to grade school children.

Fig. 1. Family History according to Tia Carmen. Cartoons often indicate the popularity of a scientific theory. Artists: Cantu and Castellanus. www.cartoonstock.com

I. A Catastrophic Impact

The full story was set out by Alvarez in *T-Rex and the Crater of Doom* (1997). So why did he return in 2017 to an event that had been confirmed more than a quarter century earlier? The answer lies in the unifying theme of the "improbable journey." From this perspective, *T-Rex and the Crater of Doom* and *A Most Improbable Journey* can be seen as a single two-part presentation, rich in geological lore and illustrating a motto Alvarez uses to introduce the basics of geology and petrochronological dating: *Ex libro lapidum historia mundi*, "The history of the world [comes] from writings in rocks." The significance of these volumes lies in putting to rest a long standing assumption of geological change as occurring gradually and uniformly over vast time periods. Their deeper significance, especially the second volume, lies in his big history narrative with an emphasis on the theme of contingency. The Alvarez discovery shows that the existence of life, including human life as we know it, depends on events of the past sometimes forgotten, perhaps undiscoverable, and often catastrophic. The asteroid that struck Earth 65 million years ago symbolizes all such events and brings home the tenuousness of the human situation. By extension, it suggests that the possibility of life across the Universe may be due for reexamination.

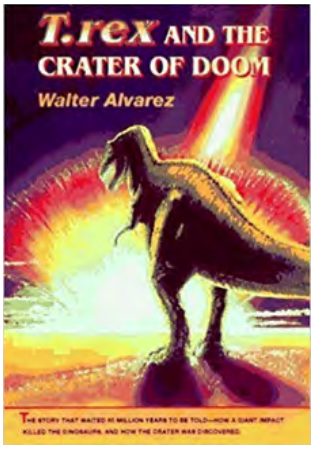

Fig. 2. *T-rex and the Crater of Doom (1997) tells the story of t*he day an asteroid struck Earth at Chiczulub 65 million years ago, its author's 1979 discovery of asteroid fallout at the K-T boundary in the Apennines, his theory of dinosaur extinction, and the 1991 confirmation of a 65-million-year-old crater buried under nearly a mile of sediment in the Yucatan Peninsula and Gulf of Mexico.

The gradualist uniformitarian theory that prevailed through most of the twentieth century was so deeply embedded that it is worth examining its history, for therein lies the importance of the Alvarez books. The contrary theory of catastrophism that preceded it had its heyday in the late eighteenth and early nineteenth centuries, with periodic resurgences among twentieth century fundamentalists. Its foundation was the catastrophic biblical flood (Gen. 6-8) which many thinkers, even those with scientific interests, regarded as literal fact. The Flood had seemingly been established as an historical event by Bishop James Usher's dates worked out in *Annals of the World* (1649); his dates were printed in the margins of both Oxford and Cambridge editions of the Bible for the next 230 years and remained the starting point for geological explanation. Fossils found far above sea level were seen as evidence of a worldwide flood that had carried marine life to the heights of the world's mountains. Fossils of primitive organisms at lower levels were evidence of their inability to adapt to this catastrophic event while fossils of more advanced creatures at higher levels were evidence of their greater resilience and superior skills—in essence, their higher position in the Great Chain of Being, the prevailing model of the Universe through the Renaissance and the eighteenth century (Tillyard 1942; Lovejoy 1936). Such inventive explanations to protect biblical stories had developed through Christian history from at least Augustine's fourth century *Civitas Dei* (*The City of God)*. But, as Alvarez remarks, "Geology could not become a real science until the strangle-hold of Biblical chronology was broken" (1997, 43).

In the late 18th and early 19th centuries, geologists committed to fact-based, evidence-driven science began to consider new chronologies. James Hutton (1726-1797), an explorer of the wilds of Britain and a founding member of the Edinburgh branch of the Royal Society set a new standard of geological analysis. With a general education in the classics followed by studies in chemistry and medicine, he appears to have escaped all biblical influences, as did a group of associates that

included the mathematician John Playfair, philosopher David Hume, and economist Adam Smith. In essence, Hutton recognized a material cycle whereby erosional material flowing from mountains formed layered sedimentary rock on ocean bottoms that was subsequently uplifted to form new mountains. His theory was delivered at the first two meetings of the Royal Society (1785), then published, but his *Theory of the Earth* (1788) was (and still is) virtually unreadable; however, John Playfair's *Illustrations of the Huttonian Theory of the Earth* (1802) brought it into the clear light of day. Though the cycle was too slow to observe—and neither Hutton nor Playfair had the slightest inkling of what forces drove the cycle—evidence could be observed in various geological formations. Charles Lyell (1797-1875) confessed that he did not get through Hutton's book, but early in his career he traveled with Playfair to Siccar Point—the North Sea cliff where Hutton, Playfair, and James Hall had found the proof for Hutton's theory and a vision of the past now referred to as "deep time" (Wood 2019).

Charles Lyell, the greatest geologist of the 19th century, built on Hutton's insights, but he was keenly aware of flood fictions and fabrications that were still widely promulgated in Europe. Although he had little patience with such fabrications, he took the high road, recognizing that a more compelling narrative rather than an attack or refutation was the proper method to combatting deluge theology.

Lyell's three-volume *Principles of Geology* (1830-1832), which went through twelve editions, can be seen as a sustained repudiation of catastrophism and an unrelenting presentation of evidence for uniform gradualism. Lyell refers to catastrophes just twice: first, in a context of ancient Greek and Egyptian mythology (*Principles* I, 9)—hardly an idea in his view to be taken seriously; second, he introduces a discussion of volcanoes with a cautionary remark: "we are not about to advocate the general doctrine of catastrophes recurring at regular intervals" (*Principles* II, 160-161). He made no mention of the destruction of Pompeii by

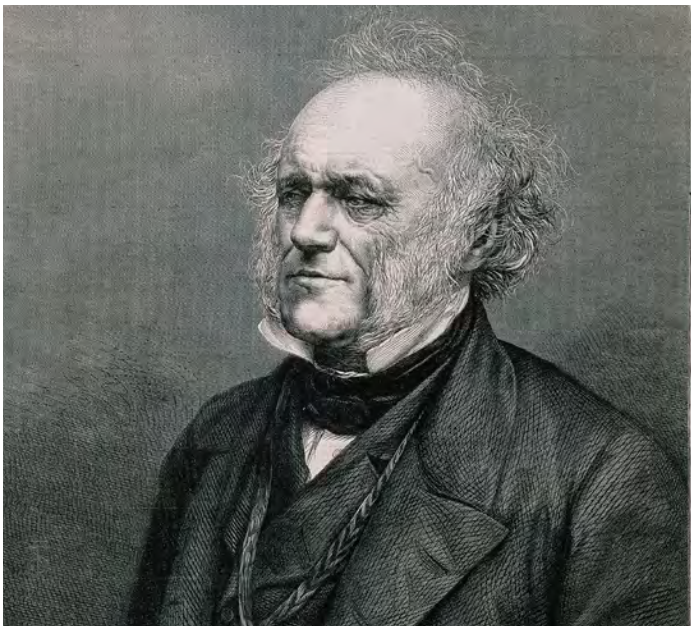

Fig. 3. Charles Lyell, the most prominent pre-20th century geologist, opposed catastrophism with his sustained presentation of uniform gradualism, thus exerting a century-long influence on 20th century geologists until the Chicxulub crater verified catastrophic events as an unpredictable geological force.

Vesuvius, probably because it was a human rather than geological catastrophe. In his extensive exploration of Mount Etna (*Principles* III, 75-94), which had erupted a handful of times in recorded history, he noted evidence of ninety eruptions. However, his descriptive language (including quotations of poetry from Robert Schomburgk and John Milton) reduces immense overlapping lava flows to a romanticized landscape of gradualism; this was the period when English literature was dominated by Romantic poetry. His textbook, *Elements of Geology*, which went through six editions (1838-1865), did not mention catastrophism—not even to refute it—thus weeding out the idea for several generations of geology students. Lyell's strategy was to circle around catastrophism as if such phenomena never did and never could occur, a condemnation by silence.

So gradualism became the conventional geological wisdom of the day. As Alvarez puts it, "Uniformitarian

gradualism provided an excellent framework for answering questions about the Earth" (1997, 59). Everywhere one turns—whether rock faces along cross-country highways or views from the rim of the Grand Canyon—hundreds of layers of sedimentary rock that can sometimes be thousands of feet thick testify to the snail-pace accumulation of silt on ancient ocean bottoms. The tilt of sedimentary layers at the Joggins Fossil Cliffs of Nova Scotia (which Lyell visited) and and the distorted rocks in the Scottish Highlands and the Alps were clearly the result of steady uplift or lateral pressure over millions of years. The sedimentary layers that folded on themselves without fracturing were proof of gradualism. South-running scorings on Precambrian rock surfaces in the Canadian Shield were the result of glaciers moving mere inches per year. As Alvarez remarks, "Geologists learned uniformitarianism from their teachers and found that in practice it almost always led to reliable explanations of geologic features. . . . Gradualism had become a dogma" (1997, 59).

Against this background and Lyell's stature, it is no surprise that his gradualist uniformitarian theory of geological change persisted long into the twentieth century. It is also clear that the Alvarez theory and the subsequent confirmation that the Chicxulub impact was sufficient to drive to extinction half the life of the planet, added a dramatic new dimension, upending the prevailing geological assumptions of the twentieth century. In fact, the effects of the impact were widespread; they brought into focus a scenario that challenged the imagination. The first chapter of *T-Rex and the Crater of Doom* provides a narrative of the day catastrophe struck. The tell-tale iridium-rich layer Alvarez had discovered was confirmed at a cliff called Stevns Klint in Denmark, a butte in Montana called Iridium Hill, Raton Basin in Colorado and New Mexico, Caravaca, Spain, New Zealand, and other locations worldwide. These deposits of iridium-rich clay made clear that asteroid debris—a combination of the asteroid itself and Earth material from an immense impact crater—had been ejected into the upper atmosphere and subsequently circled the planet. This probably blocked out the sunlight long enough to cause a die-off of vegetation and subsequent animal extinction before the debris eventually settled to the ground.

The presentation in the second and third chapters is one of the most readable accounts of geological science of the later twentieth century beginning with what geologists look for: history written in rocks. Appreciation for their work grows with every page of this lucid narrative. Step by step Alvarez takes us through the unraveling of Earth history, their collection of further evidence in the Apennines, and the process of unwinding the mystery of the clay at the K-T boundary, all backed up by detailed notes and citations from numerous studies this event has spawned. Central to his account are the dating of fossils and different kinds of rocks, the unlocking of the past in various schedules of radioactive decay, and the chronological traces left by magnetic reversals, all of which underlie the temporalities of big history

Fig. 4. A centimeter-thick layer of claystone rich in iridium, dated to 65 million years ago, marks the Cretaceous-Tertiary (K-T) boundary, separating lower rocks of the dinosaur era from the upper layers following their extinction. The layer is found worldwide; this sample is from Wyoming. https://simple.wikipedia.org/wiki/K/T_extinction_event

(Wood 2015).

At first, Alvarez confesses, it was difficult to absorb the idea that a catastrophic event had caused a mass extinction. More than a century of gradualism was deeply inbred in the thinking of geologists through most of the twentieth century. He remarks on the 1968 orbiting of the Moon by Apollo 8 which highlighted the Moon's terrain heavily cratered from multiple asteroid hits—a recognition that suggested catastrophic events were much more common in the Solar System than gradualist geologists had so far realized—but it took more than a decade and the discovery of this catastrophic mass extinction 65 million years ago to adjust long-held assumptions. It took the discovery of the Chicxulub crater and its definitive dating to establish catastrophism as a recognizable though unpredictable geological force.

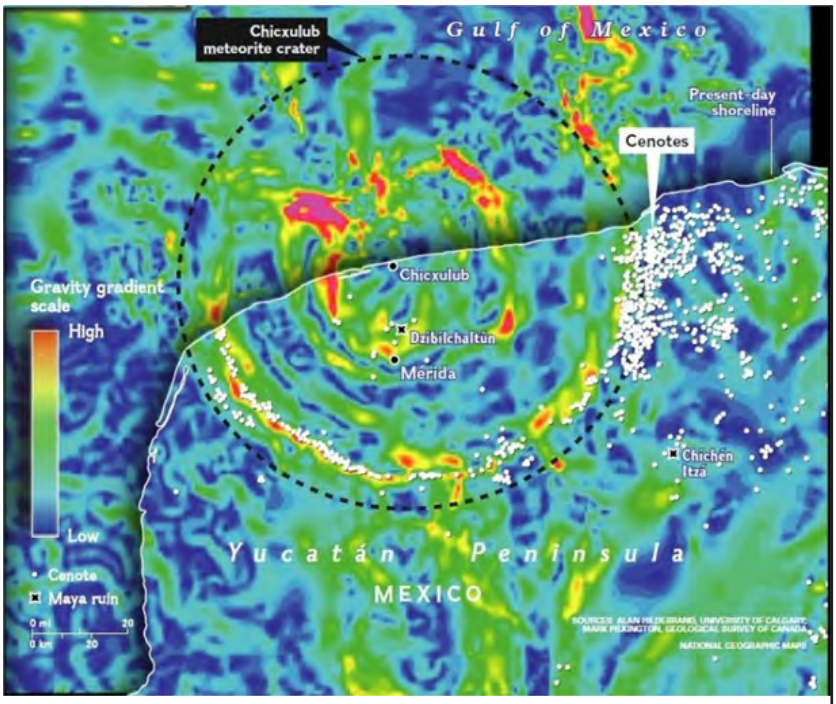

Fig. 5. Chicxulub, the site of the asteroid impact, is near the coast of the Yucatan Peninsula, indicated by the shadowed white line. Buried below hundreds of feet of silt, the 110-mile-diameter crater is here visible as a gravity anomaly. Surface evidence includes numerous cenotes—water-filled sinkholes—many of which are associated with the gravity-gradiant perimeter. Cenotes are here added to the gravity-gradient map by Alan Hildebrand, Geological Survey of Canada.

The later expedition to Mexico described at the beginning of *A Most Improbable Journey* provides more details of the search for evidence of how the Chicxulub catastrophe had unfolded along with notes, explanations, and citations to a growing list of geological studies. It was soon clear that a massive tsunami hundreds of meters in height had rolled ashore in Cuba, Mexico, and Texas leaving behind thick deposits of sand and gravel. Shocked quartz ejected from the impact was found at 30 sites worldwide. In addition, dateable glasslike impact "spherules" were found in Alberta, Italy, Mexico, Spain, and another 65 sites around the world. "The sperules," Alvarez writes, "were formed from droplets of rock that had been melted by the heat of the impact, were ejected from the impact crater, left Earth's atmosphere and traveled long distances in ballistic free fall before reentering the Earth's atmosphere and falling back to Earth" (2017, 6).

Locating the crater provided proof that an impact had occurred; the global distribution of debris completed the picture of a truly catastrophic event sufficient to cause a massive die-off of species already evident in the fossil record. As Alvarez puts it, "Chicxulub marked a watershed. With the KT crater found at last, the kind of hard-core uniformitarianism which automatically rejects all inferences of catastrophic events was dead. Though no serious scientist doubts that most Earth change is gradual, geologists are now free to explore the occasional catastrophic events which have punctuated Earth history" (1997, 129).

II Earth Sorts Things Out

Alvarez takes up his big history story in the next eight chapters, summarized in the sequence now basic to the big history

Fig. 6. Impact spherules from the Chicxulub impact have been found worldwide, with considerable concentration around the Gulf of Mexico (A), the Brazos River Valley of Texas, and multiple locations in northeast Mexico (B) where widespread evidence of a 50 to 150 meter (165 to 480 foot) tsunami has been located.

narrative: Cosmos, Earth, Life, and Humanity. Since he is a geologist, it is not surprising to find that half of these (Chapters 3 to 6) are devoted to Earth narratives. Here he begins exploration of one of his most important ideas: Earth concentrates resources, thus laying the foundation for both the rise of Life and Humanity's innovations. When the Solar System began to form 4.6 billion years ago, earlier supernovas and kilonovas had scattered the full array of the ninety-two elements through space, including the dust cloud from which the Sun and planets were formed. These unsorted materials were 99% hydrogen and helium, with all heavier elements confined to less than one percent. The formation of the planets around the giant gaseous ball of the Sun began a sorting process: light gases were blown to the far reaches of orbiting debris by solar wind, leaving behind concentrations of heavy elements in the inner Solar System. This sorting resulted in the distant gas giants—Jupiter, Saturn, Uranus, and Neptune—and the inner rocky planets—Mercury, Venus, Earth, and Mars. The resulting Earth contained the full array of heavier elements which now make up living things—carbon, oxygen, nitrogen, calcium, and a few others—and the much heavier elements we call metals and minerals: silicon, iron, nickel, copper, aluminum, tin, platinum, and gold.

This planetary sorting was the beginning of a process Alvarez wants to highlight: the continuing work of sorting and concentrating materials in the Earth itself. Chapter 3, "Gifts from the Earth," provides a wealth of examples. During its early molten years heavier elements sink, forming Earth's iron core beneath lighter mantel materials on which buoyant surface materials of continental plates float and migrate. Within this generalized structure, additional processes are at work. The most common changes occur at the earth's surface as mountains are created, either by volcanic eruption or collision of tectonic plates. During the cooling of lava, a further sorting occurs: dense materials solidify first and sink; lighter silicon materials such as quartz (SO^2) rise to the top, resulting in a greater concentration of silicon near the Earth's surface. This has served humans from the time they first fashioned stone tools out of silicon-rich chert until today when silicon is a major component of tools of all kinds, including computer chips, aptly symbolized in the region now casually called Silicon Valley.

No matter how permanent mountains may seem, they are eventually eroded away. The Appalachians are eroded vestiges of much higher mountains from a very early tectonic collision; the Canadian Shield is the foundation remnants of some of the earliest mountains

on Earth. Meanwhile the jagged mountains of the Alps, and Himalayas or in the process of formation from tectonic collision. But as long as any elevation remains, erosion continues its work of breaking down every kind of rock into granules of various sizes and weights. Quartz may be dissolved and precipitated from silt to form concentrated layers easily accessed. Sea creatures protect themselves with shells formed from calcite ($CaCO^3$) separated from seawater. Fine-grained clay washes out from quartz crystals to form separate layers of clay, later slate, while quartz crystals wash up to form the world's beaches, the source of sand, from which humans have been making glass for the past 4,000 years.

Alvarez recognizes the risk of oversimplification; brevity of description glosses over many intermediate steps. But his contribution is clear in detailing how Earth processes gradually concentrate elements in ways essential to the development of life, tool making, glass making, and advanced technology. Examples could be multiplied; as he notes, "Almost every chemical element gets enriched by Earth in one or more ways" (2017, 59). As illustration, Olga García-Moreno, with Alvarez *et al* (2017) have published an interesting corollary on Earth's concentration of gold, a geological process that affected modern history, especially the wealth accumulation of the Iberian Peninsula. The "gifts from the Earth" chapter thus adds an important dimension to the big history story; indeed it could qualify as a new chapter added to a seminal work published forty years ago by Erich Jantsch, also relevant for big history: *The Self-Organizing Universe* (1980).

III Earth Shapes Human History

From a different perspective, the continents and oceans have been shapers of life and human history. The supercontinent Pangea provided the developmental stage for many amphibians and reptiles, including dinosaurs that wandered across the entire landmass before Pangea broke apart. Much

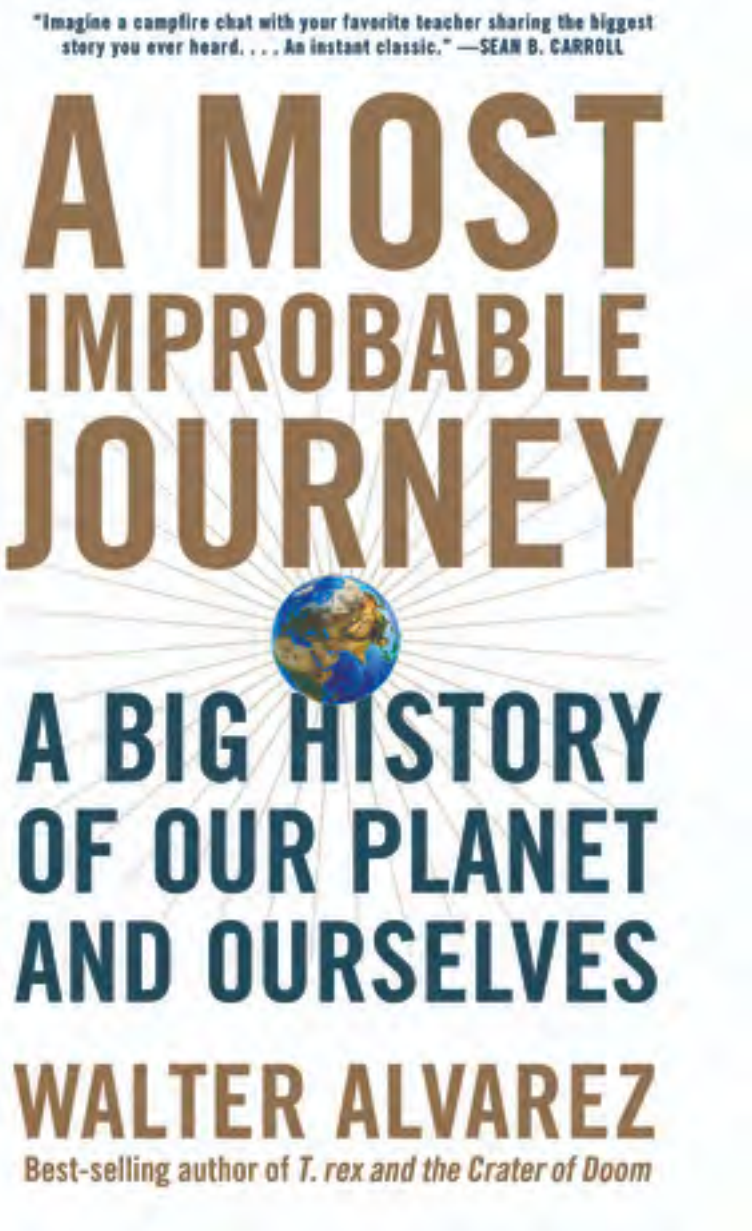

Fig. 7. Within the now well-established framework of big history, Alvarez organizes his version around a four-part narrative: Cosmos, Earth, Life, and Humanity. With the effects of the cataclysmic asteroid strike 65 million years ago as a starting point, the author opens up the theme of contingency, exploring the human situation within the improbability of human life ever evolving on Earth.

later, the discovery of similar megafauna fossils on widely-separated continents tipped off Alfred Wegener to the idea that the continents were once joined. With this insight, he developed the first comprehensive theory of continental drift in *The Origin of Continents and Oceans* (1912). Continental drift theory was later folded into the theory of plate tectonics which became a kind of Copernican Revolution in geology. Alvarez remembers "an almost unbearable intellectual excitement" (2017, 69) in the geological community when plate tectonics emerged as the master theory of geological change.

Once the continents had drifted out of sight of each other, regional life forms developed, resulting in the great variety of birds and mammals and the quite different marsupial species confined to Australia. Much more recently, geology has ontinued to influence human history. Africa, the place where humans originated, is barely attached to the Eurasian landmass. Even then, the dominant out-of-Africa model of human migration now favors a water crossing at Bab el-Mandab (the Gate of Grief) to the southern coast of Arabia—the so-called Southern Route—as the first step in the peopling of the Earth. Had Eurasia been situated farther across water and out of sight, the departure from Africa would have occurred differently, much later, with a delay in cognitive enhancements sometimes attributed to environmental challenges as humans moved from tropical Africa to insular, montane, temperate, and Arctic conditions. Such geological connections between continents have shaped human history and migration in multiple ways: the relatively brief existence of Beringia and geologically recent joining of North and South America at Panama made possible a journey that took *Homo sapiens* on their greatest journey, from South Africa to Pantagonia.

More recently, mountain ranges have shaped human history. Of the Alps, Alvarez remarks, "they have influence or controlled great movements in history, separating language groups and religions"—a compressed history of two millennia with various effects. The Alps confined the Italic languages—Latin and its descendants: Italian, French, Romanian, Spanish, and Portuguese—to southern Europe; this confinement included the Roman Church which adopted Latin as its sacred language. To the north of the Alps, a quite different cluster of languages emerged—German, Danish, Norwegian, Swedish, and eventually English. Never quite in tune with the paternalist religion of the Roman Church, northern Europeans were the first to break away; Martin Luther rebelled, broke with the Catholic south, and Protestantism spread, initially gaining a solid foothold through regions north of the Alps. Equally influential have been the vast east-west range of the Himalayas. To the north, The Altaic and Sino-Tibetan languages dominated through China, Japan, and Korea, along with the religions of Confucianism, Shinto, and Taoism while the Dravidian language and a migrant branch of Indo-European dominated South Asia where the radically different religions of Hinduism and Buddhism emerged. In more recent history, Alvarez explores the way a channel at the Straits of Dover prevented a Spanish land invasion of England and a fortuitous wind scattering the Spanish Armada gave victory to England along with command of the high seas and the settlement of North America. From such seemingly inconsequential events, results of great consequence can follow.

The narrative center of *A Most Improbable Journey* develops around a train trip across America from New York to San Francisco. The journey structure reminds us of the earlier boating-and-trekking expedition to Oregon (1804-1806) commissioned by President Jefferson summarized in *The Journals of the Lewis and Clark Expedition* (1814) and *The Oregon Trail* (1847) by Francis Parkman describing his summer tour of the Great Plains segment—Colorado, Kansas, Nebraska and Wyoming—both rich with encounters with Native Americans. But Alvarez's east-to-west journey is perhaps most comparable to geologist John McPhee's in his four-volume, *Annals of the Former World* (1998), though with a presentation difference. The Alvarez narrative is strictly linear, unified by a

four-day train trip from coast to coast; McPhee's was composed from numerous geological explorations over more than a dozen years (1978-1992), so that, as he puts it, "The structure is not linear—not a straightforward trip from New York to San Francisco on the interstate. It jumps about the country" (1998, 6). The contrast explains why so very many books of detailed analysis are desirable reads for big historians and highly relevant to big history without *being* big history: the final test is whether or not the book captures the big history narrative or some significant segment of the narrative.

The train route runs north up the Hudson Valley, west along the Erie Canal, and eventually the route of Interstate 80 from Chicago to the west coast. His observations are based on geological discoveries that abound across the continent. The 400-foot-high Palisades along the Hudson River tell a story of an igneous sill formed by ancient magma (2017, 98-99); the elongate drumlins and north-south Finger Lakes of the State of New York are tracks left behind by glaciers that spread as far south as the Ohio and Missouri Rivers; the deep fertile plains of the Midwest are erosional material from once-towering mountains over the Canadian Shield; the salt flats across Utah are the remnants of prehistoric Lake Bonneville in northwest Utah. The most fascinating discovery is of datable zircons among the quartz crystals of Colorado Plateau sandstone originating to the east in the northern Appalachians, evidence that during the Jurassic (150 to 200 million years ago), long before today's north-south drainage of the Mississippi watershed was established, an ancient east-to-west river flowed along an indeterminate route, following a westward slope across the Midwest that no longer exists.

Thus, virtually indestructible zircons from the Adirondack Mountains were carried more than 1,600 miles west to the Colorado Plateau, a geological province that straddles Four Corners. Alongside the seemingly permanent geological structure on his route west, Alvarez touches briefly on the not-so-permanent and highly vulnerable geology of the west coast under the hand of humans. Tragic environmental destruction was caused by rapacious gold mining during the 1848-1849 gold rush along the foothills of the Sierras. There, "debris washed down by hydraulic mining overwhelmed the Sacramento River and the Central Valley" eventually "choking" parts of San Francisco Bay, leading to a ban on hydraulic mining (2017, 112-113).

Fig. 8. Zircons are useful for dating the oldest rocks, in some cases all the way back to the Hadean Era 4+ billion years ago. Virtually indestructible, they survive intense erosion and weathering, with chemical signatures that allow geologists to trace tectonic movement or riverine transport from points of origin to locations hundreds or thousands of miles away. Source: www.gemrockauctions.com

In his treatment of the Life segment of big history, Alvarez unpacks the intersection of geology and biology with his discussion of the origin of life at hydrothermal vent locations along the same mid-ocean ridges that are forcing apart the Earth's tectonic plates. Life in this scenario dates to the late Hadean or Early Archean eras around four billion years ago.

The subsequent a long incubation of single celled Archaea and Eubacteria was followed by the emergence of invertebrate colonies of cells, and eventually the vertebrate ancestors of modern humans. Finally, after seven-eighths of Life's history on Earth

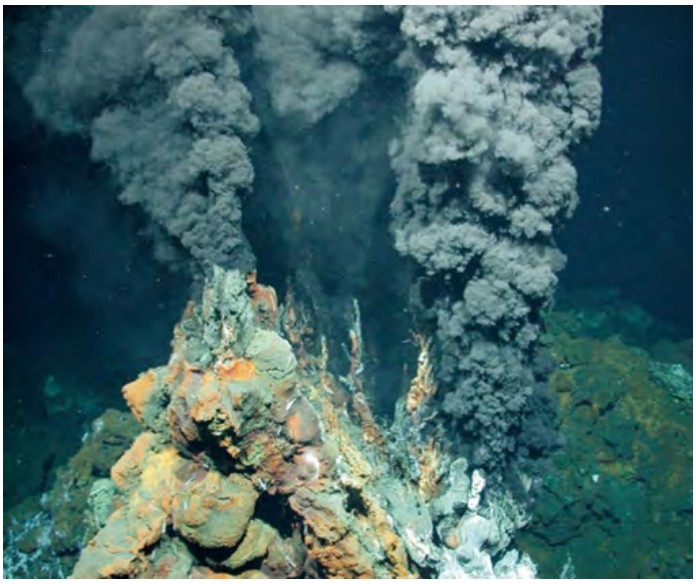

Fig. 9. Deep-sea hydrothermal vents, otherwise known as Black Smokers, are now considered likely locations for the origin of life, replacing the long-standing theory of the "warm little pond" made popular from the final paragraphs of Charles Darwin's *Origin of Species* (1859).

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had passed, the recognizable structures, organs, and processes of vertebrates took shape. This rapid summary recounts the movement of life from sea to land, then to the end of the saurian age 65 million years ago that set the stage for mammalian and primate rise to prominence. His treatment of Humanity is equally rapid, summarizing the rise of modern humans, their acquisition of skills related to geology—the use fire, the mining of copper and tin, and tool making—while skirting developmental stages well covered in big history books by David Christian (2004), Cynthia Stokes Brown (2007), and more recently, Wendy Curtis (2013).

However, the Alvarez presentation differs from the versions by Christian, Eric Chaisson (2007), and Tyler Volk (2017). Chaisson organizes his "epic of evolution" as "seven ages of the cosmos"; Christian's "maps of time" progresses through eight "thresholds"; each of Volk's transition to a higher complexity is termed a "cosmogenesis." These paradigms suit the Cosmos and Life phases of big history, but Alvarez sees the Earth story as a journey through time that can be discovered in continents, mountains, and oceans—above all in rocks. The present is the key to the past. Against the slow unfolding of this journey, the Chicxulub asteroid shows that regularity may be punctuated by dramatic, contingent events.

IV Inescapable Contingency

The emphasis through this journey is continuity: the continuous creation of seafloor at midterm ridges, the steady movement of continents, the rising of mountains an inch at a time, erosion wearing them down over millions of years. But continuity is also evident in the evolution of life and in the generations of humanity. Every human alive today is the product of parents, grandparents, and their forebears who survived to reproduce. Each human's personal existence is continuous with and depends on ancestors stretching back millions of years to earlier hominid species and eventually to our primate forebears; if any one of them had failed to reproduce, we would not exist. The conclusion makes clear Alvarez's primary theme of his "most improbable journey": "Human history is riddled with contingency, and this is part of what makes it impossible to find laws controlling history." Sometimes the minor stream of contingencies may be intensified by a dramatic, contingent event. Attempting to define a contingent event, Alvarez ventures that it "needs to be (1) rare, (2) unpredictable, and (3) significant" (2017, 181). The Chicxulub asteroid answers to all three.

The construction of the big history narrative leads us to look for regularity and pattern. Thus, we observe fine-grained temperature differences in the Cosmic Background Radiation (CBR) signifying minute density differences; then we observe that the subsequent galaxy clusters and vast empty spaces correspond to these differences in the CBR. Out of such patterns, we construct a history. But the fact is that the formation of our Sun and planets—and of every star-and-planetary system—is more far complex

than identifying prior regions of greater density. The Sun and Earth are products of rare, unpredictable, but significant supernovas and even more rare, unpredictable, but significant kilonovas (Wood 2018), and the resulting dust clouds within which new star systems emerge. The more we examine the past, the Hadean impacts, colliding and subducting plates, volcanic eruptions, earthquakes, and random asteroid impacts, the more we realize how the present is a complex result of multiple contingent events which foreground the larger continuities.

This interaction of continuity and contingency forms the theme of *A Most Improbable Journey.* The book ends with a chapter called "What was the Chance of All This Happening?"—a philosophical excursion triggered by contemplating our own existence. Just what does life mean on a tilted planet swinging round a star? The number of species that have existed on Earth adds up to hundreds of millions, but not one apart from *Homo sapiens* reveals the potential for the higher intelligence we have achieved. If modern humans went extinct, would intelligent beings emerge again? In one of the most penetrating discussions of extinction, Jonathan Schell (1982, 114) remarked that it is "impossible to know what course evolution would take after human extinction, but the past record strongly suggests that the reappearance of man is not one of the possibilities. Evolution has brought forth an amazing variety of creatures, but there is no evidence that any species, once extinguished, has ever evolved again." Since Schell penned this, it has become clear that the contingencies of time, place, environment, and unpredictable events forestall evolutionary repetition.

Alvarez notes that contingencies are so numerous, particularly in the realms of Life and Humanity, that we bypass contemplating them; however "what we learn by estimating our improbability may give us insights into some of the deepest questions we can ask. This is a part of the human situation that I have never seen discussed" (2017, 193). But Alvarez chooses to discuss it by presenting it in the context of his primary discovery: "We humans exist only because of the extinction of the dinosaurs" (2017, 184). Our ancestors thus include primitive squirrel-or-cat-sized mammals which, in their own puzzled and confused vision, witnessed the demise of the dinosaurs and somehow avoided their fate. Once that inescapable conclusion takes root, we can see that our much earlier ancestors escaped four earlier mass extinctions 444, 375, 250, and 200 million years ago.

However, we are not simply descendants of survivors at these five critical times in the history of life; we are descendants of an unbroken lineage extending to the dawn of life itself; every one of some 35 trillion cells in our bodies has descended from an unbroken genealogy of cells through billions of creatures to the earliest chemical cluster that edged away from a black smoker. And every cell division and every mating in that long genealogy is the result of events dependent on a complex web of contingencies. We are here because every ancestor survived birth, youth, sickness, and accidental death to reach reproductive age. Finally, each mating was a union of one of many ova with one of millions of swimming sperm. Had a different sperm reached the destination in any one of millions of matings, a different genetic configuration would have resulted—a small change that would have echoed through every later generation. Again, the precise persons we are would never have come into existence.

Alvarez ends *A Most Improbable Journey* with a striking analogy. Counting up all the ova and sperms that enter the reproductive lottery, we see that the humans born in a single generation—around a billion (10^9) today—represent a miniscule number compared to the total permutations and combinations (10^{25}) that could have been born. To paraphrase the Alvarez analogy, fill a glass full of sand from the beach: if this represents humans actually born, all the sand on all the beaches of the world represents the astronomical number that could have been born. What is true of this generation is true of every earlier generation, each of which was the result of an almost infinite number of contingent events—metaphorically, where each

grain of sand was on the beach when the sand was gathered. "We live our lives immersed in an ocean of contingencies . . . we can see it in the chance contingencies in each of our genealogies. Going back even one or two generations, the probability of any one of us ever being born would have been vanishingly small" (2017, 192-193).

The contingent event of the Chicxulub crater and the catastrophic extinction it brought on thus points to contingency in the broadest sense: the astronomical number of contingencies that make up life on Earth. By bracketing his big history narrative between the search for the effects of Chicxulub and the mathematics of genealogical contingencies, Alvarez opens up a new theme in the big history story, leading us to still larger questions, the deepest questions we can ask. The deepest contingency question we can ask may well be about life in the Universe because it addresses our significance or insignificance.

For half a century, the famous equation with eight plug-in variables developed by Frank Drake has led people to imagine civilizations spread across the galaxy, and by extension the Universe. With hundreds of billions of galaxies, each with hundreds of billions of stars and planets, we have tended to feel that intelligent life may be common, a virtually assured phenomenon based on statistics alone. An optimistic public has embraced this conclusion: Isaac Asimov's *Foundation Trilogy* (1951-1953) and the never-ending *Star Trek* series have nurtured it for decades. Carl Sagan's exhilaration over the idea of extraterrestrial life that permeates his *Cosmos* series (1980) and helped to launch the Search for Extra Terrestrial life (SETI) and the Voyager space crafts has kept the idea simmering and kept funding flowing for space probes and more powerful telescopes. But SETI has so far turned up nothing, bringing us to the question posed by Enrico Fermi, now known as the Fermi Paradox: If vast numbers of worlds harboring extraterrestrial life exist, where are they?

The Alvarez discussion of contingencies points to ultimate philosophical questions about the human situation, and perhaps the meaning of our existence. Thus, it is worth considering various conclusions about extra-terrestrial life. On the one hand, Drake himself has suggested that the numbers he and others assumed for each of the eight Drake variables are problematic because they are based on assumptions subject to preconceptions. He now considers that these assumptions were perhaps too cautionary and conservative, leading to estimates for extraterrestrial life that may have been too low. Intelligent life in the universe, he thinks, may be far more common than we have believed. Notably, however, Drake's view does not attempt to address the Fermi Paradox.

On the other hand, a recent study by Ander Sandberg *et al* (2018) reexamines the Drake Equation, revealing possible flaws in the paradox which arise from an extremely confident assumption of intelligent life elsewhere in the Milky Way and the Universe. In attempting to incorporate more "realistic distributions of uncertainty," they suggest "a substantial *ex ante* probability of there being no other intelligent life in our observable universe." Our earlier mistake may have been assuming a "high and extremely confident prior for the number of civilizations in our galaxy." This view has undoubtedly been influenced by the search for exoplanets during the last quarter century; planetary environments that might possibly harbor extremophiles could be among the thousands located, but no obvious, certain, perfect candidates for intelligent life are evident. As Frank and Sullivan (2016) write, "Recent advances in exoplanet studies provide strong constraints on all astrophysical terms in the Drake equation." Thus, Sandberg *et al* suggest that our "extremely confident prior" is highly tenuous against the "absence of evidence" and "current state of scientific knowledge." We have, they argue, "no reason to be highly confident that our galaxy (or observable universe) contains other civilizations." In this light, the Fermi paradox might not be a paradox at all but simply observations of an uninhabited Universe beyond our own planet.

This is not a denial of extraterrestrial life; it is

rather a recognition of a possibility that Earth is the only place where intelligent life has appeared. Even though this is only a possibility, it is nevertheless a startling suggestion. That Earth could possibly be the only location harboring intelligent life and civilization among 350 billion galaxies, each containing as many as 100 billion planetary systems is astonishing, almost beyond comprehension. But the lesson of contingencies on Earth alerts us to the fact that contingencies must apply everywhere, and where life squeezed through multiple bottlenecks here, it would take only one impassible bottleneck on a distant world to eliminate all possibilities of intelligent life there.

Clearly this matter is unresolved and may remain so for a very long time. As long as there are solar systems left to survey—a situation that will necessarily exist until the Sun dies—an absence of evidence will prove nothing. If we do locate even a single example of intelligent life beyond Earth, the matter will be settled. Realistically, we may never be able to find it, though the more planets we discover with no demonstrable sign of intelligent life, the more the astonishing fact of our own existence will grow, and from that the significance of our own existence will also grow. If we turn out to be a common flowering everywhere, as common as space debris, we have little claim to uniqueness, but if we are without companions anywhere in the Cosmos, our significance is beyond words, understanding, and imagination, and how we got here is truly a most improbable journey.

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Review of
From Big Bang to Galactic Civilizations: A Big History Anthology

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Introduction

Big History is increasingly important in many ways in our world today. In light of this growth, it is both timely and helpful that Primus has published *From Big Bang to Galactic Civilizations: A Big History Anthology*. This three volume compendium of essays offers a wide-ranging and highly varied window into this exciting field.

Many of these essays tap into the wonder and grandeur of Big History. The wonder and granduer that I felt from the field of Big History before this field also shared that name. My first glimpse into this wonder came very early. As a child, my siblings and I were encouraged to investigate the world around us, including the woods near our house that were abundant in discoveries waiting to be found. There, hills became ancient mountain forts, moss covered logs became huge beasts, and simple depressions in the ground became dinosaur footprints. These marvels brought the woods to life, each in its own way. Then, in 1980, my dad introduced me to Carl Sagan's Cosmos series. This opened my eyes to our Universe – showing both marvels far beyond the neighboring woods, and also showing how much more marvelous (in both deep time and in microscopic form) all of the things in the woods actually were. Most importantly, by showing the deep time history of our Universe – what we now know as "Big History"– all of these little miracles now formed a seamless whole, connected to each other through time and history to become the awesome Universe, which also includes me! As Big History brings our formerly separate academic fields together in a unified whole, I'm thrilled to see it spreading and bringing deeper understanding to students, to teachers, and to others worldwide today.

Like the many disciplines Big History unifies, this set of essays has a lot of variety. This variety spans many different areas: some essays are concerned with the whole sweep of history while others are focused on comparatively tiny regions, there are essays by authors with diverse cultural backgrounds, essays based strictly on current evidence as well as more speculative essays about the past, present, and the future. This variety not only grows from the different topics of these essays, but also from the many different academic disciplines they hail from. Though all of these three volumes are about the overall topic of Big History, they have very different flavors and areas of emphasis.

Volume 1:

The First Volume is titled "Our Place in the Universe: An Introduction to Big History". True to its name, the anthology leads with essays From Roberta Bondar, Siegfried Kutter, Walter Alvarez, and David Christian which give a clear and engaging overall view of Big History.

Roberta Bondar (space traveler, scientist, and education champion) opens the anthology with one of the most important points of Big History – that

Big History helps show that the boundaries between disciplines are human constructions and that our body of knowledge is one body of knowledge. She does this by making the powerful and insightful analogy to the view of Earth from space, where similar human-made national boundaries cannot be seen. This realization, that all of the areas of knowledge can form a unified whole, just as our world does around us, is one of the most important realizations of Big History, one that has been important in my life and especially in sharing the joy and excitement of our Universe with both my children and my students. Approaching all academic disciplines as simply additional facets of the same incredible body of knowledge was something that I learned (perhaps unintentionally) from my dad, as he showed us the discoveries of space without regard to keeping the disciplines separated. From there, it followed naturally for me to include new knowledge into this growing body of knowledge, organized by stories and connections rather than walls and barriers. From there, the same approach then comes out in my teaching not only in the classroom but also to my own children. This makes both lifelong learning and teaching so much easier as well as more fun! Few things in life can compare to seeing the thrill of discovery spread across the face of the learner (of any age), and knowing that thrill myself.

The following essay by Siegfried Kutter gives information essential to understanding how we got here, and why understanding Big History is a requirement for anyone to be able to make good decisions for our future world. After this, Walter Alvarez gives a glimpse (and even this is just the tip of the iceberg) of the literal mountains of knowledge upon which Big History is built upon.

Deeply personal stories can be found in the middle of Volume 1, including the touching story of Antonio Velez and Barry Rodrigue's reminder of what Robby the Robot teaches us. Robby's lesson that technology alone (without a lot of human effort) can't save us, is an important complement to the many technologically future focused essays, found especially in Volume 3.

One of the most important points from Volume 1 can be found in two excellent essays by Alexander Mirovic and Nigel Hughes. Both essays help us see that all ideas are not equally true, some are well supported by evidence and some are not. While this is obvious to many of us, there are places where relativism is so strong that the very idea of one using evidence to decide between ideas is questioned. This is especially relevant to Big History because the very same mountains of knowledge referenced above— upon which Big History and indeed, humanity's discoveries over the past dozens of thousands of years— rest on foundations of evidence. Without a reliance on evidence, ideas become untestable, and one realizes that then none can be reasonably believed. Thus, drifting away from a reliance on evidence can rob one of all wonders that do exist and leave one searching for more unsupported ideas as a counter productive means to bring awe back into one's life.

This same reliance on evidence is again made clear in the intriguing windows into the deep roots of Tiananmen and Jericho opened by the little big histories of these places by Craig Benjamin and Esther Quaedackers.

The importance of seeing our world as a whole, of inclusion in the decision making process (the polity), of using evidence, and of working for a better world is shown in the essay by Lowell Gustafson, which helps draw together many of the threads weaving through this first volume. These essays come together in Volume 1 to give the reader both a clear view of the facts and approaches of Big History, as well as their importance today.

Volume 2

With a title of "Education and Understanding" Big

History Around the World", the second volume of this anthology clearly marks the global scope and impact of Big History.

To begin, the worldwide success of Big History is examined through examples from around the world in the first seven essays (Eric Chaisson, Seohyung Kim, Mojgan Behmand, Barry Rodrigue, Jos Werkhoven, Douglas Northrup, Cameron Gibelyou, and Barry Wood). Each essay is a poignant story centered around growth and experience in teaching this emotionally moving subject (often for decades) and seeing the minds of many students exceeding their expectations. In addition, the essay by Barry Rodrigue points out the important realization that the very structure of the old way of teaching history (including "Western Civilization") was both ethnocentric and exclusionary.

Like volume 1, volume 2 also contains many touching personal stories. These stories reflect the human face within the rise and advancement of Big History. In addition to the many personal aspects of the essays mentioned above, the contributions from Lucy Hawking, Roland Saekow, Rana Singh, Lana Ravandi-Fadai/Kevin McNeer and many others make reading volume 2 a lot like a casual conversation with an old friend. Indeed, the essay by Brian Swimme captures the need for stories themselves For as long as we have been human, our Ancestors have been telling stories. It is stories which give us our roots, which give us a reason to exist, which connect us with those other people we consider to be "like us", and which empower us to work for the future. People remember stories, learn by stories, live by stories, and hope by stories. Brian Swimme reveals the critical importance of our cosmic story, for all of humanity, in serving all of those roles. Not least of those roles is the identification of who is another person to care about. Narrow, nationalistic stories have long closed people off to other humans, stoking hatred and violence. Our cosmic story has begun to reverse this, drawing in all humans, and indeed all life, into our story – fostering inclusion and caring for all. It does so by showing that we are all members of the same family tree; we literally and truly are all realted. Anyone we meet, no matter who they are or what they look like, has parents. Stepping back through those parents to their parents, ever further until we come to an Ancestor who is also one of our Ancestors, creating a direct line of parents and children that leads to us. This realization can mean, if one chooses so, that everyone we meet – and those we don't meet- is a person to care about, a person "like us". Indeed, the same process also links us to everything alive on Earth and only means that we need to go back through a larger number of parents to do so. How can anyone foster racist, nationalistic, or life destroying views after seeing that we are literally all one family? I know I cannot and would not want to. At a time when racism and nationalism are reappearing on our societal landscape (of course they were never gone), these realizations are very relevant today, especially for those of the next generation who have a major role in crafting the world of tomorrow.

It is a clear fact that this connection to all life is essential for our future. This realization is also made clear in William Grassie's essay, which shows that this globally inclusive story could not only reverse the harmful path we are now on, but should we fail to build a just, healthy, and sustainable world, this story is a necessary for civilization's recovery.

Volume 2 comes to a close with an enormous range of voices from many different regions and nations, including China, Somalia, Japan, North Africa, the Caucasus, Iran, and the Middle East. These essays include regional art, the impact and ongoing growth of Big History in these areas, musings on life on other planets and our future, deep local history, ecology, and more. Volume 2 leaves the reader both connected to our global family overall and more aware of the many wonderful stories to be found in specific regions around the world.

Volume 3

The previous two volumes of this anthology have given us a solid overview of Big History as well as a global view. The third volume, "The Ways that Big History Works: Cosmos, Life, Society and our Future", extends our gaze far into the future, drawing on what we know about our past ~14 billion years to try to estimate even the next few centuries on our tiny Earth.

Appropriately, the first essay in this volume (by Kathy Shick & Nicholas Toth) connects much of the future speculation which follows with our deep time past using our human evolution as a bridge between them. This review is very timely and helpful, especially because so much has been discovered in just the past few decades about our evolution from earlier primates. Compared to the small amount of information known on human evolution just a few decades ago -- the wealth of transitional fossils and DNA evidence-- the data we have today is yet to be understood and well worth analyzing. This review of our primate Ancestors was especially important to me in light of our family connections described earlier. In fact, the ability of so many people to get their direct DNA analyzed today makes DNA evidence more understandable and much closer to home. I've been excited to find the discoveries both in myself and my extended family which personalized DNA testing has uncovered. Suddenly I've been able to find direct links to people around the world, of many different races, while also finding which segments of my own DNA randomly made it to my kids and which did not.

The background, as well as the extensive Big History information from the first two volumes, prepares the reader for the consideration of several proposed frameworks for approaching Big History. These frameworks comprise about half of volume 3. Our human brains are incredibly versatile, and are often able to draw parallels from disparate sets of data – parallels which sometimes are due to the same physical process going on in two areas, as well as parallels which are simply mental ways to categorize similar overall phenomena (while some parallels fall somewhere in between). By noticing these parallels, new terms and new overall descriptions of common features can be used to build overall theoretical explanatory frameworks. Some of the many frameworks described in volume 3 are compatible with each other, and even work well together, while others are separate ways to approach Big History as a whole. To me, these many frameworks show that frameworks themselves may fall under a "Goldilocks rule", as does much of Big History. Detailed frameworks, by adding more to study, are less valuable because they decrease simplification in the different areas to which they are applied. At the other extreme, very simple frameworks can explain basic commonalities while missing much of the detail in the various areas of study. Between these two is perhaps a Goldilocks zone: explanatory frameworks which are complex enough to capture important details, while being simple enough to still have explanatory power.

Futuristic speculation makes up the last main section of volume 3. Envisioning the future with any accuracy is very difficult. Yet, after examining the past 14 billion years of history, it's very tempting to at least think about the next few centuries. After all, even the next whole millennium of 1,000 years is only 0.000007% of our 14 billion year history! Speculation about the future is, of course, speculation, so little beyond the most trivial predictions can be said with certainty. At the same time, so much of our world today would be utterly amazing to our Ancestors from even a few centuries ago, so who knows? While the futures described in this section are often optimistic, they are balanced to some extent by the possibility of a collapse of civilization as described by William Grassie in volume 2. Such as with the various frameworks described above, some of these essays.

In addition to these main areas, volume 3 contains an important idea which can be missed in our society. An essay by Lawless lays out this idea as the importance

of the bio-region in our understanding of any place or history. Today, one of the many problems that people in industrialized countries face is a sense of alienation. Alienation in that people are separate from the land around them, that they are not really "home." Little big histories help us see the essence of the place we are in – the deep time story that led to everything we see. It makes each location come alive, making our home unique, glorious, and special instead of just a patch of ground. It also fosters appreciation for every location on Earth, by showing that all of them have their own stories that make them what they are today. Not only is this another much-needed realization brought by Big History, it is also simply true. This idea has been hinted at in essays throughout these three volumes, especially in volume 2, where region after region was highlighted. This recognition of the importance and history of a location is one of the important concepts of Big History, and indeed of human existence. Unlike many concepts, there is not a goldilocks zone here. Local understanding has shaped many of us. This can be recognized in parallel to the also essential recognition of larger areas like the Earth or Milky Way as well as smaller areas like the cell and atom. The ability to see across orders of magnitude, both in space and time, is perhaps the most wonderful aspect of learning Big History, and this compendium of essays shows both the wide range and personal touch of Big History.

Conclusion

The essays in this three volume set give a wide view of Big History, giving both an understanding of Big History itself as well as a demonstration of the wide diversity of views within this growing and important field. For me, so many of these essays spoke to me personally and deeply, recalling my own meaning and purpose. Of course, each of us can find meaning and purpose in different ways and using different metaphors, but for me, the simple facts of our world are in no way "dry facts", but fantastic building blocks of a reality which gives both meaning and purpose.

Big History ties together these facts, which show that we are made of atoms forged in the awesome furnaces of ancient stars, and that we've evolved from simple molecules to cells to tiny cell colonies to aquatic worms to eels to fish clambering onto land, and so on to us. Big History, and the understanding of our history, transformed my world from a pointless, bewildering struggle into an invigorating challenge. The evidence gives my life incredible meaning and purpose. I marvel at my family tree, which goes back though innumerable life forms, through amazing stories of survival, hope, courage, and parental love. It includes the tiny mammal, surviving through the freezing, yearlong darkness after the asteroid impact by eating, and likely hiding in, a frozen dinosaur carcass, it includes the first mother to produce milk, and the first blurry view through a newly evolved eye. Our actual history has shown me that all life on earth is my family, bonded to me through billions of parental links of love. Realizing this gives the deep forest the same warmth and comfort as the family reunion which it is.

Feeling the gratitude toward countless Ancestors for my own existence, I feel the need to "pay it back" – but of course I can't, because those Ancestors are no longer alive. Instead we can all "pay it forward" by working to build a just and sustainable world. It could happen after centuries of environmental disasters, bloody wars, and untold suffering, or it could happen sooner, through our efforts to build a loving, rational culture focused on this world. It's up to us to choose when we'll get there. My family, your family, and indeed our family - including all life on earth - will live with the consequences tomorrow of the decisions we make today. Many of these essays, and the wider field of Big History, help me see that. May they do so for you as well.

The Origins of the Ptolemaic Tradition and its Adoption and Replacement in Colonial America

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Abstract
This monograph addresses the vital impact of ancient Greek thought on Colonial American cosmography, through an analysis of the ways Colonial Americans interpreted and applied Greek ideas. The conflict between the Ptolemaic tradition and the heliocentric model of Copernicus provides a focal point for this study. To highlight this cosmographic reformation, I examine the influence of Greek democratic culture, in particular the tolerance of open discussion, as well as attitudes of scientific objectivity, mathematical reasoning and religious openness. In turn, this cultural inheritance inspired and enabled leading Colonial American cosmographers associated with Harvard and Puritanism to view scientific truth as God's truth. Thus, religiosity and the understanding of God's created universe in Colonial America embraced an ongoing journey of discovery shaped by scientific inquiry and an openness to changing received wisdom concerning the cosmos.

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I: Introduction

The mapping of the universe and the attempt to understand the cosmos and one's place within it has been a constant intellectual quest of the human race since ancient times. This systematic scholarly investigation is known as cosmography. In this Big History monograph, I analyze how early Colonial American scholars made sense of ancient Greek understandings of cosmography. In particular, I will focus on the way these Greek ideas shaped American thinking not only about the cosmos itself, but also about the way cosmographic understanding became intertwined with views about God and theology.

When they first arrived in North America, Colonial Americans generally subscribed to a cosmography that was based on the Ptolemaic tradition. But, once they became established in the new world, and especially after the founding of Harvard University, a cosmographic revolution taking place in Europe began to resonate in the so-called New World. Some Colonial American scholars willingly engaged in contemplation of the new outlook and proved receptive to the heliocentric theory of Nicolas Copernicus. Not surprisingly, in a land where scientific and religious thought overlapped so extensively, heated scholarly debate ensued over the topic and even resulted in student protests at Harvard University. The record of these debates can be traced back to the 17th-century writings of Colonial America, as illustrated by several astronomical almanacs that since have been preserved as vitally significant artifacts of intellectual life in the colonies. These almanacs were at the heart of published debate between the Ptolemaic tradition and the ideas of Copernicus.

In order to organize this topic most effectively, I use Big History methodology, to break up my analysis into distinctive phases to draw connections, bridging the period between the Colonial Americans and the ancient Greeks. These phases, each centered on three distinct threads of intellectual development, illuminate the reception of ancient Greek astronomical knowledge and reasoning by the Colonial Americans. The first phase, represented in chapter II, titled "Origins of

the Ptolemaic Tradition," examines the origins of Alexandrian scientific and philosophical tradition and attempts to reconstruct its development. This analysis will be driven by three major points, which I have identified to be crucial to the evolution of the Ptolemaic tradition. 1. The Greek tradition of freedom of thought, stemming from Athenian democracy. 2. The objective, empirical approach of Claudius Ptolemy when conducting his research. 3. The mathematics of Ptolemy on which his theory rests. To avoid any confusion, discussion of the mathematics concerns the theoretical implications of his quantitative study, rather than the specific mathematical calculations themselves.

In the next phase in chapter III, called "Reception of the Ptolemaic Tradition in Colonial America," addresses how Colonial Americans received the Ptolemaic tradition. Here it is important to identify the way the Ptolemaic understanding became established in America and the evidence of its influence on Colonial American cosmography. Taking into account important primary and secondary sources, discussion revolves around three points: 1. The Ptolemaic tradition in Europe prior to the founding of Colonial America. 2. Popular Colonial American ideas about astrology. 3. The Colonial American belief in the Geocentric theory advanced by Ptolemy. Based on this contextual discussion, I concentrate on the primary source writings left by the Colonial American scholar and professor at Harvard, Charles Morton, who wrote the first Harvard University textbook on Astronomy.

In my third phase, I inspect the Colonial American movement towards the ideas of Nicholas Copernicus and evaluate the causes of the corresponding drift away from the Ptolemaic tradition. In chapter IV, titled "The Shift Towards the Copernican Tradition," The causes are reducible to following three main lines of discussion: 1. The Puritan use of ancient Greek thought. 2. The Puritan's religious openness towards new ideas. 3. The scientific support the Puritans received from England. Because this chapter represents the heart of my research, the claims of several important scholars receive especially close scrutiny and help establish the foundation of my historical explanation. Most prominent among the primary sources are the writings of Zechariah Brigden, the groundbreaking Colonial American scholar who analyzed the relationship between science and the Copernican tradition, as well as why the Copernican tradition was superior to its Ptolemaic predecessor. Related pro-Copernican essays by Colonial Americans such as Samuel Cheever, Thomas Brattle, and John Foster bolster the case. A concluding assessment of Claudius Ptolemy's own statements about the complementary relationship between science and theology actually reinforces the claims of Colonial American writers.

To be sure, it is important to note that this research should serve as an introduction to the exploration of the origins of Colonial American cosmography in relation to the Ptolemaic tradition. There is more research to be done to fully grasp this topic, given the enormity of the subject. Still, I hope my work serves to acquaint readers with an intriguing matter that has to my knowledge not previously been explored in this way, entailing across such a large timescale between the founding of the Ptolemaic tradition and the intellectual awakening of Colonial Americans. Upon founding their new lives in North America, colonial thinkers were in some respects enjoying an opportunity to reconsider received wisdom about the world and the cosmos. In the midst of building a new society, they reflected on the journey of cosmographic wisdom across centuries and how ancient Greek influence persisted across historical eras. Therefore, I hope this investigation will shed light on the major connection between the cosmography of the Greek world and Colonial America that has largely been unrecognized until now.

Ultimately, through this methodological approach, I will answer the following three main questions I pose. Why and how did the Ptolemaic tradition develop in the Greek world? Why and how did the Ptolemaic tradition influence Colonial Americans? And lastly, why and how did Colonial Americans replace the Ptolemaic tradition, with the Copernican tradition?

The Ptolemaic tradition originated in Alexandria,

as opposed to somewhere else, due to a convergence of historical circumstances. Prominent among them was a cultural outlook transmitted directly from democratic Athens to Alexandria that promoted the freedom of scholarly thought. The scholarly objectivity and empirical approach of Claudius Ptolemy clearly owe much to the influence of the Athenian philosophers, as does Ptolemy's emphasis on the usefulness of mathematics. These factors would in turn lay the foundations of the Ptolemaic tradition in the Western world. The views of Colonial Americans reflect this enduring tradition, as seen in their belief in astrology and the geocentric theory, a direct inheritance from England. Subsequent replacement of the Ptolemaic tradition in Colonial America was possible due to a combination of religious openness and intellectual vitality that reflected the long-term influence of the Greek outlook. Also significant were timely contributions by English astronomers. Colonial Americans believed the search for truth to be an active enterprise, an idea that itself stemmed from Greek traditions and would make questioning the Ptolemaic tradition a natural rather than heretical act.

II: Origins of the Ptolemaic Tradition

The origins of what would become the Ptolemaic tradition trace to the ancient Greek philosopher Anaximander of Miletus, who was born in 610 B.C.[1] He argued that the Earth was at rest and in the center of our cosmos.[2] Building on the work of Anaximander, Plato, who was born in about 427 B.C., took this idea a step further, depicting the Earth at the center of a massive rotating sphere, which contained the stars, planets, and the sun.[3] Next, this idea would be expanded on by Eudoxus of Cnidus who was born around 390 B.C.[4] Eudoxus of Cnidus tried to explain the reason for the daily orbit of these fixed stars around the Earth, arguing that it occurs due to what is called "uniform motion."[5] Thus, Eudoxus believed that the sphere would turn on a fixed axis once a day covering an equal distance at equal intervals of time. For Eudoxus, this explained why the stars returned every night in the same position, because unfortunately Eudoxus did not have the tools to notice that the stars can actually move. Eudoxus' successors, Aristotle and Ptolemy, would both come to this conclusion as well.

Now, planets were a bit trickier for these astronomers, because the planets did not actually behave according to this theory and the Greeks studying these astronomical phenomena knew it. This led to the Greeks calling celestial bodies like the sun, moon, and planets "wanderers", because they could not understand why their movement did not follow the theory behind the "fixed axis", as the stars did.[6] To solve this mystery, Eudoxus assumed there must be more fixed spheres in order to accommodate the movements of all seven identified planets. In all, he came up with 26 spheres. Then came Aristotle, born in 384 B.C.; he added more spheres bringing the count to 56.[7] There were so many different trajectories of the planetary orbits that ancient Greeks, desperately trying to make their system fit what they were observing, were unable to reconcile empirical observation with theory.

Not all of the ancient Greek astronomers agreed with the hypothesis of Geocentric theory, though. Considering that cosmography was still in its

1. Alban Dewes Winspear. *The Genesis of Plato's Thought*. (London: Transaction Publishers, 2011), 112.

2. Dirk L. Couprie, Robert Hahn, and Gerard Naddaf. *Anaximander in Context: New Studies in the Origins of Greek Philosophy*. (Albany: State University of New York Press, 2003), 31.

3. Stephen Blake, *Astronomy and Astrology in the Islamic World*. (Edinburgh: Edinburgh University Press Ltd., 2016), 7.

4. Leonid Zhmud. *The Origin of the History of Science in Classical Antiquity*. (Berlin: Hubert & Co., 2006), 232.

5. Edwin Hung. *Philosophy of Science: A Text on Traditional Problems and Schools of Thought*. (Wadsworth: Wadsworth Cengage Learning, 2014), 452.

6. Hung, *Philosophy of Science: A Text on Traditional Problems and Schools of Thought*, 452.

7. Hung, *Philosophy of Science: A Text on Traditional Problems and Schools of Thought*, 453; Norriss Hetherington. *Planetary Motions: A Historical Perspective*. (Westport: Greenwood Press, 2006), 27.

infancy, this is not surprising. For example, one alternative view came from Aristarchus of Samos who was born around 310 B.C. and spent most of is life living in Alexandria.[8] Aristarchus stands out because he actually suggested that the Earth orbited the Sun in a circular motion.[9] Using basic geometry, he calculated the spatial relationship between the Earth, sun and moon.[10] Combined with careful, but imperfect observations, he reached what at the time were novel conclusions. Aristarchus concluded that the universe was expansive and believed that the Sun and the stars were stationary.[11] Unfortunately, this was an unpopular astronomical belief among the ancient Greeks and was even stigmatizing for Aristarchus, as it led some to question his piety.[12] Mostly, however, other astronomers just did not think it was scientifically accurate enough to be true, based on what they could observe.[13]

The other notable Alexandrian astronomers from the 3nd century B.C. include Eratosthenes, who was influential in the field of mathematics and was famous for measuring the Earth's circumference.[14] We also have the astronomer Hipparchus, who had substantial influence on the astronomer Claudius Ptolemy, because of his mathematical insights in astronomy, which paved the way for Ptolemy to fully transform Greek astronomy into a mathematical science. Hipparchus was also able to predict the precession of the equinoxes.[15] Next, Archimedes worked on methods for determining areas and volumes, which would later become the basis of calculus.[16] Lastly, there were the astronomers Timocharis and his student Aristyllus who recorded the movements of the stars.[17] Clearly, Ptolemy had many great predecessors in Alexandria.

Next, we will examine what the scholarly scene was like in Alexandria, Egypt before and at the time of Claudius Ptolemy. The city of Alexandria was famous for having the Library of Alexandria, founded by a former general of Alexander the Great, Ptolemy Soter. This library held the collections of Babylonian, Greek, Jewish, and Egyptian intellectual thought and science.[18] [19] The library's most prominent feature was its extensive collection of Greek literature and the numerous translations of non-Greek works into Greek.[20] The first nucleus of the libraries' collection was built by a student of Aristotle's named Demetrius of Pharlem, with the goal of mimicking the model of Aristotle.[21] As a result, this Alexandrian thirst for knowledge made Alexandria the center of science

8. Marcelo Gleiser. *The Dancing Universe: From Creation Myths to the Big Bang*. (Hanover: Dartmouth College Press, 2005), 50-54.

9. Rosen Edwards. *Copernicus and his Successors*. (London: Hambledon Press, 1995), 5.

10. Morris Kline. *Mathematical Thought From Ancient to Modern Times: Volume 1*. (Oxford: Oxford University Press, 1972), 156-157.

11. Edwards, *Copernicus and his Successors*, 5.

12. Thomas Heath. *Aristarchus of Samos, the Ancient Copernicus: A History of Greek Astronomy to Aristarchus, Together with Aristarchus' Treatise on the Sizes and Distances on the Sun and Moon*. (Cambridge: Cambridge University Press, 2013), 304.

13. Jean-Claude Pecker. *Understanding the Heavens: Thirty Centuries of Astronomical Ideas from Ancient Thinking to Modern Cosmology*. (Berlin: Springer, 2001), 88.

14. Kline, *Mathematical Thought From Ancient to Modern Times: Volume 1*, 160.

15. Kline, *Mathematical Thought From Ancient to Modern Times: Volume 1*, 158.

16. Rory MacLeod. *The Library of Alexandria: Centre of Learning in the Ancient World*. (London: I.B. Tauris Publishers, 2000), 6.

17. MacLeod, *The Library of Alexandria: Centre of Learning in the Ancient World*, 6.

18. MacLeod, *The Library of Alexandria: Centre of Learning in the Ancient World*, 8.

19. Robert Barnes. "Cloistered Bookworms in the Chicken-Coop of the Muses: The Ancient Library of Alexandria." in *The Library of Alexandria: Centre of Learning in the Ancient World*. (London: I.B. Tauris Publishers, 2000), 61.

20. MacLeod, *The Library of Alexandria: Centre of Learning in the Ancient World*, 7.

21. Enrico Berti and Virgilio Costa. "The Ancient Library of Alexandria. A Model for Classical Scholarship in the Age of Million Book Libraries." *CLIR Proceedings of the international symposium on the scaife digital library*, (2009), 14. http://www.perseus.tufts.edu/~ababeu/Berti-Costa_Alexandria_Kentucky.pdf; MacLeod, *The Library of Alexandria: Centre of Learning in the Ancient World*, 2.

in the ancient world, where new explorations in the sciences were conducted.[22] The secret to this success was that Alexandria based its learning on the model set by the Athenian Aristotle, where scientists, poets, historians, and grammarians worked together and this collaborative environment produced tremendous knowledge as a result in the fields of mathematics, engineering, and astronomy.[23]

On top of this, another example of Athenian influence in Alexandria comes from their use of Platonic thought, which was quite popular Alexandria.[24] In fact, the first edition of Plato's works as a collection was produced in Alexandria by Aristophanes of Byzantium in the 2nd century B.C. and was divided into a trilogy.[25] Other Alexandrian scholars like Erastothenes and Eudorus were serious students of Platonism. Erastothenes studied Platonism's mathematics and Eudorus was influential in its revival in Alexandria.[26] Platonism, of course, stems from Plato and people who subscribed to Platonism were attempting to understand the master's ideas and teachings. This was to a certain degree subjective, and much of Plato's thought left room for interpretation. Thus, although there are various views of what Platonism is, generally speaking, it embraces the following ideas: The universe has systematic unity, it is hierarchical, God is essential to the explanation of this hierarchy, the soul is the main principle of life and a person's soul is immortal, and lastly there are various ways of acquiring knowledge, which are hierarchical and based on varying levels of correlation to objective reality.[27] Hence, it appears Alexandrian academia was greatly influenced by the Athenian Socratic thinkers Plato and Aristotle, the same two thinkers who thrived in the democratic intellectual atmosphere that predominated in Athens.

Some scholars, though, argue that Alexandrian and Athenian science really did not have much in common. For instance, H. Floris Cohen, in his book *How Modern Science Came into the World* argues "In Athens the central operation was explanation through the positing of first principles; in Alexandria, description in mathematical terms. First principles of various kinds were put forward by a range of Athenian thinkers; what these first principles had in common was, indeed, their being *posited*, with a blend of inner self-evidence and external, empirical illustration serving to underwrite their validity. Validity was held in each case to be warranted by the very nature of the principles – but for the level of details, knowledge was not just probable but established once and for all. Alexandrian thought had no use for any such first principles. Practitioners took the basics for granted. Their sole aim was to establish mathematical regularities without explanatory pretensions or underlying ontology. Still, they also laid claim to indubitably certain knowledge, albeit attained quite another way, by means of mathematical proof for each successive theorem."[28] Essentially, Cohen says that Alexandrian science was based on mathematics, while Athenian science was more based around natural philosophy. Cohen reiterates this opinion "The argument so far has concerned Athenian natural philosophy and Alexandrian mathematical science as two distinct, largely separate entities." In short, "despite some overlaps (notably, a shared intellectualism and a commonly held conviction of a centrally fixed Earth),

22. Berti and Costa. "The Ancient Library of Alexandria. A Model for Classical Scholarship in the Age of Million Book Libraries.", 17.

23. Berti and Costa. "The Ancient Library of Alexandria. A Model for Classical Scholarship in the Age of Million Book Libraries.", 18.

24. Tanner. "Aristotle's Works: The Possible Origins of the Alexandria Collection.", 144.

25. Maren R. Niehoff. "Philo's Role as a Platonist in Alexandria." *Etudes platoniciennes*, Vol. 7, (2010), 35. https://www.academia.edu/26405975/Philo_s_Role_as_a_Platonist_in_Alexandria?auto=download.

26. Niehoff. "Philo's Role as a Platonist in Alexandria.", 35.

27. Lloyd P. Gerson "What is Platonism?" *Journal of the History of Philosophy*, Vol. 43, No. 3. (2005), 258-260. http://individual.utoronto.ca/lpgerson/What_Is_Platonism.pdf.

28. H. Floris Cohen. *How Modern Science Came into the World: Four Civilizations, One 17th-Century Breakthrough*. (Amsterdam: Amsterdam University Press, 2010), 16-17.

overall they stood far apart."[29] Still, this paper contends that there are three fundamental points of congruence. How can the contrast be so stark given how influential it seems the Athenian philosophers Plato and Aristotle were in shaping Alexandria's intellectual foundations?

Cohen makes an important point about Alexandrian and Athenian academia, but it appears he is not focused on the early origins of education in Alexandria or the impact of the "shared intellectualism" between the two cities. Rather, he appears more interested in what academia would eventually become in Alexandria. However, it seems based on the evidence provided above that Alexandria in at least its early stages was heavily influenced by Athenian academia, especially by the model created by Aristotle. However, I do think Cohen makes a good point about the subsequent role of mathematics in Alexandrian education.

What does Cohen's argument mean for Claudius Ptolemy though? Before we examine this question, first, I think it will be important to describe who Ptolemy was and what he did. Claudius Ptolemy was born in 100 A.D.[30] His name Ptolemy shows Greek ethnic origins and his name Claudius shows that he was a Roman citizen and that an ancestor of his was granted citizenship by the Emperor Claudius.[31] Ptolemy lived around Alexandria in the Greco-Roman world and created astronomical models, which would serve as the western world's guide to astronomy up to the Scientific Revolution.[32] Ptolemy is known for attempting to create a model of the entire universe that was known to him.[33] In this model called the Ptolemaic system, Ptolemy placed the Earth in the center, being orbited by the following celestial bodies in order of closeness: the moon, Mercury, Venus, the sun, followed by the rest of the planets, and then the sphere of fixed stars.[34] As pointed out earlier, these were all ideas, which came from astronomers prior to Ptolemy. Ptolemy's biggest contribution to the field of astronomy were the mathematical models Ptolemy developed in his works, like the *Almagest* and the *Planetary Hypotheses*, where he detailed the motions of the celestial bodies or what he called "the heavenly motions."[35] [36]

This leads us to ask the question, what exactly in the field of mathematics did Ptolemy do that led to his strong support of the subject? To start, Ptolemy was a pioneer on a number of fronts when it came to his mathematically based astronomy. For instance, his planetary models and parameters were grounded in geometric techniques, based on very specific and dated observations.[37] He was the first person to ever produce such work.[38] This was special because Ptolemy was using a new and improved scientific method to mathematically describe why and how the moon,

29. Cohen, *How Modern Science Came into the World: Four Civilizations, One 17th-Century Breakthrough*, 27.

30. Pecker, *Understanding the Heavens: Thirty Centuries of Astronomical Ideas from Ancient Thinking to Modern Cosmology*, 93.

31. Blake, *Astronomy and Astrology in the Islamic World*, 9.

32. Jaqueline Feke. *Ptolemy in Philosophical Context: A Study of the Relationships Between Physics, Mathematics, and Theology*. (Toronto: Institute for the History and Philosophy of Science and Technology University of Toronto, 2009), 1.

33. Robert R. Newton. "Astronomy, Astrology, Ptolemy, and US." *Johns Hopkins APL Technical Digest*, Vol. 3, No. 1 (1982), 79. http://www.jhuapl.edu/techdigest/views/pdfs/V03_N1_1982/V3_N1_1982_Newton.pdf.

34. Newton, "Astronomy, Astrology, Ptolemy, and US.", 79.

35. A. Murschel "The structure and function of Ptolemy's Physical Hypotheses of Planetary Motion." *Journal for the History of Astronomy*, Vol. 26. (1995), 33. http://adsbit.harvard.edu//full/1995JHA....26...33M/0000057.000.html.

36. Elizabeth Anne Hamm. *Ptolemy's Planetary Theory: An English Translation of Book One, Part A of the Planetary Hypotheses with Introduction and Commentary*. (Toronto: Institute for the History and Philosophy of Science and Technology, University of Toronto, 2011), 2.

37. Bernard R. Goldstein. "Saving the Phenomena: The Background to Ptolemy's Planetary Theory." *Journal for the History of Astronomy*, Vol. 28, No. 1. (1997), 1. http://www.pitt.edu/~brg/pdfs/brg_i_3.pdf.

38. Goldstein, "Saving the Phenomena: The Background to Ptolemy's Planetary Theory.", 1.

planets, sun, and fixed stars orbit the Earth.[39] On top of this, Ptolemy set out to calculate the distances between these celestial objects, as well as their sizes.[40] These calculations were used by Ptolemy to come up with conclusions that were the most sophisticated ones up to date at the time.[41] Ptolemy was insistent that to have a legitimate astronomical model of the universe, such a model must have a uniform and circular motion, be simple, accurate, and based on empirical data.[42]

Therefore, based on his research, he maintained the belief of his predecessors Eudoxus and especially Aristotle that the celestial bodies have a uniform and circular motion, the heavens are endless, and at the center of all of this, is planet Earth.[43] His exception, though, was how he described the motion of the planets around the Earth, which stumped all his predecessors. Ptolemy describes this problem his predecessors faced in this passage "Now it is our purpose to demonstrate for the five planets, just as we did for the sun and moon, that all their apparent anomalies can be represented by uniform circular motions, since these are proper to the nature of divine beings, while disorder and nonuniformity are alien [to such beings]. Then it is right that we should think success in such a purpose a great thing, and truly the proper end of the mathematical part of theoretical philosophy. But, on many grounds, we must think that it is difficult, and that there is good reason why no-one before us has yet succeeded in it. For, [firstly], in investigations of the periodic motions of a planet, the possible [inaccuracy] resulting from comparison of [two] observations (at each of which the observer may have committed a small observational error) will, when accumulated over a continuous period, produce a noticeable difference [from the true state] sooner when the interval [between the observations] over which the examination is made is shorter, and less soon when it is longer."[44] As one can tell, Ptolemy is quite aware of the difficulties that have historically existed when tracking the planetary motions, because data has been inconsistent between various observers. This of course is because geocentric theory is wrong, but how Ptolemy tries to make sense of these motions based on the supposed truth of geocentric theory being true is quite ingenious.

Ptolemy then goes on to describe the main issue when identifying the motions of the five planets stating "In investigation of the anomalies, considerable confusion stems from the fact that it is apparent that each planet exhibits two anomalies which are moreover unequal both in their amount and in the periods of their return: one [return] is observed to be related to the sun, the other to the position in the ecliptic; but both anomalies are continuously combined, whence it is difficult to distinguish the characteristics."[45] Ptolemy here describes why many astronomers have struggled to accurately calculate the motions of the planets because of what he calls their "anomalies", which were strange motions the planets were observed to make that didn't make sense according to astronomical models prior to Ptolemy. Ptolemy explains his solution to solving the anomalies of planetary motion this way: "There are, as we said, two types of motion which are simplest and at the same time sufficient for our purpose, [namely] that produced by circles eccentric to [the centre of] the ecliptic, and that produced by circles concentric with the ecliptic but carrying epicycles around. There are likewise two apparent anomalies for each planet: [1] that anomaly which varies according to its position in

39. Hamm, *Ptolemy's Planetary Theory: An English Translation of Book One, Part A of the Planetary Hypotheses with Introduction and Commentary*, 65.

40. Hamm, *Ptolemy's Planetary Theory: An English Translation of Book One, Part A of the Planetary Hypotheses with Introduction and Commentary*, 5.

41. Hamm, *Ptolemy's Planetary Theory: An English Translation of Book One, Part A of the Planetary Hypotheses with Introduction and Commentary*, 21.

42. Hamm, *Ptolemy's Planetary Theory: An English Translation of Book One, Part A of the Planetary Hypotheses with Introduction and Commentary*, 39.

43. Hamm, *Ptolemy's Planetary Theory: An English Translation of Book One, Part A of the Planetary Hypotheses with Introduction and Commentary*, 21.

44. Claudius Ptolemy. *Ptolemy's Almagest*. G.J. Toomer trans. and Annot. (London: Gerald Duckworth & Co. Ltd., 1984), 420.

45. Ptolemy, *Ptolemy's Almagest*, 420.

the ecliptic, and [2] that which varies according to its position relative to the sun of each individually."[46] In turn, Ptolemy came to the conclusion that the planets moved on a small sphere called an epicycle, which was connected to a bigger sphere, like the one's described by Eudoxus and Aristotle as mentioned earlier.[47] Because of this theory, he was the first person to be able to determine the location of these planets based on a geometrical theory and solved the mystery of their movement improving the geocentric theory.[48]

Therefore, the *Almagest* and the *Planetary Hypotheses* are considered to be some of the greatest works of science ever and they were the first to incorporate complex mathematical principles to create a solution to solve the mystery of the planetary motions, which Ptolemy's predecessors failed to do.[49] Elizabeth Anne Hamm describes the legacy of Ptolemy in her work *Ptolemy's Planetary Theory: An English Translation of Book One, Part A of the Planetary Hypotheses with Introduction and Commentary* in the following statement: "The second-century A.D. natural philosopher Claudius Ptolemy is arguably the most important author whose works exist on Greco-Roman science. His works of science encapsulated and exceeded the work of his predecessors…While he owes much of his success to his predecessors, it is Ptolemy's own contributions – namely his ingenuity, his thoroughness, and his ability to coalesce theories – that made him an authority in so many fields."[50] In fact, Ptolemy built off of the texts representing Aristotle's geocentric theory to construct the best astronomical model the world had seen until this of Nicholas Copernicus in the 16th century, which would not gain widespread favor until the 18th century.[51] [52]

Mathematics was the Ptolemy's specialty and clearly a major factor in why his work was tremendously influential. However, does this mean that no other factors played a role in his research? No, as Cohen points out "Ptolemy provides the one and only case of a mathematical scientist expertly and more than fleetingly concerned to construct the very kind of specific linkages between Alexandrian and Athenian approaches that I have demonstrated were by and large absent from Greek nature-knowledge…With *heavenly bodies* Ptolemy sought in three different ways to enlarge upon the geometric two-dimensional models presented in the *Almagest*. At the head of that book he placed six 'hypotheses' (points of departure), for example, 'that the Earth makes no motion involving change of place'. He drew support for these hypotheses from empirical phenomena if he could and from natural philosophy (Aristotelian or stoic) if he had nothing else to draw on."[53] At the same time though, I believe Cohen downplays the role of Athenian influence, by describing Athenian philosophy as more of a last resort option, rather than a complementary method.

To challenge Cohen, we must examine scholar Jacqueline Feke's work *Ptolemy in Philosophical Context: A Study of the Relationships Between Physics, Mathematics, and Theology.* Feke notes the following about Ptolemy "His philosophy, his motivation and method for studying mathematics and natural philosophy, remains relatively unstudied."[54] This is a very important idea, because when we focus on the philosophy behind his work, Ptolemy's research appears littered with philosophical reasoning stemming from the Socratic philosophers of Athens. Evidence of this statement comes from Ptolemy's engagement

46. Ptolemy, *Ptolemy's Almagest*, 442.

47. Thomas Kuhn. *The Copernican Revolution: Planetary Astronomy in the Development of Western Thought*. (Cambridge: Harvard University Press, 1957), 69-70.

48. Stephanie Lynn Budin. *The Ancient Greeks: New Perspectives*. (Santa Barbara: ABC-CLIO, Inc., 2004), 383.

49. Ptolemy, *Ptolemy's Almagest*, 1.

50. Hamm, *Ptolemy's Planetary Theory: An English Translation of Book One, Part A of the Planetary Hypotheses with Introduction and Commentary*, 1.

51. Ptolemy, *Ptolemy's Almagest*, 3.

52. MacLeod, *The Library of Alexandria: Centre of Learning in the Ancient World*, 8.

53. Cohen, *How Modern Science Came into the World: Four Civilizations, One 17th-Century Breakthrough*, 24.

54. Feke, *Ptolemy in Philosophical Context: A Study of the Relationships Between Physics, Mathematics, and Theology*, 9.

with Aristotle, when it comes to determining the write method of astronomical inquiry. For instance, Ptolemy lays out Aristotle's three theoretical sciences in this quote: "For Aristotle divides theoretical philosophy too, very fittingly, into three primary categories, physics, mathematics and theology. For everything that exists is composed of matter, form and motion; none of these [three] can be observed in its substratum by itself, without the others: they can only be imagined." Here Ptolemy acknowledged the importance of the Aristotelian tradition. Ptolemy then goes on to deem mathematics as the only legitimate method of inquiry.[55]

Even more eye catching yet, is Ptolemy's relationship with the philosophy of the Athenian Plato. Ptolemy seems to be quite familiar with many philosophies ranging from the Socratic philosophy to the Stoic and the Epicurean. Despite his diverse interest in these philosophies, the one that stands out is what Feke calls "Platonic Empiricism."[56] As Feke observes, "At the foundation of Ptolemy's scientific method is his criterion of truth, grounded in what later came to be labeled empiricism and designed to differentiate opinion from knowledge, a distinction which he expresses in Platonic terms. This criterion serves as the means by which Ptolemy categorizes every object in the cosmos, determines the epistemic success of the theoretical sciences, and establishes a scientific method aimed at producing knowledge."[57] Consequently, Ptolemy appears to use Plato's theory of knowledge versus opinion, when it comes to determining that mathematics is the only true source of knowledge out of Aristotle's three theoretical sciences.[58] Thus, this sheds light on the influence of the Athenian philosophers Plato and Aristotle on Ptolemy and also shows how critical Athens was to the future development of knowledge in the Greek world. In turn, not only were Athenian philosophers influential when it came to the foundations of the scholarly climate of Alexandria, regardless of what it would later become, they also affect Ptolemy's research when it came to seeking knowledge.

To put this another way, it is hard to imagine the intellectual flowering of Alexandria had it not been stimulated by a democratic intellectual impulse from Athens. Without it, perhaps Plato and Aristotle would not have been as influential on the academic world of Alexandria and consequently Ptolemy too. This then begs the question, what was it about democratic Athens that was so critical to the development of the philosophies of Aristotle and Plato? To understand this connection, we must go back to the Greek freedom of thought found in Athenian democracy. The legacy of ancient Greek democracy is well known and the influence of these democratic ways was critical to the future development of Greek science. This is because under Athenian democracy the freedom of thought reached its apex in Greece. As scholar Enrico Berti argues, "freedom of speech was an essential aspect of Athenian democracy."[59] In fact, the Athenian Plato, who was critical of democracy as a political system, realized Athens was friendlier to free speech than any other place in Greece. According to Berti, Plato even called Athens "in love with speech" and the city of "many speeches."[60] How then does this relate to Ptolemy, who lived hundreds of years later under the more authoritarian Roman Empire? To answer this, it is important to note that Greek democracy may have died in Athens, but it bequeathed sophisticated systems of thought for the cultures which descended from it. Though not sufficient by itself to explain subsequent intellectual life, Athens' democratic culture was an invaluable contributor. Viewed through

55. Ptolemy, *Ptolemy's Almagest*, 35.

56. Feke, *Ptolemy in Philosophical Context: A Study of the Relationships Between Physics, Mathematics, and Theology*, 221.

57. Feke, *Ptolemy in Philosophical Context: A Study of the Relationships Between Physics, Mathematics, and Theology*, 221-222.

58. Feke, *Ptolemy in Philosophical Context: A Study of the Relationships Between Physics, Mathematics, and Theology*, 43.

59. Enrico Berti. "Ancient Greek Dialectic as Expression of Freedom of Thought." *Journal of the History of Ideas*, Vol. 39, No. 3 (1978), 348. http://www.jstor.org/stable/2709382.

60. Berti. "Ancient Greek Dialectic as Expression of Freedom of Thought.", 348.

another lens, Athenian philosophers were not brilliant due to a genetic predisposition, but rather because of an environment that allowed bold ideas to flourish. Obviously, there were very intelligent Greeks before the Socratic thinkers, but Athenian democracy created a more favorable atmosphere for intellectual thought to develop in ways not seen before.

As Berti writes: "Naturally I do not intend to maintain that a philosophical and cultural movement as complex as that of the Sophists, or also a succession of philosophies as profound as those of Socrates, Plato, and Aristotle should be derived entirely from the freedom of speech allowed by Athenian democracy. It is well known that the major Sophists had their own particular conception of arete…Nevertheless it seems to me undeniable that the freedom of speech assured by Athenian democracy was one of the causes which contributed to the rise of such philosophies."[61] Ergo, though there is always an eclectic mix of factors which shape various cultural phenomena, Athenian democracy was surely a fundamental part of the process and one that stands out as the most influential of all factors other than an individual's talent, intellect, or ambition. There is no question that ancient Greek philosophers were immensely talented and intelligent, but without being in the right circumstances at the right time, it is certainly more difficult for such characteristics to reach their full potential. As a result, living in a democracy can give a talented person an edge over someone born in a less freethinking society. Nevertheless, Athenian philosophy and science occurred due to the freedom of thought, which allowed it to develop. In turn, its legacy lived on specifically through the intellectual products it left behind in the fields of philosophy and science. As Ober details in his chapter titled "Conditions for Athenian Democracy" in the book *The Making and Unmaking of Democracy: Lessons From History and World Politics*, "Because the new democratic state proved wildly successful on the international scene and spectacularly productive of literary, artistic, and philosophical culture, the Athenian model was highly influential and never forgotten."[62]

The evidence of the freed inquiry in Ptolemy's research, emerges from the debates he engaged in over various astronomical concepts. Ptolemy was not at all shy about criticizing his predecessors, even if they were of the likes of the great Aristotle or Plato. This fact alone reveals the importance of openness in Athenian intellectual life. He criticized Aristotle specifically, in regard to his work on celestial spheres.[63] As Hamm states, "Ptolemy argued that the arrangement proposed by Aristotle would not be physically feasible and he produced reasons as to why the concentric spheres proposed by Eudoxus and Aristotle did not provide a realistic description of the cosmos." This is because for Ptolemy, the movement of the celestial spheres could be caused by themselves and did not have to be driven by something else.[64]

In turn, one can clearly see that the climate of academia in the Greek world at the time was not restrictive of the opinions, whether favorable or opposed, of scholars towards the works of others, though there are a few exceptions. For the most part, the ancient Greeks were not being forced to follow some state sponsored ideas of the universe, but were instead challenging mainstream concepts and brainstorming new ones. As scholar James Evans points out "The second point to bear in mind in assessing the importance of Aristotle's physics is that the astronomers were capable of abandoning it whenever it seemed expedient…The Greek astronomers simply never were blind slaves to Aristotle's system that they sometimes have been made out to be."[65] This is a very important

61. Berti. "Ancient Greek Dialectic as Expression of Freedom of Thought.", 349.

62. Josiah Ober. "Conditions for Athenian Democracy." in *The Making and Unmaking of Democracy: Lessons From History and World Politics* edited by Theodore K. Rabb and Ezran N. Suleiman. (London: Routledge, 2003), 18.

63. Murschel "The structure and function of Ptolemy's Physical Hypotheses of Planetary Motion.", 38.

64. Hamm, *Ptolemy's Planetary Theory: An English Translation of Book One, Part A of the Planetary Hypotheses with Introduction and Commentary*, 220.

65. James Evans. *The History and Practice of Ancient Astronomy*. (Oxford: Oxford University Press, 1998), 20.

point, because if the ancient Greeks were not allowed to question those like Aristotle, then who knows how harmful it would have been to the development of Greek astronomy. Therefore, the freedom of thought stemming from democratic Athens allowed for the development of Athenian Greek philosophy, which would influence the construction of the Ptolemaic tradition in Alexandria, due to the influence of Plato and Aristotle on the origins of Alexandrian academia.

Hence, thanks to the influence of Athenian philosophers like Plato, Ptolemy's research was also highly successful, by virtue of his ability to be objective via his empirical reasoning, rather than plaguing his research with his own biases. As Ptolemy detailing his thought process himself, asserted: "Since we observe, examine, and come to understand reality by sense perception, reasoning, and by discourse either in our own minds or with other people, it would be not unreasonable to match sense perception with the instrument with which the subject under judgment is judged, intellect with the agent of judgment, and *logos* with the means by which the agent judges." Essentially, he is saying that we obtain knowledge by using reason to judge our sense of perception.[66] This is a relevant idea for all of human history, because it is still so easy for people to come to unreasonable conclusions via illogical analysis and confirmation bias. The fact that Ptolemy was so aware of this speaks volumes about his intellect and the sophistication of intellectual thought in the Greco-Roman world.

Ptolemy was open to new ideas, but not afraid to criticize bad ones. As the scholar Andrew Barker expresses in his book *Scientific Method in Ptolemy's 'Harmonics'* "He shows himself to be well informed about the debate, and he offers sharp criticism of extreme views on either side. His own position is designed to incorporate promising insights from any doctrinal repertoire, while avoiding the faults they had carried with them, and to fuse them into a new methodological amalgam, more balanced and more adequate to its task."[67] Here Barker does a nice job of describing what makes Ptolemy so skilled as a scientist, because he is not cherry-picking facts, nor is he obsessed with his own ideas. In fact, Ptolemy even denounces such behavior as seen in the following quote: "For those who approach this science in a true spirit of inquiry and love of true thought to use any new methods they discover, which give more accurate results, to correct not merely the ancient theories, but their own too, if they need it. They should not think it disgraceful, when the goal they profess to pursue is so great and divine, even if their theories are corrected and made more accurate by others beside themselves."[68] Thus, it is evident that for Ptolemy his research is about seeking the best possible interpretation of nature, it is not about who is right or who is wrong. This is ultimately the characteristic of a great scientist and one who is a modest and an objective seeker of knowledge.

Now one can argue today that if Ptolemy was so reasonable and based on logic, why did he believe in astrology? After all, Ptolemy essentially wrote the "how-to" guide of astrology. If we keep to the historical context of his time, though, this is not so strange. Throughout history, people have had religious beliefs that seem to contradict the reasoning behind some of their scientific research, though. For example, only in the modern era is it common to have such a large number of scientists who are atheists, agnostic, non-believers, or people who simply believe in God, but don't have an opinion of who or what God is. Throughout history the majority of the greatest scientific minds, irrespective of culture, were people of religious faith. Therefore, Ptolemy is not so much a walking contradiction, but rather normal for his time. Just because someone is reasonable about one thing, does not mean they will be reasonable about another. As Feke states "It is true that Ptolemy also wrote a book on astrology, but then so did many of those to whom

66. Feke, *Ptolemy in Philosophical Context: A Study of the Relationships Between Physics, Mathematics, and Theology*, 55.

67. Andrew Barker, Andrew. *Scientific Method in Ptolemy's 'Harmonics'*. (Cambridge University Press: Cambridge, 2000), 14.

68. Hamm, *Ptolemy's Planetary Theory: An English Translation of Book One, Part A of the Planetary Hypotheses with Introduction and Commentary*, 28.

we attribute much of our modern…In the Almagest Ptolemy was at his scientific best. Whatever may have been his astrological views they do not seem to intrude anywhere in his astronomical work. This was certainly not the case in the work of Kepler."[69]

Ptolemy was not only an astronomer, which I detailed earlier, but also an astrologer. As a matter of fact, Ptolemy was so influential in the field of astrology that he wrote the handbook on it for the Greco-Roman world and western civilization. This book was known as the *Tetrabiblos*. In this work, Ptolemy defends astrology as a beneficial discipline, because he feels it helps people understand the power and influence of the celestial bodies. In fact, for Ptolemy astronomy and astrology went hand in hand. For him, the only differences between the two subjects were that astronomy explains and predicts the locations and movements of celestial bodies and astrology studies and predicts the influence of these celestial bodies on Earth.[70] Thus, in the *Tetrabiblos* Ptolemy was concerned with the influence of the planets on human beings. Supposedly, because the planets' rays affect the development of human beings in regard to their bodies and souls. Ptolemy describes these assumption in the following passage from the *Tetrabiblos*: "In somewhat summary fashion it has been shown how prognostication by astronomical means is possible, and that it can go no further than what happens in the ambient and the consequences to man from such causes—that is, it concerns the original endowments of faculties and activities of soul and body, their occasional diseases, their endurance for a long or a short time, and, besides, all external circumstances that have a directive and natural connection with the original gifts of nature, such as property and marriage in the case of the body and honor and dignities in that of the soul, and finally what befalls them from time to time."[71] The reasoning behind this was that Ptolemy felt that if the sun and the moon have physical effects on the Earth, then the planets must as well; in turn the planet's rays must affect people, because a person's soul and body are all made of matter just like a planet's rays.[72] [73]

This is not at all surprising, given the fact that Ptolemy also believed the planets to be divine. As Ptolemy states, "Now it is our purpose to demonstrate for the five planets, just as we did for the sun and moon, that all their apparent anomalies can be represented by uniform circular motions, since these are proper to the nature of divine beings."[74] That being said, Ptolemy still viewed astrology as conjectural, whereas astronomy due to mathematics, as mentioned earlier, was considered truth.[75] Ultimately, Ptolemy's views were quite common in the Greco-Roman world, originally stemming from the Babylonians.[76] In addition, astrology and astronomy were often considered to go hand in hand for much of history. The lack of clear distinction between astrology and astronomy was something that lasted in Europe until around the time of the Renaissance.[77] By about 1600 educated Europeans began rejecting astrology.[78] Also, all studies of Ptolemy's research deem it scientific, based on reason, and unhindered by his astrological beliefs. It was not the scientific method that was lacking in Ptolemy's work, but more the tools necessary to see the universe for what it is.[79] For example, when one looks at the night sky, it appears that the planets are

69. Feke, *Ptolemy in Philosophical Context: A Study of the Relationships Between Physics, Mathematics, and Theology*, 18.

70. Feke, *Ptolemy in Philosophical Context: A Study of the Relationships Between Physics, Mathematics, and Theology*, 4-5.

71. Feke, *Ptolemy in Philosophical Context: A Study of the Relationships Between Physics, Mathematics, and Theology*, 169.

72. Newton. "Astronomy, Astrology, Ptolemy, and US.", 79.

73. Feke, *Ptolemy in Philosophical Context: A Study of the Relationships Between Physics, Mathematics, and Theology*, 170.

74. Ptolemy, *Ptolemy's Almagest*, 420.

75. Feke, *Ptolemy in Philosophical Context: A Study of the Relationships Between Physics, Mathematics, and Theology*, 157.

76. Evans, *The History and Practice of Ancient Astronomy*, 343.

77. Newton. "Astronomy, Astrology, Ptolemy, and US.", 77.

78. Newton. "Astronomy, Astrology, Ptolemy, and US.", 79.

79. Feke, *Ptolemy in Philosophical Context: A Study of the Relationships Between Physics, Mathematics, and Theology*, 18.

moving, but not the Earth. As a result, we are only as good as the tools we have at our disposal when it comes to astronomy.

In turn, this objectivity was what led to the development of mathematics and how Ptolemy used it to change the history of astronomy. You see, Ptolemy had a unique philosophy of mathematics. As mentioned earlier, Ptolemy was one of the few Greeks to see mathematics as the only true source of knowledge and criticized other fields popular with the Greeks like physics and theology, considering them as nothing more than mere speculations.[80] As Ptolemy himself argues in the *Almagest*, "From all this we concluded: that the first two divisions of theoretical philosophy should rather be called guesswork than knowledge, theology because of its completely invisible and ungraspable nature, physics because of the unstable and unclear nature of matter; hence there is no hope that philosophers will ever be agreed about them; and that only mathematics can provide sure and unshakeable knowledge to its devotees, provided one approaches it rigorously. For this kind of proof proceeds by indisputable methods, namely arithmetic and geometry."[81] Feke nicely summarizes just how powerful this statement by Ptolemy is stating, "According to Ptolemy, physics and theology are conjectural, and mathematics alone yields knowledge. This claim is unprecedented in the history of ancient Greek philosophy."[82] The reason for this is that in the Greco-Roman world prior to Ptolemy, science was more of a philosophical field and not as much a scientific one in the modern sense and thanks to Ptolemy science would be greatly improved.[83] Therefore, Greek astronomy was focused solely on physical explanations of the universe, instead of numerical ones.[84] Ptolemy would change this and rewrite the book so to speak on how science should be conducted.

Ptolemy understood that observation alone could not answer every question and he realized that mathematics played a very large role in the understanding of the universe as well.[85] Ptolemy recognized that observation is limited by interpretation and imprecision, while mathematics is not subjective. The evidence Ptolemy gives to support his theory of mathematics, when it comes to understanding astronomy can be seen by Feke in this statement "Ptolemy explains in Almagest 1.1 that astronomy studies mathematical objects that are divine, eternal, and unchanging. It is because these objects are eternal and unchanging that the mathematical knowledge associated with them is itself eternal and unchanging."[86] As one can tell, Ptolemy clearly sees mathematics as some sort of language of the Gods in a way, because he considers it to be the only way of discovering truth in the universe. Therefore, mathematics is the only method of acquiring knowledge about the heavens and the divine objects such as the planets. Overall, mathematics was orderly, consistent, aesthetically perfect, and useful in explaining phenomena in the real world. This is similar to how the Puritans in Colonial America saw it as well, which will be described in a later chapter.

Next, besides the divinity of the subject of mathematics for Ptolemy, from a methodological standpoint, he believed mathematics was based on reason, because mathematics is not someone's opinion, it is based on mathematical models and formulas, which are perceptible and testable.[87] As Ptolemy describes "These things belong to the loftiest and loveliest of intellectual pursuits, namely to exhibit to human understanding through mathematics [both] the heavens themselves in their physical nature (since they can be seen in their revolution about us), and

80. Feke, *Ptolemy in Philosophical Context: A Study of the Relationships Between Physics, Mathematics, and Theology*, II.

81. Ptolemy, *Ptolemy's Almagest*, 36.

82. Feke, *Ptolemy in Philosophical Context: A Study of the Relationships Between Physics, Mathematics, and Theology*, II.

83. Feke, *Ptolemy in Philosophical Context: A Study of the Relationships Between Physics, Mathematics, and Theology*, 1.

84. Evans, *The History and Practice of Ancient Astronomy*, 217.

85. Evans, *The History and Practice of Ancient Astronomy*, 392.

86. Feke, *Ptolemy in Philosophical Context: A Study of the Relationships Between Physics, Mathematics, and Theology*, 60.

87. Feke, *Ptolemy in Philosophical Context: A Study of the Relationships Between Physics, Mathematics, and Theology*, 61.

[the nature of] the Earth through a portrait (since the real [Earth], being enormous and not surrounding us, cannot be inspected by any one person either as a whole or part by part." Thus, according to Ptolemy mathematics allows us to see the nature of the universe.[88]

III: Reception of the Ptolemaic Tradition in Colonial America

Now, before we delve into the Ptolemaic tradition in Colonial America, it is important first to understand where the tradition was prior to the British colonization of the new world. For instance, in Europe. The Ptolemaic tradition was dominant in Europe up until the Renaissance. The first person to challenge this theory in Europe was the Polish astronomer Nicholas Copernicus. According to scholars, Nicholas Copernicus, who was born in 1473 was concerned with Ptolemy's claim that the celestial bodies were on a small sphere, connected to a bigger sphere orbiting the Earth. This is known as Ptolemy's "Equant."[89] For Copernicus, this theory did not match up with Aristotle's claim of the necessity of a uniform and circular motion. As a result, Copernicus began exploring other potential celestial arrangements, which would fit Aristotle's theory of planetary motion.[90] Copernicus then came up with another idea, arguing that the motion of the sun and the planetary motions that Ptolemy described are flawed, because they are based on observations from Earth, which is also in motion.[91] Therefore, in an attempt to return astronomy back to Aristotle's theory of uniform motion, Copernicus made the bold claim in his work *On Revolutions* in 1543 that the Sun was the center of the universe and was orbited according to uniform motion by Earth and the other planets.[92] Unfortunately, Copernicus' work was not widely accepted.[93] In fact, before 1600 scholars estimate that there were only 10 supporters in Europe of Copernicus' ideas.[94] Despite common myth, however, this was not due to the church, but rather just due to the fact that scholars disagreed with his ideas, because they did not quite match the observational data available.[95] Interestingly enough, though, Copernicus' astronomical work spread all over Europe and a second edition came out in 1566.[96] Many scholars even regarded his criticisms of Ptolemy's "equant" legitimate.[97] Despite this, as mentioned earlier the heliocentric theory was still not accepted much among astronomers. The 16th century scholars mostly just used some of Copernicus' findings in an attempt to improve the Ptolemaic tradition.[98] Some scholars rejected it on scientific grounds, while other scholars believed it just went against the Bible and thus

88. Feke, *Ptolemy in Philosophical Context: A Study of the Relationships Between Physics, Mathematics, and Theology*, 62.

89. Evans, *The History and Practice of Ancient Astronomy*, 420.

90. Moritz Hutten. "A new Cosmos-a novel Physics: The Scientific reception of the heliocentric world view in the Renaissance." *Max Planck Institute for the History of Science*, (2013), 3. http://www.haus-der astronomie.de/3440709/01Huetten_HelioCentricCosmos_korrigiert.pdf.

91. Jerry Dobrycki. "Nicolaus Copernicus-His Life and Work," in *The Scientific World of Copernicus: On the Occasion of the 500th Anniversary of his Birth 1473-1973* edited by Barbara Bienkowska. (Dordrecht: D. Reidel Publishing Company, 1973), 20.

92. Sun Kwok. *Our Place in the Universe: Understanding Fundamental Astronomy from Ancient Discoveries*. (Berlin: Springer, 2017), 194.

93. Kuhn, *The Copernican Revolution: Planetary Astronomy in the Development of Western Thought*, 185.

94. Martin V. Curd. "The Rationality of the Copernican Revolution." *Proceedings of the Biennial Meeting of the Philosophy of Science Association*, Vol. 1 (1982), 3. http://www.jstor.org.proxy.uba.uva.nl:2048/stable/ pdf/192651.pdf?refreqid=excelsior%3A5e3cfe33be6579619121acd834fe2391.

95. Nicholas P. Leveillee. "Copernicus, Galileo, and the Church: Science in a Religious World." *Inquiries Journal/Student Pulse*, Vol. 3 No. 5, (2011), 1. http://www.inquiriesjournal.com/articles/1675/copernicus-galileo-and-the-church-science-in-a-religious-world.

96. Pietro Daniel Omodeo. *Copernicus in the Cultural Debates of the Renaissance: Reception, Legacy, Transformation*. (Leiden: Brill, 2014), 63.

97. Evans, *The History and Practice of Ancient Astronomy*, 420.

98. Jean-Pierre Luminet. "The Provençal Humanists and Copernicus." *Inference*, Vol. 2 No. 4 (2017), 5. https://arxiv.org/ftp/arxiv/papers/1701/1701.02930.pdf.

valued some of his observations, but considered his conclusion anti-Christian.[99] It also must be pointed out that Copernican astronomy also had its flaws. For instance, J.B. Brackenridge in his work titled "Kuhn, Paradigms and Astronomy" explains in a very useful way two important points. First, there were a lot of flaws in Copernicus' work, which is one reason for its slow acceptance. To some degree, Copernicus reached the right conclusion about a heliocentric universe, even though his work was not really objectively much better than that of Ptolemy. A subsequent study by Kepler and Newton was necessary to consolidate a real "scientific revolution." To this point, Brackenridge cites the words of another scholar, Thomas Kuhn: "Modern historians, making ample use of the advantage of hindsight, stress the revolutionary significance of the heliocentric system and the simplification it had introduced. In fact, the actual computation of planetary position was exactly the ancient pattern and the results are the same. The Copernican solar theory is definitely a step in the wrong direction for the actual computation as well as for the underlying cinematic concepts…Had it not been for Tycho Brahe and Kepler, the Copernican system would have contributed to the perpetuation of the Ptolemaic system in a slightly more complicated form but more pleasing to philosophical minds."[100] Kuhn then continues arguing, "Thus the astronomical revolution that provides the transition from the Aristotelian world view, as reflected in the Almagest, to the Newtonian world view, as reflected in the Principia, takes place over an extended period of nearly one hundred and fifty years."[101] However, Copernicus' work was still critical in breaking the stranglehold that Ptolemy's vision of the universe had over the astronomical views held by most scholars at the time. The fact that subsequent proofs were necessary to prove the point does not diminish this fact. Still, this also helps explain why some scientists were reluctant to latch onto Copernicus' view. He had solved one problem, but not others that were associated with it.

Now turning towards Colonial America, which began to forge a common culture in the early 17th century, one can see based on the earlier historical outline of the 16th century in Europe that the Ptolemaic tradition was still enshrined throughout European academia, except for a few individual scholars. This being said, in order to fully understand the Colonial Americans, we must first understand who these people were. For this, we need to start with the Puritan movement in England, which was one of the results of the Protestant Reformation in Europe spawned by Martin Luther. The Puritans were very much influenced by Calvinism and developed a very strict interpretation of Christianity, which led them on a quest to purify the Church of England. For the Puritans, they believed that the church was still plagued by remnants of Catholicism and they wanted to purge it of all things they believed were not found in scripture like idolatry, which was the worship of images and symbols. Their strong religious ideas and their outspokenness about them did not mesh well with the other Christians in England and caused many conflicts. Because of this, Puritans in England suffered from persecution and decided to move to the new world to create the society they desired.[102] Not all Puritans came directly to the new world, however. One particular Puritan minister by the name of John Davenport, who was educated at Oxford University, moved to Amsterdam in 1633.[103] There, Davenport was the co-minister of the Church of England. Unfortunately, this position would not last long, because Davenport was too extreme in his religious beliefs for the church there in Amsterdam

99. Luminet, "The Provençal Humanists and Copernicus.", 5; Omodeo, *Copernicus in the Cultural Debates of the Renaissance: Reception, Legacy, Transformation*, 19.

100. Bruce J. Brackenridge. "Kuhn, Paradigms, and Astronomy: Astronomy as a Case Study of Khunian Paradigms." *Proceedings of the American Philosophical Society*, Vol. 129, No. 4 (1985), 446. https://www.jstor.org/stable/986938.

101. Brackenridge. "Kuhn, Paradigms, and Astronomy: Astronomy as a Case Study of Khunian Paradigms.", 447.

102. Murrell. *Essential Church History: And the Doctrinal Significance of the Past*, 131-132.

103. Samuel Eliot Morison. *The Founding of Harvard College*. (Cambridge: Harvard University Press, 1995), 374.

and had many disagreements with other members of the church. Thus, in 1637, Davenport set off for the new world to join his fellow Puritans.[104] Later, Davenport will be an important figure when it comes to understanding the mentality of the Puritans towards new scientific ideas.

In the new world, the Puritans founded the Massachusetts Bay Colony in 1630. In this colony, the Puritans were the drivers of science in Colonial America and the founders of Harvard University. Before we delve into the science of the Puritans, though, we must understand that the Puritans were an extremely religious group of people. The colonists were motivated by religion and lived by their faith.[105] Thus, for the Puritans living in the Massachusetts Bay Colony it was a religious utopia, where all people worked together for the greater good of the colony through their various talents, which according to the Puritans, were God given.[106] For example, in the Puritan Dedham community in Massachusetts, their lives were lived according to a covenant, based on the following points: "the fear of God," the practice of "everlasting love," and lastly the idea that one should let all disputes among men be settled by a third party.[107] This was an agreement sworn by all Puritans in Dedham. This oath represents the Puritan goals of having societal peace and order.[108] Citizens also would regularly gather together to take part in town meetings and participated in the decision-making progress by expressing their opinions.[109] The main decision makers were the elected selectmen chosen by the people. These selectmen were rarely questioned or rejected once elected. Nevertheless, though, the Puritan communities used these social gatherings to come up with compromises to solve communal disagreements.[110] Over time, as generations passed these communal decisions would become less and less based on the selectmen and more based on popular support.[111]

On top of these beliefs, Puritans believed in predestination, for example, they believed they were already predestined by God to go to heaven or hell from birth. They also believed in a personal covenant relationship with God, which they felt was crucial for an individual to escape their sins.[112] The scholar Elizabeth Patton describes in her article "The Excellency of Theology: A Critique of Robert K. Merton's 'Puritan Thesis,'" these aspects of Puritanism: "Ascertaining these marks of grace was central to Puritan theology, for it linked directly with the doctrine of Election, the idea that some were predestined for salvation, while others were damned. Only God truly knew who was assured and who was not, but individuals could gain assurance by finding the signs of grace in their own lives. Thus, the hope and desire for [election], the awareness of it, and the assurance of it, were fundamental to the Puritan religion."[113] As one can discern from Patton's statement the Puritans were quite dedicated to their faith and this would play an influential role on their astronomy as well.

When it came to science, the Puritans were quite interested in astronomy, due to the strong connection

104. Morison, *The Founding of Harvard College*, 374.

105. Morison, *The Founding of Harvard College*, 350.

106. Abram C. Van Engen. *Sympathetic Puritans: Calvinist Fellow Feeling in Early New England*. (Oxford: Oxford University Press, 2015), 41, 50.

107. Francis J. Bremer. *The Puritan Experiment: New England Society from Bradford to Edwards*. (Lebanon: University Press of New England, 1995), 104.

108. Bremer, *The Puritan Experiment: New England Society from Bradford to Edwards*, 104-105.

109. Bremer, *The Puritan Experiment: New England Society from Bradford to Edwards*, 103-105.

110. Bremer, *The Puritan Experiment: New England Society from Bradford to Edwards*, 103-105.

111. Bremer, *The Puritan Experiment: New England Society from Bradford to Edwards*, 103-105.

112. Bremer, *The Puritan Experiment: New England Society from Bradford to Edwards*, 18.

113. Elizabeth Patton. "The Excellency of Theology: A Critique of Robert K. Merton's 'Puritan Thesis.'" with Reference to the Works of Robert Boyle," *Journal of Faith and Science Exchange*, (2012), 17.

between their religious and astrological beliefs.[114] Astronomy was often written about in the astronomical almanacs produced by the Puritans, which featured the latest astronomical research by colonial scholars.[115] In light of this, it is important to note that the idea behind these astronomical almanacs actually comes from Claudius Ptolemy.[116] Evidence of this comes from the year 150 A.D., when Ptolemy made a catalogue of the stars, tracking their movements in records, which would create the basis for which the colonial almanacs would be structured.[117] Now, these almanacs were fixated on religious matters until about the 18th century, when the amount of religiosity in them started to shrink.[118] Also, these 17th century almanacs were usually produced by Harvard graduates.[119] In fact, 41 out of 44 almanacs produced prior to 1687 were written by Harvard graduates.[120] Harvard University was founded by the Puritans in 1636 as a religious institution.[121] At Harvard University in the 17th century, there were only a few textbooks on astronomy, which came from the private collections of John Winthrop the Younger and the family of Cotton Mather.[122] John Winthrop the Younger is considered by Colonial American scholars to have been the first American astronomer and scientist who would help lay the foundation of American astronomy.[123] Following in the footsteps of Winthrop, there were Colonial Americans who were making an impact in astronomy on the global stage. One noteworthy example was Colonial American scholar Thomas Brattle, who contributed to Isaac Newton's research on gravity via his research on the elliptical orbit of the comet of 1680.[124] He was not the only Colonial American with a connection to Isaac Newton though. Colonial American astronomer Arthur Storer was even friends with Newton and regularly exchanged letters regarding astronomy with him.[125]

Upcoming, I will analyze the influence of the Ptolemaic tradition on the Puritans. I will do this by focusing on the thriving beliefs in astrology and the Geocentric theory in Colonial America. As stated previously, these two fields must be grouped together because from even before the time of Ptolemy to the beginning of Colonial America, astrology and astronomy were inseparable. As scholar Robert R. Newton argues "In Greek civilization, and also in European civilizations until about the time of the Renaissance, little distinction was made between astrology and astronomy. When a distinction was made, we can see in the very names which subject was considered more important: astrology means the science of the stars whereas astronomy means merely their arrangement."[126] Because of this, when the Colonial Americans inherited the Ptolemaic tradition, they not only inherited its astronomy, but also its astrology. Now, starting with astrology, it is

114. F. E. Brasch. "John Winthrop (1714-1779), America's First Astronomer, and the Science of His Period." *Publications of the Astronomical Society of the Pacific*, Vol. 28, No. 165 (1916), 154. http://adsabs.harvard.edu/full/1916PASP...28..153B.

115. Samuel Eliot Morison. "The Harvard School of Astronomy in the 17th Century." *The New England Quarterly*, Vol. 7, No. 1 (1934), 16.

116. Charles L. Nichols "Notes on the Almanacs of Massachusetts." *Almanacs of Massachusetts*, (1912), 15. http://www.americanantiquarian.org/proceedings/45647891.pdf.

117. Nichols "Notes on the Almanacs of Massachusetts." *Almanacs of Massachusetts*, 15.

118. Nichols "Notes on the Almanacs of Massachusetts." *Almanacs of Massachusetts*, 17.

119. Donald K. Yeomans "The Origin of North American Astronomy—Seventeenth Century." *Isis*, Vol. 68, No. 3 (1977), 423. http://www.jstor.org/stable/231317.

120. Nichols "Notes on the Almanacs of Massachusetts." *Almanacs of Massachusetts*, 18.

121. Brasch. "John Winthrop (1714-1779), America's First Astronomer, and the Science of His Period.", 154.

122. Yeomans "The Origin of North American Astronomy—Seventeenth Century.", 422.

123. Brasch. "John Winthrop (1714-1779), America's First Astronomer, and the Science of His Period.", 154, 170.

124. F. E. Brasch. "The Isaac Newton Collection." *Publications of the Astronomical Society of the Pacific*, Vol. 74, No. 440 (1962), 388. http://adsbit.harvard.edu//full/1962PASP...74..366B/0000368.000.html.

125. Roberta J.M. Olson and Jay M. Pasachoff. *Fire in the Sky: Comets and Meteors, the Decisive Centuries, in British Art and Science*. Cambridge: Cambridge University Press, 1998), 26.

126. Newton, "Astronomy, Astrology, Ptolemy, and US.", 77.

important to understand why Colonial Americans developed these beliefs from the Ptolemaic tradition. In the Colonial American almanacs, scholars always detailed the monthly celestial events of each year and their correlations with astrology. On top of this, these almanacs also contained various essays on astronomy and astrology. For a notable number of Colonial Americans, but not all, astrology was taken quite seriously. For example, an author of some of the colonial almanacs by the name of Samuel Danforth believed the following about comets: "Most commonly they are observed to precede if not portend great calamities."[127] This was a very common theme for astrological supporters throughout history going back to the ancient world and the idea of comets representing pending disasters was popular among the colonists. Another Colonial American by the name of Increase Mather who was a Puritan minister, believed that comets were God's warnings to the sinners of Earth and a sign that those who have sinned must repent or prepare for disaster. Mather took this so seriously his grave warnings were commonly incorporated into his sermons.[128] He also wrote a book about astrology and comets in 1683 in a book titled *Kometographia*, where he argued about how comets symbolized God's anger.[129]

Despite this though, he denied that astrological predictions based on celestial events were legitimate, even though he was still superstitious about them.[130] Mather explains his theory of astrology in the following statement from his book *Kometographia* "There are those who think, that inasmuch as comets may be supposed to proceed from natural causes there is no speaking voice of heaven in them, beyond what is to be said of all other works of God. But certain it is, that many things which may happen according to the course of nature, are portentous signs of divine anger...Thunder, Lightning, Hail, and Rain, are from natural causes, yet are they sometimes signs of God's holy displeasure." [131] In turn, for the Puritans, like the ancient Greeks and Greco-Romans nature represented God or the Gods.

When it comes to the colonial non-believers of astrology, they reacted quite differently to the field of astrology. For instance, though astrology was written about in the almanacs, it was consistently criticized in them as well. As early as 1653, Harvard University condemned astrology as false. By 1690 Harvard had less influence on the almanacs and more astrology began to appear in them. To illustrate this, colonist John Holwell wrote astrological predictions in the almanacs from 1689 to 1700.[132] Nonetheless, astrology was still on its way out among the educated, as explained by Colonial American scholar Charles Morton in 1687 in his textbook on astronomy titled *Compendium Physicae*, where he states "The End of Comets hath been Guessed by their supposed effects; to prognosticate some Great evills to Some particular Country; So that they have stricken Great terror into the Vulgar; But [wiser] men see no satisfactory reasons for these Supposed Omens. They see that which is Said in this business is Grounded on [44] falsehood, (or at least [uncertainty]) Namely that they are inflamed matter and that their smoke and Ashes pollute the Air."[133] It should also be noted that in the 17th century students and scholars at Harvard had access to the following works as well:

127. Yeomans "The Origin of North American Astronomy—Seventeenth Century.", 419.

128. Yeomans "The Origin of North American Astronomy—Seventeenth Century.", 419.

129. Clark A. Elliot. *Science at Harvard University: Historical Perspectives*. (Bethlehem: Lehigh University Press, 1992), 34.

130. Yeomans "The Origin of North American Astronomy—Seventeenth Century.", 421.

131. Increase Mather. *Kometographia. Or A discourse concerning comets; wherein the nature of blazing stars is enquired into: with an historical account of all the comets which have appeared from the beginning of the world unto this present year, M.DC.LXXXIII. : Expressing the place in the heavens, where they were seen, their motion, forms, duration; and the remarkable events which have followed in the world, so far as thay have been by learned men observed. : As also two sermons occasioned by the late blazing stars*. (Boston: S.G., 1683), 18. https://quod.lib.umich.edu/e/evans/N00277.0001.001?view=toc.

132. Yeomans "The Origin of North American Astronomy—Seventeenth Century.", 421.

133. Charles Morton. *Compendium Physicae*. (Boston: Colonial Society of Massachusetts, 1940), 93. https://www.colonialsociety.org/node/526.

Usefulness of Experimental Natural Philosophy (1663) by Robert Boyle and *Astronomia Instaurata* (1656) by Vincent Wing and Adrian Heereboord's *Parallelismus Aristoteliscae et Cartesianae Philosophiae Naturalis* (1643). These works would provide the research of the great scholars around the world like Descartes, Galileo, Gassendi, Kepler, Newton, and Halley.[134] [135] Nonetheless, Colonial American astrology would start to fade away, after the Copernican tradition became ingrained in society.[136] Based on my research it is not clear why it lasted so long in society, but colonial leaders very much wanted to get rid of it.[137] Perhaps the reason why it lasted so long though was because of the idea of predestination in Puritan society, since astrology gave people the ability to see into the future, it empowered them to prepare for what was yet to come. Overall, however, when it comes to the origins of Colonial American astrology, there is a connection to Ptolemy, because Ptolemaic tradition provided the inseparable fields of astrology and astronomy to the Western world and thus astrological ideas like genetic traits were culturally passed down to the Colonial Americans.

Moving on from astrology in Colonial America, we turn to the Colonial American belief in the Geocentric theory by Ptolemy. From its founding, Harvard University was teaching the Ptolemaic tradition. As a matter of fact, the first president of Harvard University, Henry Dunster, in 1640 was teaching the Ptolemaic tradition and Aristotelian natural philosophy from a book by Johannes Magirus. A German physics professor, his work was titled *Physiologia peripatetica*.[138] [139] Magirus' work, which was first published in 1597, was very popular at Cambridge University in the 17th century.[140] In his work, he talked about various astronomical subjects including: the planets, fixed stars, eclipses, and comets, based on the Ptolemaic tradition.[141] All these things were important to the astronomical studies of the Colonial Americans. Magirus also stressed the need to study nature and the universe to truly understand God.[142] This was the mentality that the Puritans especially embraced in the theological underpinnings of their astronomy. Harvard University would continue teaching from this book until 1671.[143] In addition, in the colonial almanacs as late as 1656 there were still Pro-Ptolemaic astronomy essays being written. For example, Thomas Shepards' essay in the almanac of 1656 titled "A Brief Explication of the most Observable Circles in the Heavens."[144]

In the early days at Harvard University, the first generation of students adopted the teachings of the Ptolemaic tradition without protest.[145] The reason for the Colonial Americans' unquestioned embrace of the Ptolemaic tradition, stems from the inability of

134. Perry Miller and Thomas H. Johnson. *The Puritans: A Source Book of Their Writings.* (New York: HarperCollins, 1963), 733.

135. Louis B. Wright. *The Cultural Life of the American Colonies*. (Mineola: Dover Publications, Inc., 2002), 220.

136. Nichols "Notes on the Almanacs of Massachusetts." *Almanacs of Massachusetts*, 20.

137. Butler, Jon. "Magic, Astrology, and the Early American Religious Heritage, 1600-1760," *The American Historical Review*, Vol. 84, No. 2 (1979), 339. http://www.jstor.org.proxy.uba.uva.nl:2048/stable/1855136.

138. Yeomans "The Origin of North American Astronomy—Seventeenth Century.", 415.

139. Rutkin, Darrel H. "Astrology," in *The Cambridge History of Science, Volume 3: Early Modern Science* edited by Katharine Park and Lorraine Daston. (Cambridge: Cambridge University Press, 2006), 555.

140. Katherine Neal. *From Discrete to Continuous: The Broadening of Number Concepts in Early Modern England*. (Berlin: Springer Science + Business Media, 2002), 12.

141. Alan Gabbey. "Newton, active powers, and the mechanical philosophy." in *The Cambridge Companion to Newton*. edited by Rob Iliffe and George E. Smith. (Cambridge: Cambridge University Press, 2016), 423.

142. Terhi Kiiskinen. "The natural philosophy of Sigfrid Aronus Forsius: between the created world and God." in *Medicine, Natural Philosophy and Religion in Post-Reformation Scandinavia*. Edited by Ole Grell and Andrew Cunningham. (London: Routledge, 2017), 157.

143. Wright, *The Cultural Life of the American Colonies*, 220.

144. Erwin V. Johanningmeier *Americans and Their Schools*. (Long Grove: Waveland Pr Inc, 1985), 14.

145 Morison, "The Harvard School of Astronomy in the 17th Century.", 3.

scholars to see the stellar parallax, meaning Colonial Americans in support of the Ptolemaic tradition were unable to see the differences in the stars, when viewing them from different positions. This is because they did not possess the technology to view the deviations of the stars. As scholar Rose Lockwood states in her article "The Scientific Revolution in Seventeenth Century New England," "The absence of any perceptible parallax in the stars was used early as an argument against the Copernican system, for if the Earth were in fact moving, then according to the critics, the stars should change in their relationship with one another. To evade this criticism, Copernicus had been forced to place the sphere of the fixed stars at such a great distance from the Earth that the shifting relationships would be imperceptible."[146] In turn, as scholar Louis B. Wright points out in his book *The Cultural Life of the American Colonies* "Many learned men of the seventeenth century, in the colonies as elsewhere, lived and died in Ptolemaic orthodoxy."[147] This anti-Copernican mindset would not dominate the colonies for too much longer though and it is due to the Puritans' outlook that the sciences contributed to their theology.

IV: The Shift Towards the Copernican Tradition

The Copernican tradition came to replace the Ptolemaic tradition. This would occur due to three major factors: The Puritans' religious openness to new scientific ideas, the use of Greek intellectual thought by the Puritans, and the scientific aid given by England. To start, I will focus on the scientific thought behind this shift towards Copernicus and the debates that were being held. For example, the role of important ideas regarding logic and mathematics was central. Before adopting the Copernican tradition, Colonial Americans in academia had already set the stage for this transition. Despite embracing the Ptolemaic tradition, the Colonial Americans stilled gazed at the heavens above to learn more about them.[148] As a result, as the scientific revolution occurred, the Colonial Americans did not isolate themselves.[149] In fact, the Puritans would do the exact opposite. In fact, several Puritans became members of England's top scientific group, the Royal Society, and in 1683 Puritans even created their own scientific organization called the "Philosophical Society."[150]

This movement all began in the New England almanac of 1659 by Zechariah Brigden who made the following statement, which would change Colonial America forever: "In the lowest room of the world is placed the sun, which challengeth to it itself a central motion…which is evidenced by the admirable invention of the telescope…After Venus is placed y Earth, which befides her diurnal revolution in 24 houres, hath an anual periodical through y ecliptique performed in 365 dates...that this is the true & genuine system of the world."[151] Therefore, he asserted that the sun is at the center of the universe and that the Earth revolves around it. Because of this daring essay the freedom of thought would be tested early in Colonial America. Naturally, such an essay would most certainly catch the attention of the Puritan church leaders. As mentioned earlier, however, the church was open to the ideas of Brigden, in turn leaving room for Colonial

146. Rose Lockwood. "The Scientific Revolution in Seventeenth-Century New England." *The New England Quarterly*, Vol. 53, No. 1 (1980), 89. http://www.jstor.org/stable/365290.

147. Wright, *The Cultural Life of the American Colonies*, 220.

148. Milton Sernett. *Portent and Providence- An Investigation of the Puritan Habit of Deciphering the Will of God in the Natural and the Preternatural with Special Reference to "The Scarlet Letter" by Nathaniel Hawthorne*. (Saint Louis: Concordia Seminary, 1967), 18.

149. Sernett. *Portent and Providence- An Investigation of the Puritan Habit of Deciphering the Will of God in the Natural and the Preternatural with Special Reference to "The Scarlet Letter" by Nathaniel Hawthorne*, 18.

150. Sernett. *Portent and Providence- An Investigation of the Puritan Habit of Deciphering the Will of God in the Natural and the Preternatural with Special Reference to "The Scarlet Letter" by Nathaniel Hawthorne*, 18.

151 Zechariah Brigden. *An Almanack of Coelestial Motion for this Present Year of the Christian Era 1659*. (Cambridge: S. Green, 1659), 14. https://catalog.hathitrust.org/ Record/010586548?type%5B%5D=all&lookfor%5B%5D=Zechariah%20Brigden&ft=.

American science to grow.

Next, Brigden's almanac was then followed by other Pro-Copernican almanacs like *An almanack for the year of our Lord 1661* by Samuel Cheever, Cheever also came out in support of the Copernican tradition arguing "The ancient opinion of the Earth's motion...is quite rejected...Copernicus now appeares, and allowing the Earth her diurnall and anuall motion, cleares up by infallible geometricall demonstrations that all motions are performed about the Sun the undoubted center of y Planetary Orbs....Whereupon in this age, Galileus, Bullialdus, Keplerus, Gassendus, and fundry other mathematicians, have learnedly cortuted the Ptolemaick & Tychonick systeme, and demonstrated the Copernican Hypothesis to be most confentneous to truth and ocular observations."[152] This was a huge development for Colonial America, because a trend started to occur, where year after year the Copernican tradition was being favored in the local almanac in New England.

In 1671, the shift towards Copernicus would continue, as the work of Johannes Magirus would be removed from the Harvard University curriculum, due to a supposed student protest against a requirement to study the Ptolemaic tradition. In response, Harvard University replaced Magirus' work with Adrian Heerboor's *Parallelismus Aristoteliscae et Cartesianae Philosophiae Naturalis* written in 1643, which was in favor of the Copernican tradition.[153] This would also lead to dramatic changes to the New England almanacs, which would no longer give any type of support to the Ptolemaic tradition. Evidence of this comes from Colonial American scholar John Foster and his almanac called *An Almanack of Coelestial Motion for this Present Year of the Christian Era*, where he states "The Ptolemaick Hypothesis having for many centuryes of years been the basis of astronomical calculations, is now in this latter age of the world by astronomers wholly rejected. Who have found out a way by far more plausible for the salving of the wonderful variety of motions and appearances among the planets, they being now generally of opinion (how strange forever it may seem) that the Earth moves and that the sun stands still."[154] This is fascinating, because only about 16 years after Brigden's essay, the Ptolemaic tradition died among the scholarly community in New England.

Another example, of this movement towards Copernicus comes from Charles Morton, who states "What is said may suffice to Shew that the old doctrine of the heavens was imperfect, and that this latter seams more probable, and better suted to other things in nature, we shall have occasion to speak of hereafter this recommends itself to our acceptance as the most artificial for that it is the most Simple, and intelligible, and free from the other Intricacies as may be seen in the diagram. Absurd and intricate the old is yet, Tichoes imperfect, the Other is compleat."[155] In his 1687 Harvard textbook Morton wrote *Compendium Physicae*, declaring the Copernican tradition to be the only complete astronomical model, whereas the Ptolemaic tradition and others are not.

This was incredibly important to the scientific revolution in Colonial America, because the almanacs were the most widely spread literature in the colony. Now, one should also point out that this shift was more in the academic community, rather than the general public, because most of the public was not educated enough to understand essays in the almanacs. However, because Harvard University would sponsor the new astronomy as truth and something that is in line with the Bible as well, the Copernican tradition developed great authority among the church and its members in the colony.[156] It also helped that scientists all around Europe and Colonial America were making discoveries, which helped cement the new astronomical theory in Western science. As scholar J. Rixey Ruffin

152. Samuel Cheever. *An almanack for the year of our Lord 1661*. (Cambridge: S.G. and M.I., 1661), 15. https://catalog.hathitrust.org/Record/010586540.

153. Wright, *The Cultural Life of the American Colonies*, 220.

154. John Foster. *An Almanack of Coelestial Motion for this Present Year of the Christian Era*. (Cambridge: S. Green, 1675), 14.

155. Morton, *Compendium Physicae*, 24.

156. Morison, "The Harvard School of Astronomy in the 17th Century.", 16.

points out, "As discoveries proceeding from the New Science multiplied, acceptance of heliocentrism was increasingly inevitable. Astronomers had grappled with a host of questions about celestial bodies, distances, and forces since Copernicus had first advanced his theory. By 1700, many of those questions had been answered."[157] This was made possible by the use of tools like the telescope, which helped scholars better amass evidence for heliocentric ideas.[158] Thus, among the scholarly community in the West, the Copernican tradition had prevailed.

Despite this strong push towards Copernicus, the general public still was not completely convinced of the Copernican tradition. For example, in 1713 some were still advocating for the Ptolemaic tradition, including Colonial American Daniel Leeds.[159] In 1714, when Puritan Minister Cotton Mather had stated in a sermon that the Copernican tradition was correct, a church member named Samuel Sewall commented "I think it inconvenient to assert such problems", ergo insinuating that such statements were inappropriate.[160] Also in 1722, a Colonial American by the name of Nathaniel Bowen argued that the Earth was the center of the universe.[161] Because of these developments, in 1723, some Copernican scholars expressed their remorse that the Copernican tradition had not yet become fully recognized by the public.[162] These attacks on the Copernican tradition would not go unanswered by the Pro-Copernican scholars and many would respond to the Pro-Ptolemaic remarks through essays.

For example, scholars like Thomas Fleet in 1720 or the anonymous writer, B.A. Philo-Astro, responded to criticism of the Copernican system. B.A. Philo-Astro especially played an important role in rebuking these anti-Copernican attacks and was quite a thoughtful writer with deep insight into the perspectives of Colonial America. One particular instance revealing this was his response to Nathaniel Bowen, in which B.A. Philo-Astro pleaded with the public not to condemn ideas that do not conform to their preconceived notions.[163] As Philo-Astro himself claimed in regard to the almanac he wrote in 1723, his almanac was meant for the "unlearned" in hopes that they could "know the general Opinion of the Learned World."[164] Also attempting to protect the Copernican tradition, you had Colonial Americans like Nathaniel Ames, who claimed the new Copernican astronomy was proven by mathematics stating, "Mathematical principles are far above the capacity of the generality of men."[165] Ames also took on the scriptural resistance towards the Copernican tradition, because many had interpreted the Bible to be based on the Ptolemaic tradition. For example, the passages from the Bible like Ecclesiastes 1:4-5, which has lines which say "the Earth abideth forever", "the sun also ariseth, and the sun goeth down, and hasteth to his place where he arose" or in Psalm 93, which says "the Earth also is established, that it can- not be moved."[166] These lines were used in an attempt to take away the legitimacy of the Copernican tradition. In response, Ames would argue against these passages deeming them to be metaphorical. Earlier we saw Brigden also take on this problem arguing that the Bible was subject to interpretation.

Another cause of the public backlash towards Copernican astronomy was the rapid pace at which

157. J. Rixey Ruffin. "'Urania's Dusky Vails': Heliocentrism in Colonial Almanacs, 1700 1735." *The New England Quarterly*, Vol. 70, No. 2 (1997), 311. http://www.jstor.org/stable/366705.

158. Lockwood. "The Scientific Revolution in Seventeenth-Century New England.", 81-82.

159. J. Rixey Ruffin. "'Urania's Dusky Vails': Heliocentrism in Colonial Almanacs, 1700 1735.", 308-309.

160. Morison, "The Harvard School of Astronomy in the 17th Century.", 7.

161. J. Rixey Ruffin. "'Urania's Dusky Vails': Heliocentrism in Colonial Almanacs, 1700 1735.", 308-309.

162. J. Rixey Ruffin. "'Urania's Dusky Vails': Heliocentrism in Colonial Almanacs, 1700 1735.", 309.

163. J. Rixey Ruffin. "'Urania's Dusky Vails': Heliocentrism in Colonial Almanacs, 1700 1735.", 310.

164. Thomas A. Horrocks. *Popular Print and Popular Medicine: Almanacs and Health Advice in Early America*. (Amherst: University of Massachusetts Press, 2008), 5.

165. J. Rixey Ruffin. "'Urania's Dusky Vails': Heliocentrism in Colonial Almanacs, 1700 1735.", 309.

166. J. Rixey Ruffin. "'Urania's Dusky Vails': Heliocentrism in Colonial Almanacs, 1700 1735.", 311.

new scientific developments were occurring and the fact that new questions, which were once considered unthinkable, suddenly became a part of the academic discourse and this ultimately spooked the public. For example, ideas such as an infinite universe and countless inhabitable worlds beyond Earth, all arose from the logical implications of Copernican analysis.[167] This is because people could no longer complacently think of Earth as being special, but rather had to grapple with the idea that Earth was potentially part of something larger and was itself no longer unique.

Therefore, the Copernican tradition did not fully become accepted by the non-academic public until after 1720. According to Ruffin, most ideas about the Copernican tradition previous to this were rejected by the non-Harvard community.[168] This was because heliocentric theory did not start to become adopted by Colonial scholars until after Brigden's essay in 1659 and after 1675 the Colonial almanacs faced competition from other almanacs and had to compete for the public's attention. In fact, by the end of the 17th century Harvard University sponsored almanacs would stop being published, due to this increase in competition with other almanac makers.[169]

Moving on, these Puritans intellectuals were the first of the Colonial Americans to apply Greek scientific traditions of reason and mathematics to the world around them, setting the foundations for what would become American astronomy. This is reiterated by Milton Sernett in this quote: "Far from disdaining intellectual pursuits, the Puritans were the earliest of Americans to apply reason to the world about them. American science owes much to the men who gathered around the 'optic tube' at Harvard in those early days. Yet in spite of their many associations with the scientific revolution in England and on the Continent and in spite of their own discoveries in the laboratory of Nature, the greatest Puritan thinkers never dared to question the fundamental theological maxim that God revealed his providence in the portents about them."[170] It was also the fact that like Copernicus, Colonial Americans through the use of reason and mathematics realized the discrepancies in the Ptolemaic tradition. Much like Copernicus, for example, they realized that the mathematics of Ptolemy did not fit the physical system of Aristotle. As a result, due to their piety these Colonial Americans felt the need to re-explain the true nature of the universe.[171] Thus, without the scientific inquiry of the Colonial Americans. American science would not become the powerhouse it is today.

Next, we will examine Puritan religion and its cohesion with the pursuit of science. To start, the scholar Jon H. Roberts in his chapter "Science and Christianity in America: A Limited Partnership" in the book *American Christianities: A History of Dominance and Diversity*, offers a very thought-provoking quote, which says "The conviction that the creation attested to its creator prompted some Puritans to play an active role in appropriating and disseminating knowledge gleaned from natural philosophy."[172] This is where the Puritan shift towards the ideas of Copernicus begins, with this Puritan openness to the Greek practice of natural philosophy. This can be seen in the memoirs of the first president of Harvard, Henry Dunster, who was also an educator there. In his memoirs from 1654, Dunster describes the requirements of the education at Harvard University to obtain a degree, stating "Every scholar that on proof is found able to read the original of the Old and New Testament into the Latin tongue, and to resolve them logically, and is instructed

167. J. Rixey Ruffin. "'Urania's Dusky Vails': Heliocentrism in Colonial Almanacs, 1700 1735.", 313.

168. J. Rixey Ruffin. "'Urania's Dusky Vails': Heliocentrism in Colonial Almanacs, 1700 1735.", 313.

169. J. Rixey Ruffin. "'Urania's Dusky Vails': Heliocentrism in Colonial Almanacs, 1700 1735.", 307.

170. Sernett. *Portent and Providence- An Investigation of the Puritan Habit of Deciphering the Will of God in the Natural and the Preternatural with Special Reference to "The Scarlet Letter"* by Nathaniel Hawthorne, 74.

171. Lockwood. "The Scientific Revolution in Seventeenth-Century New England.", 79.

172. Jon H. Roberts. "Science and Christianity in America: A Limited Partnership." in *American Christianities: A History of Dominance and Diversity* edited by Catherine A. Brekus and W. Clark Gilpin. (Chapel Hill: University of North Carolina, 2011), 328.

in the principles of natural and moral philosophy, withal being of honest life and conversation, and at any Public Act hath the approbation of the Overseers and President of the College, may be invested with his first degree: but none shall expect it until he hath been four whole years in the College, in which he hath lived blameless, and hath faithfully performed all public exercises."[173] Also at Harvard, students had to be well trained in the field of mathematics, mastering the subjects of arithmetic, geometry, and astronomy.[174]

Thus, the Puritans, as they began to develop more as a society, began to explore the field of astronomy more and more in honor of their faith. This is somewhat surprising given our twenty-first century perspective, which tends to assume that intensely religious societies tend to ignore or reject scientific inquiry. But for the Puritans, much like the ancient Greeks, their religious beliefs only increased their thirst for astronomical knowledge. This can be seen in a quote by scholar Milton Sernett in his article "Portent and Providence- An Investigation of the Puritan Habit of Deciphering the Will of God in the Natural and the Preternatural with Special Reference to "The Scarlet Letter" by Nathaniel Hawthorne", where Sernett argues "The 'warfare between science and theology' found no battleground in New England, where the clergy were leaders in liberalism and enlightenment, purveyors of new learning to the people."[175] This was not a problem when the Puritans were in England as well.[176] This was especially surprising, given the fact that Puritan science had to be able to navigate the biblical minefield that is the belief in a literal interpretation of the Bible, to which they subscribed wholeheartedly. For example, Colonial American scholar John Foster, who as mentioned earlier was a supporter of the Copernican tradition, attempted to fight off objections based on biblical scripture. This was a challenging task, because as he himself stated, the Bible had "infallible authority."[177] This is one of the most amazing things about the Puritans because you have these people who possess a persona that is incredibly rigid and pious and yet, these strict religious leaders are not taking a stand against science, but are rather for it. For them science is not an enemy, but instead a tool of God. This is also the view Claudius Ptolemy had about the relationship between science and theology. For instance, in the *Almagest*, when speaking of mathematics, which, thanks to him became the foundation of science in the West, he says, "For this is the best science to help theology…With regard to virtuous conduct in practical actions and character, this science, above all things, could make men see clearly; from the constancy, order, symmetry and calm which are associated with the divine, it makes its followers lovers of this divine beauty, accustoming them and reforming their natures, as it were, to a similar spiritual state."[178]

Interestingly enough, Colonial Americans had a very similar view of the field of mathematics as well, as described by Colonial American scholar Thomas Brattle. A professor of mathematics and astronomy at Harvard University, he characterized mathematics as, "The most true doctrine and discipline."[179] Because of this, modern day scholars like Lockwood argue "The scientific revolution was grounded in a mystical notion that God is a great geometer, and that mathematics is a revelation of God's intricately rational plan."[180] Therefore, Ptolemy and the Colonial Americans seem to have had quite a bit in common, when it came to

173. Henry Dunster. *President Dunster's Quadriennium Memoir*. (Cambridge: Harvard University Archives, 1654), 291. https://www.colonialsociety.org/node/411#ch04.

174. Elliot, *Science at Harvard University: Historical Perspectives*, 29.

175. Sernett. *Portent and Providence- An Investigation of the Puritan Habit of Deciphering the Will of God in the Natural and the Preternatural with Special Reference to "The Scarlet Letter"* by Nathaniel Hawthorne, 19.

176. Bremer, *The Puritan Experiment: New England Society from Bradford to Edwards*, 196.

177. Foster, *An Almanack of Coelestial Motion for this Present Year of the Christian Era*, 14.

178. Ptolemy, *Ptolemy's Almagest*, 36-37.

179. Rick Kennedy. "Thomas Brattle and the Scientific Provincialism of New England, 1680-1713." The New England Quarterly, Vol. 63, No. 4 (1990), 597-599. http://www.jstor.org/stable/365919.

180. Lockwood. "The Scientific Revolution in Seventeenth-Century New England.", 80.

their view of mathematics. It should also be noted that scholars in Europe like Galileo had also come up with this philosophy, but the origins of this concept started with Ptolemy.

Another important development of Puritan theology, which helped them transition towards the Copernican tradition, was their belief that their minds were part of God's creation. Therefore, their mind was competent enough to build an understanding of God's creation. This theological perspective would prevent an outlook that might deem science a useless field, due to the potentially detrimental anti-scientific belief that God's universe is unknowable. In turn, this made new ideas easier to accept, when discovered.[181] At the same time though, the advancement of science also began to shake up Puritan theology in unprecedented ways, because it opened up all previous knowledge of the universe to questioning and skepticism. This questioning even made Puritans uncomfortable, for example, as Rose Lockwood states, "These theories had devastating implications for the theology of the Creation. As the relationship between the new science and Puritan theology became apparent to New England astronomers, the confusion in their theories seemed to increase. Thus, when they came to consider the possibility of an indefinitely extended, or even infinite, universe, their close association of God with the created universe introduced the unnerving possibility of the eternity of the world."[182] Consequently, just as many societies have had to reconcile conflicting ideas, the Puritans too had to figure out how to preserve their theology, in light of seemingly contradictory scientific evidence. This will be touched upon more later in the chapter.

One of the best pieces of evidence portraying this revolution of theological thought came from the progressive Puritan scholar Zechariah Brigden, who makes a shocking claim for a Puritan in the following quote "The Scriptures being fitted as well to the capacity of the rudest mechanick, as of the blest Philosopher, do not intend so much propriety and exactness, as playness and perspicuity; and in Philosophicall truths therin contayned, the proper literal sense is alwayes subservient to the casting vote of reason."[183] This is unchartered territory for a Puritan, because here Brigden has challenged the religious status quo arguing that reason should determine the literal meaning of scripture, which represents a striking contrast to the statement made by Foster that I mentioned earlier. Lockwood claims, "New England compilers attempted to reconcile biblical cosmology with their interest in the new astronomy by arguing that the language of the Bible was more "suggestive" than literal."[184] Brigden though, does not stop there. He takes his critique of the Bible one step further, claiming, "The most seemingly contradicting Scripture is Psalm: 104. He hath founded the Earth; upon its Basis, that it should not be removed forever. But 1. Place is sometimes taken for the same with order, and in this sense the Earth doth not change its place, or is not removed. Or 2. The Basis of a figure, is that whereon it rests, answerable to which in the Earth is its center, on which the Earth is so founded, that it cannot suffer a total dissipation."[185] In turn, Brigden is arguing that the Bible is also subject to interpretation. This is a very clever strategy, because it turns what could be very controversial passages of the Bible into a matter of misunderstanding, rather than an attack on the Bible itself. This is important to note, because Puritans, who were protestants of course, were fully entitled to analyze and read the Bible which was deemed accessible to all. This is in contrast to Catholic views of the era, according to which only the church leaders had the intellectual authority to interpret scripture. In contrast, the Puritan communities were completely open to scriptural debate as a fundamental right of all who could read.

181. Lockwood. "The Scientific Revolution in Seventeenth-Century New England.", 80.

182. Lockwood. "The Scientific Revolution in Seventeenth-Century New England.", 89.

183. Brigden, *An Almanack of Coelestial Motion for this Present Year of the Christian Era 1659*, 15.

184. Lockwood. "The Scientific Revolution in Seventeenth-Century New England.", 79.

185. Brigden, *An Almanack of Coelestial Motion for this Present Year of the Christian Era 1659*, 15.

Brigden's role, though, in Colonial America does not stop there. He was also the first one to set the stage for the astronomical movement towards the Copernican tradition. Because in the New England Almanac of 1659, Brigden becomes the first Colonial American to support the Copernican tradition. One of Brigden's major sources for this almanac was the work *Astronomia Instaurata* by English astronomer Vincent Wing. Wing's book was possibly the first book to bring the discoveries of Copernicus, Galileo, and Kepler to English readers.[186] As a result of Wing's work, Brigden in his essay in the almanac of 1659 challenged Colonial American assumptions about astronomy and scripture, arguing in favor of the Copernican tradition and a common sense understanding of the Bible, where reason serves as the guide to understanding, as mentioned in the quotes above. Thus, one wonders how the Colonial Americans reacted to such a shocking essay? As a matter of fact, Brigden's essay was welcomed. Evidence of this comes from a letter exchange between the Colonial American scholar John Winthrop the Younger and Puritan clergyman John Davenport, who I mentioned earlier as a very conservative fellow. In the letter, John Winthrop the Younger was asking Davenport what he thought of Brigden's essay. Davenport then had this to say "The Almanack, which I had not seene before...The Author of it is wholly unknowne to me, save by his name in the title page…For he saith, Twice shall this planet, whereon we live and its concomitant the moone, widdow each other of theyre sunederived lustre. Now, the place, whereon we live, is the Earth The place, I say, not the planet. But he is not willing solus sapere. Therefore for his 4 proposicions he produceth, in his last page, sundry authors, who, he saith, have answered the objections from scripture against this opinion. I have not read theyre answers. But, if that be the breife or summe of them, which he notes, it will not be found, upon an exact search, to be satisfying. However it be; let him injoy his opinion; and I shall rest in what I have learned, til more cogent arguments be produced then I have hitherto met with."[187] This was quite a tolerant reaction given Davenport's extremely religious background and his history of disagreeing with things he saw as impious. If the Puritan church would have had a different reaction to Brigden, who appears to not have been an authoritative figure in the community, who knows what could have happened. Brigden could have even been excommunicated.[188]

Luckily for Brigden he wasn't and that is one of the incredible things about Colonial America. If people like Brigden were not given their voice, who knows how differently science would have developed in the colonies? As scholar Samuel Eliot Morison describes, "The reply of that worthy (March 18, 1659) is a delightful example of a tolerantly conservative attitude toward new theories…instead of opposing the acceptance of the Copernican theory, (Puritans) were the chief patrons and promoters of the new astronomy, and of other scientific discoveries, in New England."[189] Or as scholar Yeomans states, "Religious intolerance of Copernican astronomy dispersed by Colonial almanacs was practically nonexistent. Indeed, it was the Puritan clergy that most actively promoted science in the colonies during the seventeenth centuries."[190] As one can tell, the Puritans did very much have a Greek like view of the relations between God and scientific observation and how they connected. This should not be totally surprising though, when you consider the fact that the Puritans would study the Greek classics.[191] As a consequence of religious tolerance towards science, American astronomy would rapidly become top notch and among the best in the world, under Colonial America's successors.

186. Bessie Zaban Jones and Lyle Gifford Boyd. *The Harvard Observatory College: The First Four Directorships, 1839-1919*. (Cambridge: Harvard University Press, 1971), 3.

187. Morison, "The Harvard School of Astronomy in the 17th Century.", 13.

188. Morison, "The Harvard School of Astronomy in the 17th Century.", 13.

189. Morison, "The Harvard School of Astronomy in the 17th Century.", 12-13.

190. Yeomans "The Origin of North American Astronomy—Seventeenth Century.", 423.

191. David A. Lupher *Greeks, Romans, and Pilgrims: Classical Receptions in Early New England*. (Leiden: Brill, 2017), 2.

However, not all scholars see the Puritans as Pro-science and having religious beliefs that are open to free scientific thought. Take for example, scholar Milan Zafirovski who serves on the editorial board of the *American Journal of Economics and Sociology*, who in his work *The Protestant Ethic and the Spirit of Authoritarianism: Puritanism, Democracy, and Society* writes a scathing critique of the Puritans arguing "A specific and salient dimension or outcome of Puritanism's antiscientific as well as antiartistic authoritarianism is its adoption and use of science, knowledge, technology, and even the arts for essentially authoritarian and inhuman purposes. These aims range from domestic political and moral-religious authoritarian control and oppression, including totalitarian theocracy."[192] Zafirovski elaborates on his argument claiming, "In brief, for early US Puritanism, science or knowledge 'without emotional faith had no value.' Hence, for New England's Puritans there was no such thing as 'science for the sake of science.'… In short like medieval Catholicism, Puritanism seeks and succeeds to restrict science and knowledge 'to make room for faith.'"[193] Essentially, Zafirovski sees Puritans using science for power and control, not for the sake of science, but rather in support of theocratic rule. Finally, his most forceful attack on the Puritans, Zafirovski claims "And if not knowing the exact context, one may equally think that the above describes the well-known fascist, including Nazi, suppression, and manipulation of science, which confirms that Puritanism is the religious-theocratic substitute or proxy for fascism in this as well as other respects."[194]

In response to Zafirovski, his argument seems to oversimplify Puritan society. It is true that the Puritans were extremely religious, and he is correct to argue that Puritans studied science for reasons of faith. It is further true that Puritan society was theocratic and in many ways intolerant of deviation from acceptable behavior. However, Zafirovski overstates his "presentist" claim that Puritans restricted science because of their faith. In fact, as I described above the Puritans were in numerous instances quite tolerant of views that could even be seen as contradictions of scripture. As we saw with Zechariah Brigden's ground breaking essay in the colonial almanac of 1659, which challenged the status quo. Instead, reacting in condemnation of his work, as the Catholic Church did to Galileo, Davenport said that he would wait to see more arguments and that Brigden is welcome to his opinion. These colonial almanacs and the debates that took place in them represented an important feature of Puritan society. Thus, the reality of Puritan society does not fully square with Zafirovski's contention. The Puritan faith adapted to science, rather than stifling it based on claims of faith. In fact, it is reasonable to argue that Puritans were important to the advancement of science. Their study of the heavens and interest in publication demonstrated persuasively that it was possible for men of faith to embrace scientific attitudes. In a world dominated by religious believers of whatever stripe, it was important for science to find support from groups like the Puritans. As a whole, Zafirovski's line of thinking seems ahistorical.

His determination to paint the Puritans as comprehensively authoritarian, not to mention his comparison of the Puritans to the Nazis, suffers from a misunderstanding of history. As stated already in earlier chapters, there were in Puritan society elected officials, public discussions about policy, and as revealed by scientific debates significant freedom of thought. When analyzing past societies, it is important to examine them on their own terms, not in a way that is completely divorced from their reality based on our modern perceptions of how society should be. If we don't do this, one can lose track of the meaning of events in the environment in which they occurred. When it came to science, the Puritans of Colonial America were paragons of tolerance, far more reasonable than most of their contemporaries.

Finally, I shall describe the critical influence England

192. Milan Zafirovski. *The Protestant Ethic and the Spirit of Authoritarianism: Puritanism, Democracy, and Society*. (Berlin: Springer, 2007), 161.

193. Zafirovski, *The Protestant Ethic and the Spirit of Authoritarianism: Puritanism, Democracy, and Society*, 152, 163.

194. Zafirovski. *The Protestant Ethic and the Spirit of Authoritarianism: Puritanism, Democracy, and Society*, 287.

had on Colonial America in their astronomical work. A good example of the help Colonial America received from England was in 1672, when Harvard University received its first astronomical reflector telescope by the famous telescope maker James Short of London. This type of telescope uses mirrors to reflect light to form a clearer image and arrived in Colonial America thanks to John Winthrop the Younger, who, while on a trip to London to get a charter to the create Connecticut, had rekindled his relationships with English astronomers by helping them form the English Royal Society.[195] [196] The simple presence of a modern telescope in Colonial America is persuasive evidence of the thirst for discovery among the Puritans. Winthrop was also someone who was published by the Royal Society and received considerable praise.[197] As a result of Winthrop's journey, he brought back a telescope and gifted it to Harvard University.[198] Even when back in Colonial America, Winthrop was in contact with Isaac Newton and Johannes Kepler. In addition, Winthrop received scientific books and manuscripts from English scholar Samuel Hartlib, which would be contributed to the Harvard University library.[199]

These were not the only interactions between Colonial American astronomers and English astronomers though. As mentioned earlier, a few Colonial Americans contributed to the work of Isaac Newton. It was also the case that scholars like Thomas Brattle had worked with famous English scholars back in England, perhaps most notably Robert Boyle and John Flamsteed,[200] When he moved to America, he remained in touch with them and they both influenced Brattle and his astronomical research.[201] Scholar Rick Kennedy emphasizes this in the following quote: "In the process of recognizing Brattle's achievements, however, we should be careful not to de-emphasize the implications of New England's provinciality, a burden Brattle thought had limited his opportunities. That very provinciality, though, is also the key to Brattle's importance, since his statement of mathematical idealism provides the first explicit connection between England and New England of this fundamental tenet of the scientific revolution... An important link between the Old World and the New, Brattle directly imported the scientific ideas of Boyle and Flamsteed and taught them to interested students at Harvard, thus nurturing ideas that would bear fruit in subsequent generations."[202] Therefore, Brattle represents a prime example of the impact England had on Colonial America.

Harvard was founded based on the idea of following the English university traditions and attempted to replicate Cambridge and Oxford.[203] This also entailed adopting the English university curriculum.[204] It is hardly surprising that Colonial American scholars were wanting to replicate the English motherland by using them as a guide for scientific education.[205] Ergo, England had great influence over Colonial American astronomy and the research of English astronomers was commonly referenced.[206] In fact, England was so influential that the English Royal Society even sponsored Colonial American research. It wasn't until John Winthrop the Younger that Colonial American science started to exert academic independence by reforming Harvard University into a scientific

195. Morison, "The Harvard School of Astronomy in the 17th Century.", 17.

196. Jones and Boyd, *The Harvard Observatory College: The First Four Directorships, 1839-1919*, 10.

197. Brasch. "John Winthrop (1714-1779), America's First Astronomer, and the Science of His Period.", 156.

198. Morison, "The Harvard School of Astronomy in the 17th Century.", 17.

199. Yeomans "The Origin of North American Astronomy—Seventeenth Century.", 416.

200. Kennedy, "Thomas Brattle and the Scientific Provincialism of New England, 1680-1713.", 591.

201. Kennedy, "Thomas Brattle and the Scientific Provincialism of New England, 1680-1713.", 591.

202. Kennedy, "Thomas Brattle and the Scientific Provincialism of New England, 1680-1713.", 600.

203. Dunster, *President Dunster's Quadriennium Memoir*, 279.

204. Bremer, *The Puritan Experiment: New England Society from Bradford to Edwards*, 196.

205. Yeomans "The Origin of North American Astronomy—Seventeenth Century.", 414.

206. Yeomans "The Origin of North American Astronomy—Seventeenth Century.", 422.

institution.[207]

Yeomans describes this dependence on England in the following passage: "The Colonial scientist was forced to work independently; indeed, the virgin American terrain made communications between colonists so difficult that they often relied upon English correspondents for news of other colonists."[208] Yeomans really puts the experience of the Colonial astronomer in perspective. To think about how different the atmosphere was being in a brand-new society, in a very foreign and unknown land is one thing, but to attempt to do scientific research there as well is even harder. The fact that these colonists were able to make an impact and contribute to the works of people like Newton was highly significant.

V: Conclusion

All in all, the ideas of Athenian philosophers Aristotle and Plato thrived under Athenian democracy. As a result, like the passing down of genes from generation to generation, the Athenian ideas of the freedom of thought would go on to make up the educational foundations put in place in scholarly Alexandria. Eventually, the great astronomer Claudius Ptolemy would build on these Athenian philosophical foundations, specifically using Plato's objective empirical reasoning to determine that mathematical inquiry was the best tool for the pursuit of knowledge. In turn, this would lead him to create through mathematics the most advanced astronomical theory the world had ever seen, until the creation of the Copernican tradition. Because of this, the Ptolemaic tradition would greatly influence Colonial Americans over a thousand years later, leading the Colonial Americans to inherit astrology and the geocentric theory. However, due to the intellectual freedom of thought tracing all the way back to Athens, a relationship between faith and science similar to that of the Greeks became instilled in Colonial America, where becoming closer to God came through scientific study. Thus, also with some help from academics in their native England, these Colonial Americans would use ancient Greek wisdom to replace the Greek Ptolemaic astronomy. Compared to their counterparts in Europe, the Colonial Americans like their native England quickly adopted the Copernican tradition. Therefore, the Colonial Americans' Greek style tolerance towards scientific inquiry was crucial to their scientific advancement and the replacement of the Ptolemaic by Copernican tradition.

207. Brasch. "John Winthrop (1714-1779), America's First Astronomer, and the Science of His Period.", 156.

208. Yeomans "The Origin of North American Astronomy—Seventeenth Century.", 425.

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Religion in Big History: A Neurobiological and Psychological Theory

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Abstract
The most elegant and complex matter ever identified in our universe may well be the human brain, with its evolved ability to process and interpret not only our physical situation, but our existential one. For all humans ask: What is the meaning of life? Why are we here? And all humans conjecture: Surely there is something more. Although in the context of Big History we can identify elements of religion practiced as far in the past as by the stromatolites, and as recently as by our fellow primates, only humans possess the consciousness to seek definitive answers to those existential questions concerning our God or gods. In an increasingly globalized and secularized culture, is there a future for religion? Is there a place for any deity, for religion? Yes. Dramatically imagined, lovingly inclusive of all, with a shedding of institutional dogma and doctrine, cosmic religion can be found in each of us; the personal path to God or our gods lies in our evolved brains and mysterious minds.

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Introduction

The paved road to Shanidar Cave is lined with rippling, striped Iraqi flags and modern street lights. A welcome sign in English and Arabic towers above the parking lot. Like a gaping maw cut into the verdant Bradost Mountain above the Great Zab River, the cave's mouth is arched and large, its belly a hushed and ghostly burial site, where 10 human predecessors, Neanderthals, were laid to rest about 60,000 years ago.[1] One of them, with his prominent brow, bewhiskered face and hirsute body, apparently was crushed in a rockslide. Had he been crippled from his misfortune, anthropologists tell us that others would have cared for him. At his death, he was interred in a crude ritual that includes mounding stones carved to points on top of his grave, and then building a roaring fire nearby.[2] Perhaps his tribe was attempting to weight his spirit to the Earth or arm him with arrow tips for protection in the next world, a grand gesture of metaphysical hope; perhaps the angry flames were meant to keep demons at bay.

Neanderthal burial rituals tell us two things, according to neurobiologist Andrew Newberg, "First, they possessed sufficient brain power to comprehend the inescapable finality of physical death; and second, they had already found a way to defeat or cope with it, at least conceptually." [3]

Relics of ritual, proto-religious behavior, including animal sacrifices and interment with weapons, clothing and food, have been unearthed from Neanderthal gravesites scattered over Europe, Asia and the Middle East, dating to as long ago as 200,000 years.[4]

Even longer ago, several hundred thousand years, the genus *Homo* emerged in the form of *Homo erectus*, the first human to walk upright, and the first thought to perceive a spiritual reality beyond material forces, with its evolved brain that contained the complex neural structures needed for language function, including causal and antinomic thought needed for myth-making, which is critical in the evolution of human morality and religion.[5]

And much, much longer ago, in the Archean period, about 3.5 billion years ago, more than 10 billion years after the Big Bang, complex life began to emerge into an atmosphere thick with noxious sulfur and hydrochloric acid, but devoid of oxygen. For two billion years before, only simple bacterial organisms called cyanobacteria

made their home on Earth, existing on hydrogen in water molecules, and excreting oxygen, the Goldilocks condition needed to welcome photosynthesizing stromatolites, a living rock that may be thought of as the emergence of moral behavior, a precursor to religion. Anthropologist Ruth Benedict points out the common thread of religious practice in all cultures: "religion is a technique for success," because it addresses values and answers questions that are critical for our existence.[6] Fundamentally, moral behavior is inextricably based on rules of peaceful cooperation. From a Big History vantage point, these moral rules can be traced to the early stromatolites, clinging together on little rocks in shallow seas to improve their survival chances.[7]

And it is survival that motivates all organisms to negotiate their environments using their internal, organic bundles of neurons to sort, process, and make sense of the bombardment of sensory data that, if correctly interpreted, means life for a little longer. Brains, and the neural systems on which they rely, have through thousands of years of genetic fine tuning become increasingly complex, allowing organisms to understand and react to their environments in more efficient ways. "The billowing complexity that characterized the evolution of neurological systems reaches its fullest point so far in the elegant engineering of the human brain," says Newberg.[8]

The hominid(ae) family lines leading to modern humans experienced an incredible expansion of brain size, from 600 gm in *Homo habilis*, who is presumed to have walked erect and made primitive tools, although without any opposable thumbs, to 1500 gm in *Homo sapiens Neanderthalensis*. "In hominid species, therefore, it looks as though there was a very special kind of selection pressure towards larger brains, but it should be emphasized that this selection pressure began to operate at the early stages of hominid evolution, long before the emergence of *Homo sapiens*," says psychologist Stephen Walker.[9] Thus, the evolution of hominids' brain size culminates in the complex brains of modern humans, allowing us to interpret reality, including contemplation of forces beyond our perceived world, and change our behavior to adapt instead of waiting for genetic variation.[10] As William Grassie puts it, "It is worth stopping a moment to reflect that the most complicated object in the known universe is sitting right here between our ears."[11] Specifically, as species evolved, neural strings in the brain evolved too, becoming longer, looping bundles that formed neural networks, which grouped into highly specialized areas to allow even more sophisticated sensory perception, processing, and adaptation after connecting circuits developed. The cerebral, or neo cortex, the most recent addition to the heft of the hominid brain, allows humans to employ higher cognitive functions in the creation of language and culture, including religion.[12] And religious emotion in humans, once an elusive concept rooted in survival through cooperation, fear, superstition, the desire to connect with dead ancestors, and guilt, has evolved too. Today, it can be scientifically measured through brain science.

A subset of the brain, because it is wholly dependent on it, is the mind, which is much like an iceberg with consciousness visible and unconscious drives hidden beneath the surface. The heightened complexity of the brain eventually led to its ability to perceive itself, a phenomenon neurology can not explain since a non-material essence is found arising from the biological functions of the material brain. "Our hypothesis specifically holds that 'mind' and 'brain' are two views of the same reality – mind is how the brain experiences its own functioning, and brain provides the structure of mind."[13] The mind, then, is a system of computation that developed as Charles Darwin predicted, by natural selection, originally to process sensory perception and regulate body functions, but also to solve the problems our hunter-gatherer ancestors faced from the perils of nature.[14] In reverse-engineering our mind, figuring out what it was meant to do, we find answers to our biggest questions in psychology, as well as in biology, studying how the brain works.

Thus, the human cranium is a jewel case, protecting evolution's priceless gem of many facets, allowing

us to perceive reality and to enter altered states of consciousness to understand it. For surely there is something 'more' than Sartrean Existentialism. We as humans have the capacity to seek spiritual reality that lies beyond rote processing of sensory input. Our communal wish is to understand why we are here, to know how we can overcome our fear of a baffling world and of death, and to explain what makes each of us part of the whole of the universe. In other words, in a spiritual realm, we seek our god or gods for answers to how we can make order out of chaos. Grassie says, "To talk of spirituality, then, is to affirm that there is an all-encompassing realm, an invisible reality that somehow transcends and sustains human life, consciousness, and values, indeed the entire universe."[15] Our hurdle is that what we perceive as reality is only a rendition of reality that is created in the brain, subjectively ordered by genetics and interpreted with influence by the specific cultures in which we must live. The various religious practices are the bedrock of culture, and culture the form of religion.[16] But myriad religious beliefs have not been satisfactory, because different cultures, different belief systems, our own experiences, are pitted against each other. Waning participation and radical incarnations show us that we must rise above the divisiveness of competing institutional religions. The answers appear to be in each of us. "Neurology makes it clear: There's no other way for God to get into your head except through the brain's neural pathways. Even if there were a soul through which God could communicate, it would have little cognitive meaning to us without a brain," Newberg says.[17] And psychology makes it clear: A spiritual sensibility has always resided in humans, evolved within our brains. It can be found in every mind that seeks it. "This something common, this something which is left over after we peel away all the localism, all the accidents of particular languages or particular philosophies, all the ethnocentric phrasings, all those elements which are not common, we may call the 'core-religious experience' or the 'transcendent experience,'" says psychologist Abraham Maslow.[18]

And so, the inextricably evolved human brain and mind gift us with the ability to contemplate our connectedness to something more, to something transcendent. In the words of philosopher and psychologist William James, "beyond each man and… continuous with him there exists a larger power which is friendly to him and to his ideals … (a power) both other and larger than our conscious selves."[19] This is the gift found by seeking our inner numinosity. It is built from specific religious components such as cooperation, altruism, empathy, and care for others, instead of from fear and guilt, which is often prescribed by institutional religion. The seeds of numinosity began evolving in the brains of living organisms as long ago as the stromatolites, to ultimately become an intrinsic morality and spirituality in the most complex animals, primates, and specifically humans. It is this gift, along with a reimagined future for religion without the restraints of dogma, fear, and guilt, that we shall now explore.

Religious Components Within Us: Moral Behavior

Specific components that favor survival evolved within life forms as building blocks for later moral behavior, which is the foundation of religion. Just as the stromatolites practiced peaceful cooperation to survive, later primitive organisms found that group cooperation, called eusociality, contributed to adaptive reproduction. Theologian Ted Peters explains that eusociality involves not only cooperation, but in colonies of insects, crustaceans and mammals, it involves parental care for the group's young, a division of labor, and deference for breeding to the group's dominant caste.[20] Survival of the fittest is best accomplished by interdependence and interaction. Beginning with eukaryotic organisms, "life did not take over the globe by combat, but by networking. Life forms multiplied and complexified by co-opting others, not just by killing them," says biologist Lynn Margolis.[21]

In tracing the evolution of religious components, we are led to the Ethiopian Afar Triangle, where

archeologists in 1994 discovered the world's oldest hominin (a sub-family of hominid) bones ever unearthed, a 4-foot tall female, dated at 4.4 million years ago. She is categorized as the species *Ardipithecus ramidus*, which translates to 'ground floor' in the Afar language. Anthropologists named her Ardi. What we know about Ardi is that she lived in wooded areas and was both bipedal and able to climb along branches on all fours. She and the other specimens found nearby, both male and female, had small canine teeth. Scientists attribute to Ardi's species more and earlier-than-supposed pair bonding with males. The small canine teeth indicate reduced male conflict over females, as our last common ancestor appears to have been evolving attributes marked by increasing civility and socialization.

The genus *Homo* began to appear about 2.5 million years ago, when *H. rudolfensis*, *H. habilis,* and *H. ergaster* began to evolve larger brains, shorter arms, and smaller teeth, although they were still apelike in many ways. Fossils found indicate that early *Homo* species employed crude stone tools and were bipedal. About 2 million years ago, various *Homo* species had abandoned the trees for open landscapes and larger groups, with communication still limited to apelike vocalizations and gestures to convey messages to others.

The decidedly more human-like *Homo erectus* emerged about 1.8 to 1.7 million years ago, displaying a brain about 70% the size of modern humans' and a body almost the same size. About 75 skeletons have been discovered all over the world, although not in the Americas. This species no longer swung in trees and is known to have acquired balance through the emergence of human-like canals in the inner ear, allowing *H. erectus* to run, jump, and dance, which are important rituals for socialization and religious ceremonies. A narrower birth canal forced females to give birth to offspring with smaller heads, and thus with brains not fully developed, meaning newborns needed extended parental care until maturity. Since males began protecting the mothers and their offspring to better ensure survival of the helpless newborns, pair bonding became more prevalent. *H. erectus* is thought to have been the first ancestor to harness fire for cooking and warmth, which increased social interaction, including through language using simple nouns and verbs, and in the fashioning of advanced tools.[22]

Aggression, Free Riders, and Altruism

As a counterpoint to cooperation, our primitive ancestors also displayed aggression towards members of other and of the same species, a trait that is evident in modern humans. Many of the rituals associated with aggressive behavior include appeasing gestures of submission, which were meant to diffuse competition before the death of a losing actor. All vertebrate species can act aggressively, it is innate in lower species, but humans have made particular use of aggression, for instance, in their ability to make and employ weapons in war. Physiologist Konrad Lorenz makes the counterpoint that humans, with higher cognitive development, are also uniquely able to control their emotions and channel them toward altruistic pursuits; aggression thus modified by imagination and inference.[23] And if we look to other primates, particularly chimpanzees and bonobos, with whom we share about 98.8 percent of our DNA, we find strikingly similar brains that reflect the ability in primates other than humans to behave sensitively toward others. Once thought only a human purview, the spindle cell, which affects self-control, empathy, and self-awareness, has been found in the brains of apes, including bonobos. "Areas involved in the perception of another's distress, such as the amygdala and anterior insula, are enlarged in the bonobo. Its brain also contains well-developed pathways to control aggressive impulses," according to primatologist Frans de Waal.[24]

Sigmund Freud in *Totem and Taboo* shares his theory of the early *Homo* species and its propensity for aggression, early myths, and for symbols. In this proto-culture, nomadic foragers, probably *Homo erectus* living in small family bands, are ruled by a brutal,

dominant male, who mates indiscriminately, including with his daughters, and banishes, castrates, or kills any male, including his sons, who would challenge his authority. Eventually, banished sons decide as a group to end the violence and incest by attacking the father, killing him, and cannibalizing him with the belief that his strength and power would live on in them. But the human emotions of guilt and shame also arise in the murderous sons. To atone, they recreate the event in symbolic form with periodic feasts in which a totem, a sacred animal as a symbol of the slain father, is sacrificed and eaten to commemorate the father's power. Murder is outlawed, along with incest, the two taboos that are the subject of Freud's Oedipal complex. Freud believes that the killing of the father is humanity's original sin, and that the act and subsequent atonement by the sons is the beginning of morality, as a necessity for living in society and for making amends, and of religion, as a construct for handling the sense of guilt and remorse, and for reconciliation with the father by subsequently vowing obedience.[25]

Freud's theory is reiterated in part by cultural anthropologist Christopher Boehm, whose behavioral reconstruction of primates' common ancestor finds dominant alpha males in charge, and subordinates who dislike their status. "In fact, in all four of these living apes (gorillas, chimpanzees, bonobos, and humans), rebellious subordinates can form counter-dominant coalitions."[26] Ted Peters asks if a selfish gene is responsible for human violence, to which he is answered 'yes'. "Of all our human hallmarks…the one that has been derived most straightforwardly from animal precursors is genocide."[27] Although a selfish gene may aid some primates in eliminating the enemy as competition for survival, since genocide is still practiced today, Peters points out that humans also engage in gratuitous violence often spurred by memetic desire and not by survival of the fittest. Humans also love their neighbors and perform altruistic acts. "To date, sociobiology has failed to account for the most noble and enviable virtues of the human race."[28] Despite humans' propensity toward violence, our common ancestor may have experienced shame for breaking rules, including for violent acts, a preadaptation of the conscience in modern humans. In further support of Freud's theory, sacrifice, according to theologian Robert Bellah, is a crucial element in hierarchal authority found in ancient societies. In ancient Greece, for example, participation in a sacrificial meal "became a central and defining ritual of the polis itself, an early example of there being no distinction between religion and politics.[29]

Elements of Freud's concept continue today in the Christian ritual of Communion, in which Christ's body and blood are consumed in symbolic form, and of Christian adherence to moral law such as the Ten Commandments. It may even continue in its original form in Papua, New Guinea, where natives have been sharing cooked humans in a ritual to gain the victim's power, as noted in an 1846 missionary's account. "The Somosomo people were fed with human flesh during their stay at Bau, they being on a visit at that time; and some of the chiefs of other towns, when bringing their food, carried a cooked human being on one shoulder, and a pig on the other; but they always preferred the 'long pig,' as they call a man when baked."[30] Nobody since 2011 has reported that cannibalism is still occurring in New Guinea. Perhaps it is not. Or perhaps it is, and that is why nobody has reported.

Despite being capable of virtuous acts, humans have struggled with curtailing their murderous aggression, as well as with forms of cheating, since the emergence of the genus *Homo*. The beginning of a moral code, one tenet on which religion rests, is much older than institutional religion, and is entrenched in us through thousands of years of natural selection. Newberg defines it as "a combination of learned beliefs, neurological development, and peer-group consensus. But something else is needed to maintain moral beliefs, and that is social order."[31] Early hunter-gatherers learned just that as they devised an effective cure to contend with aggressors or cheating free riders who disrupt peaceful cooperation and altruistic behavior, which eventually disrupts the individual's

and the group's ability to survive. For this reason, foraging bands kept close watch for social deviance in group members, who were punished in a variety of ways, from ostracism to capital punishment. Writes anthropologist Christopher Boehm, "Thus, we must ask whether traits that make for seriously antisocial free riding – free riding that invites severe punishment – may often be far more costly to the would-be free rider than are the costs of being generous for the altruists they are genetically competing with. If so, for humans alone we have a possible definitive solution for the genetic free-rider problem."[32] Free-riders who are ostracized suffer the loss of basic human needs, which can compel them to think twice before cheating, since these needs can only be fulfilled by and through other humans forming a society. "The need for community (belongingness, contact with others) is itself a human need. Loneliness, isolation, rejection by the group — these are not only painful but pathogenic as well," says psychologist Abraham Maslow. [33]

Moral behavior is the internalized basis for prosocial activity and is codified into commandments or laws by all religions. It springs from empathy, the ability to connect emotionally with how another feels, and from altruism, aiding another who needs help preferably without thought about reciprocity.[34] It is tied to the conscience, and is an innate trait, something the evolutionary scientist Charles Darwin concludes in his 1871 pronouncement, "Any animal whatever, endowed with well-marked social instincts, the parental and filial affections being here included, would inevitably acquire a moral sense or conscience as soon as its intellectual powers had become as well developed, or nearly as well developed, as in man."[35] Thus, our moral life would be a miserable quagmire of shame and fear of punishment without innate altruistic traits. Boehm says, "Sensing the needs of others can lead us to spontaneously respond with generosity, and this, along with counting on future benefits form the generosity of others, makes the system work."[36] There also is a correlation between psychological health and altruistic behavior. As prosocial animals, humans want to help others because it feels good. "An examination of emotionally healthy persons shows that when they behave unselfishly, this behavior tends to be a phenomenon of personal abundance stemming from relative basic gratification. It comes out of inner riches rather than inner poverty. The same kind of examination of neurotic persons will show that their selfish behavior is typically a phenomenon of basic deprivation involving threat, insecurity, and inner poverty," says Maslow.[37]

William Grassie does caution us that the other side of altruism hinges on our tendency to demonize those outside of our own groups, when being wronged by an outsider often unleashes outsized emotional outrage, harnessed for evil, for instance, when soldiers will kill their perceived enemies. "The dark side of altruistic self-sacrifice, the immoral side of morality, may yet prove to be our species's evolutionary downfall."[38]

Nature, Reality, and Mind Over Matter

Our hunter-gatherer ancestors, after the invention of farming about 10,000 years ago, were free to use their larger brains for more cerebral pursuits, such as writing and thinking more abstractly in terms of a differentiated consciousness between the objective and the subjective. About 500 BCE, categorized as the Axial Age by Karl Jaspers, many diverse cultures that believed misfortune could be thwarted by ritual and sacrifice revised their belief systems to embrace philosophical and religious ideas that promoted altruism and promised spiritual transcendence. During the Axial Age, economic efficiency meant more energy which fueled "larger cities, a scholarly and priestly class, and a reorientation of priorities from short-term survival to long-term harmony."[39]

Differentiated consciousness supports dualism that is one critical view of nature, in which the body and the soul are separate realms. "What people experience in the physical world is temporal, ephemeral, corruptible, and subject to death. Beyond the shadow of the physical world is the transcendent realm of spirit, which is eternal, immutable, incorruptible, and life-giving …

to be attuned to the realm of spiritual light is to live in the truth, to live in the realm of God," writes Peters.[40] This discovery of a transcendent reality in human consciousness is called the axial breakthrough, and the axial worldview is often called perennial philosophy. Although more recent models of nature are mechanistic and contingent on rationality, scientific empiricism, and relativism, dualism is especially appealing because it bestows both sacredness and order to the universe.

Psychologist Carl Jung believes that duality in each of us, and in nature, is needed for a functioning universe. "The unconscious is not just evil by nature, it is also the source of the highest good: not only dark but also light, not only bestial, semi-human, and demonic but superhuman, spiritual, and, in the classical sense of the word, 'divine.'"[41] And in advocating for the idea that we are all one with nature, Islamic philosopher Seyyed Nasr champions "the resacralization of nature, not in the sense of bestowing sacredness upon nature… but of lifting aside the veils of ignorance and pride that have hidden the sacredness of nature from the view of a whole segment of humanity."[42]

Duality then, is a reality made up of matter and substance, an objective reality that we can perceive, and a subjective reality in our minds, in which concepts and conscience reside, along with who we deem ourselves to be, and some essence that connects us to something more. And it is to neuroscience and psychology that we now turn to find that subjective reality, that 'something more.' In the words of geneticist Theodosius Dobzhansky, "Man's conscience, the existence of life, and indeed, of the universe itself, are all parts of the *mysterium tremendum*."[43] The term *mysterium tremedum* was coined by philosopher and theologian Rudolph Otto, and discussed in his book, *The Idea of the Holy*. At the heart of the mystery is the experience he calls numinous. Otto explains numinosity this way:

"The feeling of it may at times come sweeping like a gentle tide pervading the mind with a tranquil mood of deepest worship. It may pass over into a more set and lasting attitude of the soul, continuing, as it were, thrillingly vibrant and resonant, until at last it dies away, and the soul resumes its "profane," non-religious mood of everyday experience . . . It has its crude, barbaric antecedents and early manifestations, and again it may be developed into something beautiful and pure and glorious. It may become the hushed, trembling, and speechless humility of the creature in the presence of—whom or what? In the presence of that which is a Mystery inexpressible and above all creatures."[44]

Christian mystic and theologian, Augustine of Hippo, addresses the issue in his autobiography, *The Confessions*, in which he recognizes the duality in the numinous, with its connections to something we can not fully comprehend, but which fills us with awe and wonder, as well as with a numbing chilliness. Augustine's 'wholly other' is his perception of being connected to God as an alternate but ultimate reality. He writes, "What is that which gleams through me and smites my heart without wounding it? I am both a-shudder and a-glow. A-shudder in so far as I am unlike it, a-glow in so far as I am like it."[45]

Numinosity is called many things by many thinkers. Freud calls it the oceanic feeling; Jung maintains Otto's term numinosum; Maslow calls it the peak experience; Albert Einstein the cosmic religious feeling; Ted Peters the beyond sensibility; Mircea Eliade the wholly other; and in Buddhism it is called nirvana.

Jung's Inherited Archetypes

Numinosum is involuntary, and seizes its subjects, controlling them in a peculiar alteration of consciousness. It is the job of religion to consider this state, but Carl Jung makes a clear distinction between religion and creed. "Religion appears to me to be a peculiar attitude of the human mind, which could be formulated in accordance with the original use of the term "religio," that is, a careful consideration and observation of certain dynamic factors, understood to be 'powers' spirits demons, gods, laws, ideas, ideals or whatever name man has given to such factors as he has found in his world powerful, dangerous or

helpful enough to be taken into careful consideration, or grand, beautiful and meaningful enough to be devoutly adored and loved."[46] Thus, religion is the experience brought about by numinosum, but institutional religion is not the same thing; it is dogma and creed, merely codified forms of the numinous experience. These forms coagulate into static rituals and unbending institutions. Thus, numinosity is not reserved for extreme, devout religious practitioners, or for saints and mystics. It can be reached by all of us through prayer, meditation, yoga, chanting, ritual dancing, and even through a 'devout' passion for cultural elements such as nature, science, and art. And it can, of course, be reached by searching for God, as Newberg has recorded in the brain waves of Buddhist monks and Catholic nuns. Reaching numinosity, or nirvana, however, is a long and difficult journey. "We have not all achieved nirvana and are unlikely to do so. It is perhaps the questing after enlightenment or God, rather than the actual achievement of enlightenment or finding God, that is the most wholesome and transformative aspect of religion. In that quest, there is no reason not to invite science, including the neurosciences, along for the ride," says Grassie.[47]

Jung does not claim that God exists, only that an archetypal image of Him exists; God is real in the minds of believers. As are the myths associated with the world's religions, such as the virgin birth, in which Jesus, Mohammed, Perseus, and Buddha were all born of virgins. Jung claims that he was never trying to prove that the virgin birth was a true occurrence. What is provably real is that the mind works in a certain way that allows many people to believe that the virgin birth occurred. "We live in a modern setting, where the ultimate things are doubtful, where there is a prehistory of enormous extension, and where people are fully aware of the fact that if there is any numinous experience at all, it is the experience of the psyche. We can no longer imagine an empyrean world revolving round the throne of God, and we would not dream of seeking for Him somewhere behind the galactic systems. But the human soul seems to harbor mysteries, since to an empiricist all religious experience boils down to a peculiar condition of the mind."[48]

In a prescient statement made 80 years before Newberg confirmed it with neurobiological experiments, Jung introduced us to archetypes that explain his certainty that biology and the brain, which powers the mind, were behind religious thought. He had witnessed countless of his patients express religious ideas that had prevailed for the past 2,000 years. "Such a continuity can only exist if we assume a certain unconscious condition carried on by biological inheritance. The inherited quality, I fancy, must be something like a possibility of regenerating the same or at least similar ideas. I have called the possibility 'archetype,' which means a mental precondition and a characteristic of the cerebral function."[49]

Freud's Revision

Soon after the publication of his book, *The Future of an Illusion* in 1927, Sigmund Freud received a letter from his friend, Romain Rolland, a French novelist and mystic who told Freud that he agreed with his assessment of religion as an illusion, but that Freud missed the point when he did not acknowledge the true meaning of religious sentiment. Freud writes: "This, he (Rolland) says consists in a peculiar feeling, which he himself is never without, which he finds confirmed by many others, and which he may suppose is present in million of people. It is a feeling which he would like to call a sensation of 'eternity', a feeling as of something limitless, unbounded – as it were, 'oceanic'"

Freud never found such a feeling in himself, but does not dispute that for others, it is a subjective and indissoluble bond with the universe. His theory comes from psychoanalysis, in which the ego of a mature adult, with its clear delineation of self and not-self, has retained vestiges of an infantile state before the ego recognizes this delineation, when the world and the child are one. As the child matures, the ego separates from the mass of worldly sensations that are unpleasant to it, until the mature ego can reject

and remove whatever is a source of displeasure. It is a pathology of blurred egoism, some remnant of the ego and the world as one, that comprises the oceanic feeling for Freud.[50]

In his later writings, Freud revises his view of humans as primarily ruled by a destructive or death instinct found in an aggressive and barbaric id, which we are constantly under pressure to contain through the superego (inner guilt), when we really do not wish to. Perhaps if he had lived, Freud would have reimagined his oceanic feeling as one governed by his later theory of Eros, the love instinct, that is tasked with "combining single human individuals, and after that families, then races, peoples and nations, into one great unity, the unity of mankind, making more than one into one."[51] Freud calls his revised dualistic theory of destruction and construction a cosmic struggle of opposites, the battle of the giants within us between love and hate, and it would seem reasonable to assign the oceanic feeling to Eros as a cosmic principle of creation, expansion, unification, and preservation, our connection to something greater.[52] In his final years, even the maestro of the mind reevaluates what life, death, and eternity mean to humans.

Maslow's Personal Religion

In Abraham Maslow's hierarchy of needs, the beginning of humanistic psychology, he places the numinous experience at the top of the pyramid, as a state that could not occur until the basic physiological, safety, love and belonging, and esteem needs were met. Few people were thought to be able to reach this pinnacle; after all, we must live in and maneuver the mundane world each day, but Maslow believes it is attainable by all who work hard for it. Self-actualization is the state of knowing and being, in which all prejudices and fears fall away, and a true sense of inner morality, psychological health, and contentedness overtakes us. Part of this process is the numinous, or as Maslow calls it, the peak experience.

Although the numinous began as a concept reserved for religious contemplation, predominantly by mystics and the prophets of all high religions who sought to communicate their revelations to the masses, Maslow's theory broadens the concept to include all of us, over all time, who have asked and will ask the questions concerning our meaning and existence. Maslow regards institutional religion as at odds with the peak experience because the hierarchy is comprised of non-peakers who over history have presented intellectually unacceptable answers to existential questions. "The religious questions themselves—and religious quests, the religious yearnings, the religious needs themselves—are rooted deep in human nature, and can be studied, described, examined in a scientific way, and the churches were trying to answer perfectly sound human questions. As a matter of fact, contemporary existential and humanistic psychologies would probably consider a person sick or abnormal in an existential way if he were not concerned with these 'religious' questions."[53]

The peak experience is found in both theistic or supernatural, and non-theistic contexts; it is unique to each person. Thus, "each peaker discovers, develops, and retains his own religion."[54]

Numinosity and Brain Science

And so, the large and complex brain in our early ancestors processed the responses to sociability issues, memory, imagination, but especially to fear and imminent danger, in which the limbic structures trigger the autonomic system. But because of the cerebral cortex, more developed in humans than in any other animals, humans began to think abstractly, sensing danger before it is imminent, and resolving it through inventive means, such as tool-making, and banding together, for both safety and hunting. Our ancestors also used this abstract thinking to envision a better future for all. They enacted laws, shaped civilizations, discovered science and technology, created art and music, and adopted religions to answer existential questions. "All of the lofty reaches to which human achievement has carried us—from the first spearhead to the latest innovation in heart transplant surgery—can

be traced to the mind's need to reduce the intolerable anxiety that is the brain's way of warning us that we are not safe."[55] These high-level thought processes are called the cognitive operators. This adaptive process was so successful that evolution provided the human brain with a biological compulsion to use it, which is called the cognitive imperative, which drives us to make sense of the world through by using our brains to analyze reality. Our ontological yearning inspired by the cognitive imperative led to our ancestors dealing with their anxieties about death and meaning by creating stories and ultimately myths to organize their perceptions. "Storytelling brings into play all of the cognitive and emotional circuitry evolved to deal with real experience," says noted biologist E.O. Wilson." [56]

Myth

From storytelling, myths evolved, most of which are structured to appeal to the cognitive imperative. An existential concern is identified, and the concern is framed in dualistic terms, between dueling opposites, and finally, that concern is resolved, often by gods who relieve the brain of its existential concerns, causing us to feel relieved and happy. For example, in Christian mythology, an existential dualism is identified by Augustine, naming heaven as the city of God and Earth as the city of man. Humans are sinners, so heaven is unattainable to them, until God benevolently sacrifices his only son Jesus who, with his death and resurrection, provides eternal salvation to the city of man. Other gods and chosen men have patched the rift between heaven and earth, including the Egyptian Osiris, the Greek Dionysus, the Syrian Adonis, and the Mesopotamian Tammuz.[57]

The creation of myth is most heavily influenced by two cognitive operators, the causal operator, which allows our brains to link an event to an abstract cause, and the binary operator, which allows our brains to define the world in the dualities about which Carl Jung wrote.[58] Jung's imperative that duality creates order in the universe is an evolutionary truism linked to the binary operator, which does not just identify opposites, it has evolved to create them as a way for us to conceptualize space and time into manageable units. Newberg theorizes that *Homo erectus*, our ancestor of several hundred thousand years ago, sported a brain complex enough to contain the neural network for language and speech, including a developed parietal lobe used to power causal and antinomic thinking necessary for myth-making. Many of these myths then, have been inherited throughout time. Jung believes them to be symbolic expressions of archetypes: inherited ideas and thoughts that are universal, and that exist deep within every human mind.[59]

Ritual

Along with myths, primitive humans who were bonded by kinship in tribes or clans also practiced rituals to gain favor with the deities they worshipped, as well as for many pro-social reasons, such as control of the tribe, its hierarchy and its power structure.[60] Long thought to be a cultural phenomenon, neurobiologist Eugene d'Aquili in the 1970s proposed that human ritual has biological roots, as well as evolutionary roots in common with animal ritual, both of which were used as forms of communication, sending messages of friendship, greetings, submission, and intent to mate.[61] Ritual is common in our everyday lives, for instance, the common handshake, but it is the use of ritual in transcendence on which we shall focus.

Our transcendence into a something larger than we are is the primary goal of ritualized behavior. Religious transcendence uses ritual to unite worshipers to a higher spiritual reality, one's God or gods. Historians tell us that religious rituals have existed in every human culture in many different forms in our quest to understand the mystery of something beyond our objective reality. Carl Jung claims that this quest is the innate human search for a soul because the human psyche has always yearned to fulfill deep spiritual needs. "All creativeness in the realm of the spirit as well as every psychic advance of man arises from a state of mental suffering, and it is spiritual stagnation, psychic sterility, which causes this state. It is only the

meaningful that sets us free."[62] Medieval mystic Saint Teresa of Avila describes the transcendent experience as a journey of contemplation in our search for God within ourselves. There is "a magnificent castle inside our own souls, at the center of which the Beloved himself dwells," she writes in *The Interior Castle*.[63] Our journey here ascends from the first castle where we battle base instinct, to higher levels that represent the heart beginning to fill with love and empathy for others, to the seventh and highest castle, representing the brain, into which transcendence transports us to the realm of knowing and uniting with God.

The altered state of consciousness reached in numinosity was once thought to be experienced only by mystics and saints such as Teresa, who were often dismissed as fanatics or delusional, but Arthur Newberg believes the brain is actually altered when a subject focuses on a religious idea or thought, and numinosity, with practice, is attainable by all healthy brains. Newberg began his numinosity experiments on Tibetan Buddhist monks as they meditated and Catholic nuns as they performed a centering prayer dating to the 14th Century text, *The Cloud of Unknowing*. Results were recorded using an imaging technique called single photon emission computed tomography, which measures blood flow to the brain.[64] He found that activity in the frontal lobes increased for his participants, especially just above the eyes in the prefrontal cortex, which plays a vital role in processing language, memories, self-reflective consciousness, complex social functions, pleasure, and religious activities.[65] He notes that the parietal lobes, which help us orient toward where we are in the physical world, is slowed in meditation and prayer, leaving the practitioner feeling a sense of timelessness and infinite space. "In this way, we can demonstrate that transcendent, mystical, and spiritual experiences have a real biological component. Furthermore, the neurological changes that occur during meditation disrupt the normal processes of the brain—perceptually, emotionally, and linguistically—in ways that make the experience indescribable, awe-inspiring, unifying, and indelibly real. In fact, the intensity of such experiences often gives the practitioner a sense that a different or higher level of reality exists beyond our everyday perceptions of the world".[66] Although these experiences are most often interpreted in the context of religious beliefs, nonreligious practitioners have found secular meaning in them, such as the feeling of being connected to the universe, to nature, and to all that ever was.

Newberg explains that in prayer, the sense of God becomes physiologically real for the nuns, as does the sense of inner peace for the monks. And this is due to another important brain structure, the thalamus, which regulates sensory perception as it enters the prefrontal cortex, and which becomes more active during meditation and prayer. Although perceptions are altered, the thalamus continues to work to make them lucid by communicating a sense of reality about them to the prefrontal cortex. True to one's belief system, the experience is interpreted by the nun, monk, or secular practitioner as real; transcendent, peaceful, and in the presence of God.

Our emotions are also tied to neurobiological activity in the brain. Enjoyable experiences cause the pleasure neurotransmitter dopamine to be released into the system, just as various stress hormones are released when we find ourselves in an anxious situation, which triggers fight or flight emotional cues. Thus, by meditating on something we believe to be pleasant, the amygdala and other parts of the limbic system signal our brains that an experience is emotionally powerful, causing us to accept it as real.[67] We seek these pleasant and rewarding experiences because dopamine, and the nucleus accumbens, together reinforce the motivation to seek them.[68]

Is There a Future for Religion?

Our Paleolithic ancestors almost 200,000 years ago were foragers who probably thought of themselves as an element of nature, possessing spirits that would be reincarnated into other animals or plants, all of which comprised a rudimentary spiritual belief system. Cave

paintings depicting the spirits, as well as daily life, date to as early as 70,000 years BP.[69] French sociologist Émile Durkheim tells us that these early spirits were thought of as benefactors. He says, "Of course they punish a man if he does not treat them in a fitting manner, but it is not their function to work evil." This simple belief system was the foundation of later, more complicated and diverse religious institutions, including the idea that the polytheistic spirits resemble the benevolent God of later monotheistic religions. Durkheim also tells us that despite the differences in doctrine and dogma, all religions serve the same purpose, and all are real and true belief systems for those who adhere to the doctrines and rituals of the various denominations. "All religions answer, though in different ways, to the given conditions of human existence," Durkheim says.[70]

Civilization's move from small foraging bands to agrarian societies, marks the beginning of a power hierarchy between men and women, established because farm families needed the labor of many children, whose care was relegated to women at home, while men tended to political and economic activity in public centers as populations grew. Uruk, nestled between the Tigris and Euphrates rivers, is recognized as humankind's first city, established about 3600 BCE in the first state of Sumer (southern Mesopotamia). Archaeologists excavated two ceremonial centers in Uruk, theorizing that they were temples. "The smaller one, called the White Temple, in time became associated with the sky god, An, the father of all gods, representing patriarchal authority," another precursor to modern monotheism, writes David Christian et al. As other Mesopotamian cities were established, special temples were erected to attract and care for special gods that would protect residents and grant them prosperity. Additional hierarchies were established; including the possibility that priests oversaw construction of the temples with which they were associated, as well as overseeing sacrifices to the gods, and in relaying fantastical celestial stories to the lower classes. "Religious, political, economic, and even military power may, for a brief time, have been in the hands of the priests," Christian explains.[71] Astrophysicist Eric Chaisson qualifies Christian's statement by explaining the 'brief time' that priests dominated a largely illiterate public was for several thousand years, and included surrounding ancestors of the ancient Greeks, Romans, Celts, Germans, and Slavs, who believed that the gods of Sumer ruled the world through the priestly class. "Apparently myths become truths if upheld long enough," he says.[72] These gods are believed to have created the *me*, "a Sumerian term for the institutions, forms of social behavior, emotions, and sign of office, which as a whole were seen as indispensable for the smooth operation of the world."[73] Religion and politics thus found solace in each other, with religion promoting social cohesion, including with its legitimization of a state's leaders, who in turn promoted the chosen belief system as the state religion. Durkheim reinforces this idea when he says that religion is something eminently social. "Religious representations are collective representations which express collective realities; the rites are a manner of acting which take rise in the midst of the assembled groups, and which are destined to excite, maintain or recreate certain mental states in these groups."[74] The same could be said of politics, showing us that historically, religion and politics were not strange bedfellows, which led for many centuries to power struggles, religious persecution and wars, such as the Crusades, and to genocide such as in Nazism, persisting today in predominantly Islamic countries where the two institutions are still inextricably entwined.[75]

The schism that developed between religion and science gained its foothold during the Renaissance, although the experimental test and empirical evidence were used as early as ancient Greece. A falling away from institutional religion began during the 18th Century Enlightenment period when human reason soundly questioned religious doctrine that was flying in its face, fueled further a century later in 1859 with the publication of Charles Darwin's *The Origin of Species*, which refutes conclusively the origin stories

that had been put forth by institutional religion. Sigmund Freud in the early 20th Century calls the psychological nature of religious doctrines 'illusions' in that "they are derived from human wishes" for a father's protection from nature's brutality, and for the promise of reward after death, (Freud primarily refers to Judeo-Christian doctrine).[76] He attributes religion's loss of influence on people to the scientific spirit. "The greater the number of men to whom the treasures of knowledge become accessible, the more widespread is the falling-away from religious belief," he says. And in just the past six decades, statistics show an even more dramatic seismic generational shift in religious commitment. In an analysis published in the journal PlosOne in 2015, the authors review answers given by 11.2 million respondents to four nationally distributed questionnaires about religious beliefs, which have been conducted since 1966. After comparing people of different generations at identical ages, the analysis concludes that millennials are the least religious generation in American history[77] following the cultural trend established in Western Europe earlier in the 20th Century. The theory is that modern western culture prizes individualism, and religious affiliation prizes the group, dominated by an authoritarian male, whom we need for moral guidance and whom we obey out of fear of reprisal in a next life if we do not.

As we discussed earlier, morality predates religion by countless millennia. In an explanation from Plato's *Euthyphro*, Socrates philosophizes that we would be free to appeal directly to the good reasons the gods might give us for deeming acts moral, and if we determine that the reasons are not good, we need not follow their dictates. "After all, thoughtful people can give reasons why they don't kill, rape, or torture other than fear of eternal hellfire, and they would not suddenly become rapists and contract killers if they had reason to believe that God's back was turned, or he told them it was OK," writes psychologist Steven Pinker. And in the Old Testament, God surely tells the Israelites to commit mass rape and genocide, while smiting to death blasphemers, homosexuals, adulterers, and those who toiled on the Sabbath.[78]

Our conundrum is to find something we have lost in religion, some meaning that transcends a hostile universe, where we are each but specks of matter whose time spent on a nondescript planet registers only infinitesimally on the cosmos's 13.8 billion-year-old timeline. Freud believes that "the relationship between civilization and religion must undergo a fundamental revision. By withdrawing their expectations from the other world and concentrating all their liberated energies into their life on earth, (people) will probably succeed in achieving a state of things in which life will become tolerable for everyone and civilization no longer oppressive to anyone." As the 19th Century German poet Heinrich Heine wrote in *Deutschland*, "We leave Heaven to the angels and the sparrows."[79]

What should the future of religion look like? Perhaps a combogenesis, to borrow from biologist Tyler Volk, in which a combination and integration of previously existing things form something innovative.[80] Something like Albert Einstein's cosmic religion, whose impersonal God is heavily influenced by the 17th Century philosopher Benedict De Spinoza. Combined perhaps with thoughts of numinosity discussed earlier and from the Indian mystic and 1913 Nobel Laureate Rabindranath Tagore, who in *The Religion of Man* spoke of the many times "music and the glow of a sunset have brought to our hearts the pulsation of the limitless world."[81] Tempered with Andrew Newberg's ideas that our paths to our gods snake through our brains, and reality is what each of us perceives it to be in our minds. Something for everyone. . And in concert with William Grassie's hermeneutical approach, in which all religions contain elements of truth, and all perspectives, including science, can be adopted and woven into our human story, an intellectual non-violence in which God-by-whatever-name is "the set of all phenomena—past, present, future—as well as that which may also in some sense precede and transcend this universe."[82] All of our stories, all of us, contribute to the narrative of religion's future.

Einstein's cosmic religion does not recognize dogma, nor a God made in man's image, but it is accepting of all denominations that do. And millions of faithful people with open minds subscribe to innumerable forms of religion; it is not religion that is the enemy. "The true enemy is the substitution of thought, reflection, and curiosity with dogma," Frans De Waal writes.[83] Cosmic religion is not religion based on fear of punishment, nor does it claim to have received unbending moral law from a divine source. Moral law should aid humans by responding to their changing societal needs rather than hinder humans because it is incontrovertible. Einstein writes, "The ethical behavior of man is better based on sympathy, education, and social relationships, and requires no support from religion." Cosmic religion is humanistic and encouraging. "The individual feels the vanity of human desires and aims, and the nobility and marvelous order which are revealed in nature and in the world of thought. He seeks to experience the totality of existence as a unity full of significance."[84] We are thus unapologetic for being human, and we are, with all animals, plants and inert matter, bound as one to the universe.

Einstein never wavered in his respect for others' sincere religious convictions, a tolerance that has been lacking in institutional religious beliefs both historically and today, although it surely would be part of cosmic religion. Einstein's acceptance of others' myriad religious views was expressed in a letter he wrote in 1929, "We followers of Spinoza see our God in the wonderful order and lawfulness of all that exists and, in its soul, as it reveals itself in man and animal." (Thus establishing our connection to all living things, including De Waal's bonobos.) "It is a different question whether belief in a personal God should be contested. I myself would never engage in such a task. For such a belief seems to me preferable to the lack of any transcendental outlook of life, and I wonder whether one can ever successfully render to the majority of mankind a more sublime means in order to satisfy its metaphysical needs."[85]

Mircea Eliade adds that the cosmos is a living, sacred thing, and cosmic religious experience can be as simple as observing the sky, with its transcendent power to evoke eternity. "The transcendental category of height, of the super terrestrial, of the infinite, is revealed to the whole man, to his intelligence and his soul."[86]

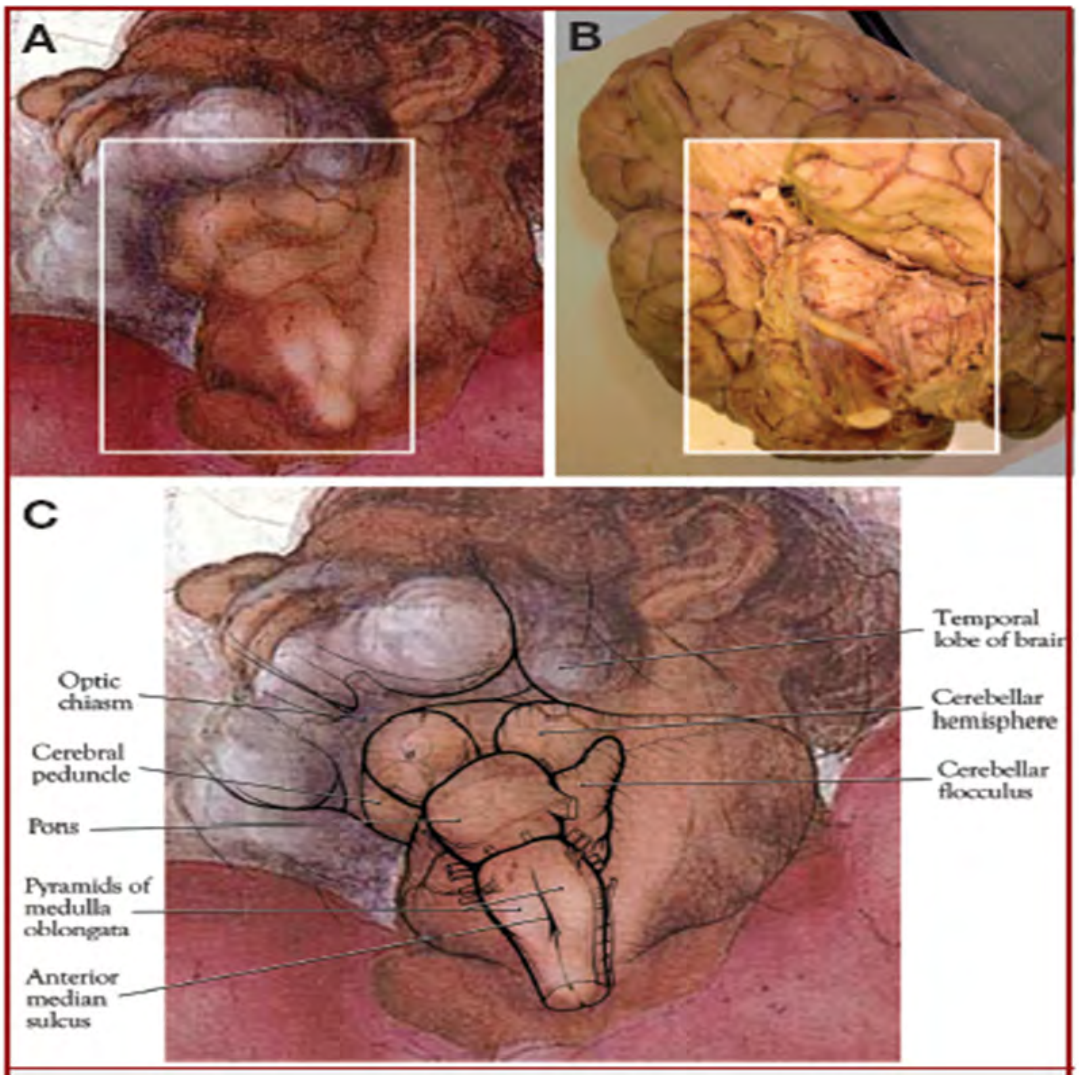
Conclusion

Buddha often said that humans interpret reality in many ways, and there is no one definitive truth. So, it is unlikely that a single religious belief system will ever be adopted by all people, in part because religious beliefs are culturally and biologically ingrained in us and cannot be proven scientifically to the satisfaction of all. Our quest to know the answers to existential questions is much like trying to know the sun, which is partially revealed when its rays pierce the clouds to warm us. But we can never stare at its face, for it would blind us. We are left to continue to use our complex brain with its highly advanced frontal cortex, and our more elusive rational mind, the consciousness that can be thought of as our psyche or soul, to contemplate the divine and to make sense of this world, as it is the only objectively real one. Indeed, French philosopher Baron D'Hobach describes the brain as integrally related to the soul. He writes, "It is by the aid of this interior organ that all those operations are performed which are attributed to the soul."[87] The key to truth is perseverance, tolerance and respect for all life and for the journeys and realities conjured in the minds of others as our brains tune out profane sensory perceptions and concentrate on the sacred forces we seek. Time and space are suspended and our sense of ourselves fades as the release of dopamine contributes to our numinous and peaceful feelings. Newberg says, "Voila! A new sense of reality—i.e., truth—awakens in our frontal lobes."[88]

Epilogue

Gracing the ceiling and walls of the Sistine Chapel are Michelangelo di Lodovico Buonarroti Simoni's early 16th Century paintings, including 'Creation of

Adam,' 'The Separation of Light from Darkness,' and 'Last Judgment,' all poignant frescoes portraying an anthropomorphized God. Michelangelo, once a devout Catholic, turned to spiritualism later in life, costing him his pension when Pope Paul IV accused him of blasphemy for suggesting in the 'Last Judgment' that one's direct path to God need not involve institutional religion. Michelangelo's hidden message in the other paintings may have inspired something Spinoza wrote more than a century later: "For both reason and the beliefs of the prophets and Apostles evidently proclaim that God's eternal word and covenant and true religion are divinely inscribed upon the hearts of men, that is, *upon the human mind*."[89] Thus, intelligent inquiry, made possible by the brain, is the true path to one's God or gods. Centuries before neurobiologist Andrew Newberg tells us that God and religion reside in the brain, and noted psychologists tell us how they are a function of the mind, Michelangelo shows us. In 'Creation of Adam,' God, surrounded by humans, is encased in an anatomically accurate human brain, and in 'The Separation of Light from Darkness,' one can see in God's throat a perfect replica of the human spinal cord and brain stem, with intact frontal lobes, the cerebrum, the basilar artery, the pituitary gland and the optic chiasm,[90] in what can be explained as a metaphysical colligation of God and our brain.[91] Michelangelo knew.



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A Religião na Macro-História: Uma Teoria Neurobiológica e Psicológica

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Resumo
A questão mais elegante e complexa já identificada em nosso universo pode muito bem ser o cérebro humano, com sua capacidade evoluída de processar e interpretar não só a nossa situação física, mas também a nossa situação existencial. Todas as pessoas perguntam: qual é o significado da vida? Porque estamos aqui? E todos os humanos conjecturam: Certamente há algo mais. Embora no contexto da Macro-História possamos identificar elementos religiosos praticados pelos estromatólitos, no passado distante, e pelos nossos companheiros primatas, muito mais recentemente, somente os seres humanos possuem a consciência para buscar respostas definitivas àquelas questões existenciais concernentes a Deus ou aos deuses. Em uma cultura cada vez mais globalizada e secularizada, existe um futuro para a religião? Existe lugar para qualquer divindade, para a religião? Sim. Dramaticamente imaginada, carinhosamente incluindo a todos, com um abandono de dogmas e doutrinas institucionais, a religião cósmica pode ser encontrada em cada um de nós; o caminho pessoal para Deus ou nossos deuses está em nossos cérebros evoluídos e mentes misteriosas.

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Introdução

A estrada pavimentada para a caverna de Shanidar é ladeada por ondulantes bandeiras iraquianas e modernos postes de iluminação. Um sinal de boas-vindas em inglês e árabe nas torres sobre o estacionamento. Como uma boca escancarada na verdejante Montanha Bradost , acima do Grande Zab, a boca da caverna é arqueada e grande, seu ventre é um local de enterro silencioso e fantasmagórico, onde 10 predecessores humanos, neandertais, foram enterrados há cerca de 60.000 anos. Um deles, com sua testa proeminente, seu rosto barbado e seu corpo hirsuto, aparentemente foram esmagados em um deslizamento de pedras. Se ele tivesse sido aleijado pelo infortúnio, os antropólogos nos dizem que outros teriam cuidado dele. Na sua morte, ele foi enterrado em um ritual rudimentar que inclui montes de pedras afiadas como pontas em cima de seu túmulo, seguidas pela construção de uma fogueira nas proximidades. Talvez sua tribo estivesse tentando pesar seu espírito para a Terra ou armá-lo com pontas de flechas para sua proteção no próximo mundo, um grande gesto de esperança metafísica; talvez as chamas violentas devessem manter os demônios afastados.

Os rituais de enterro dos Neanderthal nos dizem duas coisas, de acordo com o neurobiólogo Andrew Newberg: "Primeiro, eles possuíam poder mental suficiente para compreender a inescapável caráter definitivo da morte física; e segundo, eles já haviam encontrado uma maneira de derrotar ou lidar com isso, pelo menos conceitualmente."

Relíquias de rituais, comportamento proto-religioso, incluindo sacrifícios de animais e enterro com armas, roupas e comida, foram desenterradas de túmulos neandertais espalhados pela Europa, Ásia e Oriente Médio, datando de 200.000 anos.

Ainda há mais tempo, várias centenas de milhares de anos, o gênero *Homo* emergiu na forma do *Homo erectus*, o primeiro ser humano a andar ereto, e o primeiro que acreditamos ter percebido uma realidade espiritual além das forças materiais, com seu cérebro evoluído que continha as complexas estruturas neurais necessárias para a função da linguagem, incluindo o pensamento causal e antinômico necessário para a criação de mitos, que é crucial na evolução da moralidade e religião humanas.

Há muito mais tempo, no período Arqueano, cerca de 3,5 bilhões de anos atrás, mais de 10 bilhões de anos após o Big Bang, a vida complexa começou a emergir em uma atmosfera densa de nocivos gases como enxofre e ácido clorídrico, mas desprovida de oxigênio. Por dois bilhões de anos antes, apenas organismos bacterianos simples chamados cianobactérias construíram seu lar na Terra, subsistindo do hidrogênio em moléculas de água e excretando oxigênio, a condição de Cachinhos Dourados necessária para acolher os estromatólitos fotossintetizantes, uma rocha viva que pode ser vista como o surgimento do comportamento moral, um precursor da religião. A antropóloga Ruth Benedict aponta a linha comum da prática religiosa em todas as culturas: "a religião é uma técnica para o sucesso", porque aborda valores e responde questões críticas para nossa existência. Fundamentalmente, o comportamento moral é inextricavelmente baseado em regras de cooperação pacífica. De um ponto de vista da Macro-História, essas regras morais podem ser atribuídas aos primeiros estromatólitos, unidos em pequenas pedras em mares rasos para melhorar suas chances de sobrevivência.

E é a sobrevivência que motiva todos os organismos a dialogarem com o ambiente usando seus mecanismos orgânicos internos, seus conjuntos de neurônios para classificar, processar e dar sentido ao bombardeio de dados sensoriais que, se interpretados corretamente, significam viver por um pouco mais de tempo. Os cérebros, e os sistemas neurais dos quais eles dependem, através de milhares de anos de ajuste genético, tornam-se cada vez mais complexos, permitindo que os organismos compreendam e reajam a seus ambientes de maneiras mais eficientes. "A complexidade crescente que caracterizou a evolução dos sistemas neurológicos atinge seu ponto mais alto até agora na elegante engenharia do cérebro humano", diz Newberg.

As linhas familiares dos hominídeos que levam aos humanos modernos experimentaram uma incrível expansão no tamanho do cérebro, de 600g no *Homo habilis*, que se acredita ter andado ereto e feito ferramentas primitivas, embora sem polegares opositores, a 1500 g no *Homo sapiens Neanderthalensis*. "Nas espécies de hominídeos, portanto, parece haver um tipo muito especial de pressão de seleção em direção a cérebros maiores, mas deve-se enfatizar que essa pressão de seleção começou a operar nos estágios iniciais da evolução dos hominídeos, muito antes do surgimento do *Homo sapiens* ", diz o psicólogo Stephen Walker. Assim, a evolução do tamanho do cérebro dos hominídeos culmina nos complexos cérebros dos humanos modernos, permitindo-nos interpretar a realidade, incluindo a contemplação de forças além de nosso mundo percebido, e mudar nosso comportamento para nos adaptarmos em vez de esperar pelas transformações genéticas. Como coloca William Grassie: "vale a pena parar um momento para refletir sobre o fato de que o objeto mais complicado do universo conhecido está bem aqui entre nossas orelhas." Especificamente, à medida que as espécies evoluíram, os neurônios no cérebro evoluíram também, tornando-se mais longos e dando voltas sobre si mesmos, formando redes neurais, que se agruparam em áreas altamente especializadas para permitir uma percepção, um processamento e uma adaptação sensoriais ainda mais sofisticadas, após a conexão dos circuitos desenvolvidos. O neocórtex, a adição mais recente ao peso do cérebro dos hominídeos, permite que os humanos empreguem funções cognitivas superiores na criação da linguagem e da cultura, incluindo a religião. E a emoção religiosa nos humanos, outrora um conceito elusivo enraizado na sobrevivência pela cooperação, no medo, na superstição, no desejo de se conectar com ancestrais mortos e na culpa, também evoluiu. Hoje, ela pode ser medida cientificamente através da ciência do cérebro.

Um subconjunto do cérebro, porque é totalmente dependente dele, é a mente, que é muito parecida com um iceberg com uma consciência visível e impulsos inconscientes ocultos sob a superfície. A complexidade aumentada do cérebro levou à sua capacidade de perceber a si mesmo, um fenômeno que a neurologia não consegue explicar, uma vez que uma

essência não material é encontrada a partir das funções biológicas do cérebro material. "Nossa hipótese sustenta especificamente que ‹mente› e ‹cérebro› são duas visões da mesma realidade - a mente é como o cérebro experimenta seu próprio funcionamento e o cérebro fornece a estrutura da mente." A mente, então, é um sistema de computação que se desenvolveu, como Charles Darwin previu, pela seleção natural, originalmente para processar a percepção sensorial e regular as funções do corpo, mas também resolver os problemas que nossos ancestrais caçadores-coletores enfrentaram face aos perigos da natureza. Fazendo a engenharia reversa da nossa mente, descobrindo o que ela foi feita para fazer, encontramos respostas para as nossas maiores questões em psicologia, bem como em biologia, estudando como o cérebro funciona.

Assim, o crânio humano é uma caixa de jóias, protegendo a jóia multifacetada e inestimável da evolução, permitindo-nos perceber a realidade e entrar em estados alterados de consciência para entendê-la. Certamente existe algo «mais» do que o existencialismo sartriano. Nós, como seres humanos, temos a capacidade de buscar a realidade espiritual que está além do processamento rotineiro de informações sensoriais. Nosso desejo comum é entender por que estamos aqui, saber como podemos superar nosso medo de um mundo desconcertante e da morte, e explicar o que faz de cada um de nós parte de todo o universo. Em outras palavras, em um reino espiritual, buscamos nosso deus ou nossos deuses para obter respostas sobre como podemos criar ordem no caos. Grassie diz: «Falar de espiritualidade, então, é afirmar que existe um domínio que abrange tudo, uma realidade invisível que de alguma forma transcende e sustenta os valores, a vida e a consciência humanos, na verdade o universo inteiro." Nossa barreira é que o que percebemos como realidade é apenas uma representação da realidade que é criada no cérebro, subjetivamente ordenada pela genética e interpretada sob influência das culturas específicas em que precisamos viver. As várias práticas religiosas são a base da cultura, e a cultura, a forma da religião. Mas uma miríade de crenças religiosas não tem sido satisfatória, porque diferentes culturas, diferentes sistemas de crenças, nossas próprias experiências são contrapostas umas às outras. O declínio da participação religiosa e a presença de suas manifestações radicais nos mostram que devemos nos erguer acima da divisão das religiões institucionais. As respostas parecem estar em cada um de nós. "A neurologia deixa claro: não há outra maneira de Deus entrar na sua cabeça, exceto através dos caminhos neurais do cérebro. Mesmo se houvesse uma alma através da qual Deus pudesse se comunicar, teria pouco significado cognitivo para nós sem um cérebro ", diz Newberg. E a psicologia clarifica: uma sensibilidade espiritual sempre residiu nos seres humanos, evoluindo dentro de nossos cérebros. Isso pode ser encontrado em toda mente que o procura. "Esse algo comum, esse algo que sobra depois de removermos todo o localismo, todos os acidentes de línguas particulares ou de filosofias particulares, todos os enunciados etnocêntricos, todos aqueles elementos que não são comuns, podemos chamar de 'experiência religiosa central' ou 'experiência transcendente'", diz o psicólogo Abraham Maslow.

E assim, o cérebro e a mente humanos inextricavelmente evoluídos nos dão a capacidade de contemplar nossa conexão com algo mais, algo transcendente. Nas palavras do filósofo e psicólogo William James, "além de cada homem e… em continuidade com ele existe um poder maior que é amigável para ele e para seus ideais… (um poder) tanto alheio quanto maior que nossos eus conscientes." Essa é a dádiva encontrada buscando nossa numinosidade interna . Ela é construído a partir de componentes religiosos específicos, como cooperação, altruísmo, empatia e cuidado com os outros, em vez de medo e culpa, que é frequentemente prescrito pela religião institucional. As sementes da numinosidade começaram a evoluir nos cérebros dos organismos vivos há muito tempo com os estromatólitos, para finalmente se tornarem uma moralidade intrínseca e espiritual nos animais mais complexos, primatas, e especificamente humanos. É

esse presente, juntamente com um futuro reimaginado para a religião, sem as restrições do dogma, do medo e da culpa, que agora exploraremos.

Componentes religiosos dentro de nós: comportamento moral

Componentes específicos que favorecem a sobrevivência evoluíram dentro das formas de vida como blocos de construção para o posterior comportamento moral, que é a base da religião. Assim como os estromatólitos praticavam a cooperação pacífica para sobreviver, mais tarde os organismos primitivos descobriram que a cooperação grupal, chamada eussocialidade, contribuía para a reprodução adaptativa. O teólogo Ted Peters explica que a eussocialidade envolve não apenas cooperação, mas em colônias de insetos, crustáceos e mamíferos, envolve cuidados parentais para os jovens do grupo, uma divisão do trabalho e deferência para procriação na casta dominante do grupo. A melhor forma de conseguir a sobrevivência do mais apto é por interdependência e interação. Começando com organismos eucarióticos, "a vida não tomou conta do mundo pelo combate, mas pelo trabalho em rede. As formas de vida se multiplicaram e complexificaram ao cooptar os outros, não apenas ao matar os outros ", diz a bióloga Lynn Margolis.

Ao traçar a evolução dos componentes religiosos, somos levados ao Triângulo Etíope de Afar, onde Arqueólogos descobriram em 1994 os ossos mais antigos de homininéo (uma subfamília de hominídeos) já descobertos, uma fêmea de 1,2 metro de altura, datada de 4,4 milhões de anos atrás. Ela é categorizada como a espécie *Ardipithecus ramidus* , que se traduz em «térreo» na língua Afar. Antropólogos a chamaram de Ardi. O que sabemos sobre Ardi é que ela vivia em áreas arborizadas e era tanto bípede quanto capaz de escalar galhos de quatro. Ela e os outros espécimes encontrados nas proximidades, tanto masculinos quanto femininos, tinham pequenos dentes caninos. Os cientistas atribuem a espécie de Ardi uma ligação com os machos mais intensa e mais precoce do que o esperado. Os pequenos dentes caninos indicam redução do conflito masculino sobre as fêmeas, já que nosso último ancestral comum parece ter evoluído atributos marcados pelo aumento da civilidade e da socialização.

O gênero *Homo* começou a aparecer há cerca de 2,5 milhões de anos, quando *H. rudolfensis*, *H. habilis* e *H. ergaster* começaram a desenvolver cérebros maiores, braços mais curtos e dentes menores, apesar de ainda serem simiescos em muitos aspectos. Fósseis encontrados indicam que as primeiras espécies do Homo usavam ferramentas de pedra bruta e eram bípedes. Cerca de 2 milhões de anos atrás, várias espécies do gênero *Homo* haviam abandonado as árvores rumo a paisagens abertas e grupos maiores, com comunicação ainda limitada a gestos e vocalizações simiescos para transmitir mensagens a outros.

O decididamente mais humano *Homo erectus* surgiu há cerca de 1,8 a 1,7 milhões de anos, exibindo um cérebro com cerca de 70% do tamanho dos humanos modernos e um corpo quase do mesmo tamanho. Cerca de 75 esqueletos foram descobertos em todo o mundo, embora não nas Américas. Esta espécie não balançava mais em árvores e é conhecida por ter adquirido equilíbrio através do surgimento de canais semelhantes a humanos no ouvido interno, permitindo que o *H. erectus* corresse, saltasse e dançasse, que são rituais importantes para a socialização e para cerimônias religiosas. Um canal de parto mais estreito forçou as fêmeas a darem à luz descendentes com cabeças menores e, portanto, com cérebros não completamente desenvolvidos, o que significa que os recém-nascidos precisavam de cuidado parental prolongado até a maturidade. Desde que os machos começaram a proteger as mães e seus filhos para melhor garantir a sobrevivência dos recém-nascidos desamparados, a união de pares tornou-se mais prevalente. Acredita-se que o *H. erectus* tenha sido o primeiro ancestral a aproveitar o fogo para cozinhar e aquecer, o que aumentou a interação social, inclusive através do uso da linguagem, com substantivos e verbos simples, e da criação de ferramentas avançadas.

Agressão, Parasitismo e Altruísmo

Como contraponto à cooperação, nossos antepassados primitivos também demonstraram agressão a membros de outras e da mesma espécie, uma característica que é evidente nos seres humanos modernos. Muitos dos rituais associados ao comportamento agressivo incluem os apaziguadores gestos de submissão, que foram feitos para aliviar a competição antes que gerasse a morte de um ator perdedor. Todas as espécies de vertebrados podem agir agressivamente, a agressão é inata em espécies inferiores, mas os seres humanos fizeram um uso particular dela, por exemplo, em sua capacidade de fabricar e empregar armas na guerra. O fisiologista Konrad Lorenz faz o contraponto de que os humanos, com maior desenvolvimento cognitivo, são também capazes de controlar suas emoções e canalizá-las para atividades altruístas; a agressão é assim modificada pela imaginação e inferência. E se olharmos para outros primatas, particularmente chimpanzés e bonobos, com quem compartilhamos cerca de 98,8% de nosso DNA, encontramos cérebros notavelmente semelhantes que refletem a capacidade em primatas não humanos de se comportarem de maneira sensível com relação aos outros. Uma vez tido como uma estrutura exclusivamente humana, o neurônio fusiforme, que afeta o autocontrole, a empatia e a autoconsciência, foi encontrada nos cérebros dos macacos, incluindo os bonobos. "Áreas envolvidas na percepção do sofrimento do outro, como a amígdala e a ínsula anterior, são aumentadas no bonobo. Seu cérebro também contém vias bem desenvolvidas para controlar os impulsos agressivos ", de acordo com o primatólogo Frans de Waal.

Sigmund Freud, em *Totem e Tabu*, compartilha sua teoria sobre as primeiras espécies de Homo e sua propensão à agressão, aos primeiros mitos e aos símbolos. Nesta protocultura, as forrageadoras nômades, provavelmente *Homo erectus* que vivem em pequenos grupos familiares, são governadas por um brutal, macho dominante, que mantém relações sexuais indiscriminadamente, inclusive com suas filhas, e bane, castra ou mata qualquer homem, inclusive seus filhos, que desafiasse sua autoridade. Eventualmente, filhos banidos decidem como grupo acabar com a violência e o incesto atacando o pai, matando-o e canibalizando-o com a crença de que sua força e poder viveriam neles. Mas as emoções humanas de culpa e vergonha também surgem nos filhos assassinos. Para expiar, eles recriam o evento em forma simbólica com festas periódicas nas quais um totem, um animal sagrado como símbolo do pai morto, é sacrificado e comido para comemorar o poder do pai. O assassinato é proibido, juntamente com o incesto, os dois tabus que são o tema do complexo edipiano de Freud. Freud acredita que o assassinato do pai é o pecado original da humanidade, e que o ato e a subseqüente expiação pelos filhos é o começo da moralidade, como uma necessidade para viver em sociedade e fazer reparações, e da religião, como uma construção para lidar com o sentimento de culpa e de remorso e para se reconciliar com o pai, jurando subsequentemente obediência a ele.

A teoria de Freud é reiterada em parte pelo antropólogo cultural Christopher Boehm, cuja reconstrução comportamental do ancestral comum dos primatas encontra machos alfa dominantes no comando e outros machos subordinados que não gostam de seu status. "De fato, em todos os quatro macacos vivos (gorilas, chimpanzés, bonobos e humanos), os subordinados rebeldes podem formar coalizões contrárias ao regime." Ted Peters pergunta se um gene egoísta é responsável pela violência humana, ao qual ele é respondido com um 'sim'. "De todas as nossas marcas humanas ... a que foi derivada mais diretamente de nossos precursores animais é o genocídio." Embora um gene egoísta possa ajudar alguns primatas a eliminar o inimigo como competição pela sobrevivência, uma vez que o genocídio ainda é praticado hoje, Peters aponta que os humanos também se envolvem em violência gratuita, muitas vezes estimulada pelo desejo memético e não pela sobrevivência do mais apto. Os humanos também amam seus vizinhos e realizam atos altruístas. "Até

hoje, a sociobiologia falhou em explicar as virtudes mais nobres e invejáveis da raça humana." Apesar da propensão dos humanos à violência, nosso ancestral comum pode ter experimentado vergonha por quebrar regras, inclusive por atos violentos, uma preadaptação do consciência em humanos modernos. Em apoio adicional à teoria de Freud, o sacrifício, segundo o teólogo Robert Bellah, é um elemento crucial na autoridade hierárquica encontrada nas sociedades antigas. Na Grécia antiga, por exemplo, a participação em uma refeição sacrificial "tornou-se um ritual central e definidor da própria *pólis*, um dos primeiros exemplos de que não há distinção entre religião e política.

Os elementos do conceito de Freud continuam hoje no ritual cristão da Comunhão, no qual o corpo e o sangue de Cristo são consumidos em forma simbólica, e da adesão cristã à lei moral, como os Dez Mandamentos. Pode até mesmo continuar em sua forma original em Papua, Nova Guiné, onde os nativos têm compartilhado humanos cozidos em um ritual para obter o poder da vítima, como observado no relato de um missionário de 1846. "O povo Somosomo foi alimentado com carne humana durante sua estada em Bau, estando em visita naquele tempo; e alguns dos chefes de outras cidades, ao trazerem sua comida, levavam um ser humano cozido em um dos ombros e um porco no outro; mas eles sempre preferiram o 'porco comprido', como eles chamam um homem quando assado." Ninguém desde 2011 relatou que o canibalismo ainda está ocorrendo na Nova Guiné. Talvez não seja. Ou talvez seja, e é por isso que ninguém relatou.

Apesar de serem capazes de atos virtuosos, os humanos têm tido dificuldades com a redução de sua agressão assassina, bem como com formas de trapaça, desde o surgimento do gênero *Homo*. A origem dos códigos morais, um princípio sobre o qual a religião repousa, é muito mais antiga que a religião institucional e está entrincheirada em nós através de milhares de anos de seleção natural. Newberg define como "uma combinação de crenças aprendidas, desenvolvimento neurológico e consenso entre pares. Mas algo mais é necessário para manter as crenças morais, e isso é ordem social." Os primeiros caçadores e coletores aprenderam exatamente isso quando criaram uma cura eficaz para enfrentar os agressores ou aproveitadores que interrompem a cooperação pacífica e o comportamento altruísta, o que acaba atrapalhando o indivíduo e a capacidade do grupo de sobreviver. Por esta razão, os bandos de forrageamento mantiveram-se atentos ao desvio social dos membros do grupo, que foram punidos de várias maneiras, do ostracismo à pena de morte. Escreve o antropólogo Christopher Boehm: "Assim, devemos perguntar se o custo dos traços que levam ao parasitismo anti-social em níveis graves – parasitismo que atrai severas punições – podem ser maiores para o aproveitador em potencial do que os custos de ser generoso são para os altruístas com os quais ele está competindo geneticamente. Se assim for, só os seres humanos têm uma possível solução definitiva para o problema do parasitismo genético." Os indivíduos parasitários que são condenados ao ostracismo sofrem a perda das necessidades humanas básicas, o que pode obrigá-los a pensar duas vezes antes de trapacear, pois essas necessidades podem somente ser supridas por e através de outros humanos formando uma sociedade. "A necessidade de comunidade (pertencimento, contato com os outros) é em si uma necessidade humana. Solidão, isolamento, rejeição pelo grupo - estes não são apenas dolorosos, mas patogênicos também", diz o psicólogo Abraham Maslow.

O comportamento moral é a base internalizada para a atividade pró-social e é codificado em mandamentos ou leis por todas as religiões. Nasce da empatia, da capacidade de se conectar emocionalmente com o outro, e do altruísmo, da ajuda ao outro que precisa de ajuda, preferencialmente sem pensar em reciprocidade. Está ligado à consciência e é um traço inato, algo que o cientista evolucionista Charles Darwin conclui em seu pronunciamento de 1871: "Qualquer animal, dotado de instintos sociais bem marcados, incluindo as afeições parentais e filiais,

iria adquirir inevitavelmente um senso moral ou consciência assim que suas faculdades intelectuais se tornassem tão, ou quase tão, desenvolvidas como no homem." Assim, sem características altruístas inatas, nossa vida moral seria um pântano miserável de vergonha e medo de punição. Boehm diz: "Sentir as necessidades dos outros pode nos levar a responder espontaneamente com generosidade, e isso, junto com a expectativa de benefícios futuros da generosidade dos outros, faz o sistema funcionar." Existe também uma correlação entre saúde psicológica e comportamento altruísta. Como animais pró-sociais, os humanos querem ajudar os outros porque isso gera uma sensação boa. "Um exame de pessoas emocionalmente saudáveis mostra que, quando elas se comportam de forma altruísta, esse comportamento tende a ser um fenômeno de abundância pessoal decorrente de uma gratificação básica. Ela vem das riquezas interiores e não da pobreza interior. O mesmo tipo de exame de pessoas neuróticas mostrará que seu comportamento egoísta é tipicamente um fenômeno de privação básica que envolve ameaça, insegurança e pobreza interior ", diz Maslow.

William Grassie nos adverte que o outro lado do altruísmo se sustenta na nossa tendência de demonizar os que estão fora de nossos próprios grupos, quando ser injustiçado por alguém de fora muitas vezes desencadeia uma ofensa emocional desmedida, aproveitada para o mal, por exemplo, quando soldados matam seus supostos inimigos. "O lado negro do auto-sacrifício altruísta, o lado imoral da moralidade, pode ainda revelar-se a queda evolutiva da nossa espécie."

Natureza, realidade e mente acima da matéria

Nossos ancestrais caçadores-coletores, após a invenção da agricultura há cerca de 10.000 anos, estavam livres para usar seus cérebros maiores para atividades mais cerebrais, como escrever e pensar de forma mais abstrata em termos de uma consciência diferenciada entre o objetivo e o subjetivo. Por volta de 500 AEC, período chamado de Era Axial por Karl Jaspers, muitas culturas diversas que acreditavam que o infortúnio poderia ser frustrado pelo ritual e sacrifício revisaram seus sistemas de crença para abraçar ideias filosóficas e religiosas que promoviam o altruísmo e prometiam transcendência espiritual. Durante a Era Axial, a eficiência econômica significava mais energia que impulsionava "cidades maiores, uma classe acadêmica e sacerdotal, e uma reorientação de prioridades, de sobrevivência de curto prazo a harmonia de longo prazo."

A consciência diferenciada sustenta o dualismo, que é uma visão crítica da natureza, na qual o corpo e a alma são realidades separadas. "O que as pessoas experimentam no mundo físico é temporal, efêmero, corruptível e sujeito à morte. Além da sombra do mundo físico está o reino transcendente do espírito, que é eterno, imutável, incorruptível e vivificante... estar sintonizado com o reino da luz espiritual é viver a verdade, viver no reino de Deus ", escreve Peters. Essa descoberta de uma realidade transcendente na consciência humana é chamada de ruptura axial, e a cosmovisão axial é frequentemente chamada filosofia perene. Embora os modelos mais recentes da natureza sejam mecanicistas e contingentes à racionalidade, ao empirismo científico e ao relativismo, o dualismo é especialmente atraente porque confere santidade e ordem ao universo.

O psicólogo Carl Jung acredita que a dualidade em cada um de nós e na natureza é necessária para um universo funcional. "O inconsciente não é apenas mau por natureza, é também a fonte do bem maior: não apenas escuro, mas também luminoso, não apenas bestial, semi-humano e demoníaco, mas sobre-humano, espiritual e, no sentido clássico da palavra, 'divino.'" E ao defender a ideia de que somos todos um com a natureza, o filósofo islâmico Seyyed Nasr defende "a ressacralização da natureza, não no sentido de conferir sacralidade à natureza… mas de levantar os véus da ignorância e do orgulho que ocultaram a sacralidade da natureza da visão de todo um segmento da humanidade."

A dualidade, então, é uma realidade composta de matéria e substância, uma realidade objetiva que

podemos perceber, e uma realidade subjetiva em nossas mentes, na qual residem conceitos e consciência, junto com quem julgamos ser, e alguma essência que se nos conecta a algo mais. E é para a neurociência e psicologia que agora nos voltamos para descobrir essa realidade subjetiva, esse "algo mais". Nas palavras do geneticista Theodosius Dobzhansky: "a consciência do homem, a existência da vida e, de fato, do próprio universo, são todas partes do *mysterium tremendum.*" O termo *mysterium tremedum* foi cunhado pelo filósofo e teólogo Rudolph Otto, e discutido em seu livro *The Idea of the Holy*. No coração do mistério está a experiência que ele chama de numinosa. Otto explica a numinosidade dessa maneira:

"A sensação dela às vezes pode se espalhar como uma maré suave que permeia a mente com um clima tranquilo da mais profunda adoração. Pode se transformar em uma atitude mais fixa e duradoura da alma, continuando, por assim dizer, impactantemente vibrante e ressonante, até que afinal acaba, e a alma retoma seu humor "profano", não religioso, da experiência cotidiana... Ela tem seus antecedentes brutos e bárbaros e manifestações precoces e, novamente, pode ser transformada em algo belo, puro e glorioso. Pode tornar-se a humildade silenciosa, trêmula e sem palavras da criatura na presença de - quem ou o quê? Na presença daquilo que é um Mistério inexprimível e acima de todas as criaturas."

O teólogo e místico cristão Agostinho de Hipona aborda a questão em sua autobiografia, *Confissões*, na qual ele reconhece a dualidade do numinoso, com suas conexões com algo que não podemos compreender plenamente, mas que nos enche de temor e admiração, bem como de um frio entorpecente. O "completamente outro" de Agostinho é a sua percepção de estar ligado a Deus como uma realidade alternativa, mas definitiva. Ele escreve: "O que é aquilo que reluz através de mim e percute meu coração sem feri-lo? Estremeço tanto quanto me inflamo. Estremeço no quanto lhe sou dessemelhante. Inflamo-me no quanto lhe sou semelhante."

Numinosidade é chamada de muitas coisas por muitos pensadores. Freud chama isso de sentimento oceânico; Jung mantém o termo *numinosum* de Otto; Maslow chama isso de experiência de pico; Albert Einstein, de o sentimento religioso cósmico; Ted Peters, da sensibilidade além; Mircea Eliade, de o inteiramente outro; e no budismo é chamado nirvana.

Jung e os arquétipos herdados

O *numinosum* é involuntário e toma as pessoas, controlando-as em uma alteração peculiar de consciência. É tarefa da religião considerar esse estado, mas Carl Jung faz uma clara distinção entre religião e credo. "A religião me parece ser uma atitude peculiar da mente humana, que poderia ser formulada de acordo com o uso original do termo *religio*, isto é, uma consideração cuidadosa e observação de certos fatores dinâmicos, entendidos como 'poderes', espíritos demônios, deuses, leis, ideias, ideais ou qualquer outro nome que o homem tenha dado a fatores como ele encontrou em seu mundo poderosos, perigosos ou úteis o suficiente para serem levados em consideração cuidadosa, ou grandes, belos e significativos o suficiente para serem devotamente adorados e amados." Assim, a religião é a experiência trazida pelo numinoso, mas a religião institucional não é a mesma coisa; é dogma e credo, meramente formas codificadas da experiência numinosa. Essas formas coagulam em rituais estáticos e instituições inflexíveis. Assim, a numinosidade não é reservada a praticantes religiosos extremos e devotos, nem a santos e místicos. Ela pode ser alcançada por todos nós através da oração, meditação, yoga, canto, dança ritual e até mesmo através de uma paixão 'devota' por elementos culturais como natureza, ciência e arte. E pode, é claro, ser alcançado pela busca de Deus, como Newberg registrou nas ondas cerebrais de monges budistas e freiras católicas. Alcançar a numinosidade, ou nirvana, no entanto, é uma jornada longa e difícil. "Nem todos alcançamos o nirvana e é improvável que o façamos. Talvez seja a busca da iluminação ou de Deus, e não a realização real da iluminação ou a descoberta

de Deus, o aspecto mais saudável e transformador da religião. Nessa busca, não há motivo para não convidar a ciência, incluindo as neurociências, para o passeio", diz Grassie.

Jung não afirma que Deus existe, apenas que existe uma imagem arquetípica Dele; Deus é real nas mentes dos crentes. Assim como os mitos associados às religiões do mundo, como o nascimento virginal, em que Jesus, Maomé, Perseu e Buda nasceram de virgens. Jung afirma que ele nunca tentou provar que o nascimento virginal era uma ocorrência verdadeira. O que é comprovadamente real é que a mente funciona de uma certa maneira que permite que muitas pessoas acreditem que o nascimento virginal ocorreu. "Vivemos em um contexto moderno, onde as coisas definitivas são duvidosas, onde há uma pré-história de enorme extensão, e onde as pessoas estão plenamente conscientes do fato de que, se existe alguma experiência numinosa, é a experiência da psique. Não podemos mais imaginar um mundo empíreo, celestial, girando em torno do trono de Deus, e não sonhamos em procurá-lo em algum lugar por trás dos sistemas galácticos. Mas a alma humana parece abrigar mistérios, pois para um empirista toda experiência religiosa se resume a uma condição peculiar da mente."

Em uma declaração presciente feita 80 anos antes de Newberg confirmá-la com experimentos neurobiológicos, Jung nos apresentou arquétipos que explicam sua certeza de que a biologia e o cérebro, que alimenta a mente, estavam por trás do pensamento religioso. Ele havia testemunhado incontáveis pacientes expressando ideias religiosas que prevaleceram nos últimos 2.000 anos. "Tal continuidade só pode existir se assumirmos uma certa condição inconsciente trazida pela herança biológica. A qualidade herdada, imagino, deve ser algo como uma possibilidade de regenerar as mesmas ideias ou pelo menos semelhantes. Eu chamei a possibilidade de 'arquétipo', que significa uma pré-condição mental e uma característica da função cerebral."

Revisão de Freud

Logo após a publicação de seu livro, *O Futuro de uma Ilusão*, em 1927, Sigmund Freud recebeu uma carta de seu amigo, Romain Rolland, um romancista e místico francês que disse a Freud que concordava com sua avaliação da religião como uma ilusão, mas que Freud errou o alvo quando não reconheceu o verdadeiro significado do sentimento religioso. Freud escreve: "Isto, ele (Rolland) diz, consiste em um sentimento peculiar, sem o qual ele mesmo nunca está, que ele encontra confirmado por muitos outros, e que ele pode supor estar presente em milhões de pessoas. É um sentimento que ele gostaria de chamar uma sensação de 'eternidade', um sentimento de algo ilimitado, sem amarras - por assim dizer, 'oceânico'"

Freud nunca encontrou tal sentimento em si mesmo, mas não questiona que, para outros, é um vínculo subjetivo e indissolúvel com o universo. Sua teoria vem da psicanálise, na qual o ego de um adulto maduro, com seu claro delineamento de si mesmo e do outro, reteve vestígios de um estado infantil antes que o ego reconhecesse essa delineação, quando o mundo e a criança são um. À medida que a criança amadurece, o ego se separa da massa de sensações mundanas que lhe são desagradáveis, até que o ego maduro possa rejeitar e remover o que for uma fonte de descontentamento. O sentimento oceânico, para Freud, é compreendido como uma patologia do egoísmo embaçado, algum remanescente do ego e do mundo como um.

Em seus escritos posteriores, Freud revisa sua visão dos humanos como primariamente governada por um instinto destrutivo ou mortal encontrado em um id agressivo e bárbaro, que estamos constantemente sob pressão para conter através do superego (culpa interior), quando realmente não desejamos fazê-lo. Talvez se tivesse vivido, Freud teria reimaginado seu sentimento oceânico como governado por sua teoria posterior de Eros, o instinto de amor, que é encarregado de "combinar indivíduos humanos isolados, e depois disso famílias, então raças, povos e nações, em uma grande unidade, a unidade da humanidade, transformando

o múltiplo em um." Freud chama a versão revisada sua teoria dualista de destruição e construção de uma luta cósmica de opostos, a batalha dos gigantes dentro de nós, entre amor e ódio, e parece ser razoável atribuir o sentimento oceânico a Eros como um princípio cósmico de criação, expansão, unificação e preservação, nossa conexão com algo maior. Em seus anos finais, até o mestre da mente reavalia o que a vida, a morte e a eternidade significam para os humanos.

Maslow e a religião pessoal

Na hierarquia de necessidades de Abraham Maslow, o início da psicologia humanista, ele coloca a experiência numinosa no topo da pirâmide, como um estado que não poderia ocorrer até que as necessidades básicas de fisiologia, segurança, amor, pertencimento e estima fossem satisfeitas. Poucas pessoas foram consideradas capazes de alcançar esse auge; afinal de contas, devemos viver e manobrar o mundo mundano todos os dias, mas Maslow acredita que é possível para todos que trabalham duro para isso. A auto-realização é o estado de conhecer e de ser, no qual todos os preconceitos e medos desaparecem, e um verdadeiro senso de moralidade interior, saúde psicológica e contentamento nos toma. Parte desse processo é o numinoso, ou como Maslow o chama, a experiência de pico.

Embora o numinoso tenha começado como um conceito reservado à contemplação religiosa, predominantemente pelos místicos e pelos profetas de todas as altas religiões que procuraram comunicar suas revelações às massas, a teoria de Maslow amplia o conceito para incluir todos nós, em todos os tempos, que fizermos as perguntas relativas ao nosso significado e existência. Maslow considera a religião institucional como em desacordo com a experiência de pico, porque a hierarquia é composta de indivíduos que não atingiram o topo e que, ao longo da história, apresentaram respostas intelectualmente inaceitáveis a questões existenciais. "As próprias questões religiosas - e as missões religiosas, os anseios religiosos, as próprias necessidades religiosas - estão profundamente enraizadas na natureza humana e podem ser estudadas, descritas, examinadas de maneira científica e as igrejas estavam tentando responder perguntas humanas perfeitamente sadias. De fato, as psicologias existencialista e humanista contemporâneas provavelmente considerariam uma pessoa doente ou anormal em um sentido existencial se ele não estivesse preocupado com essas questões 'religiosas'".

A experiência de pico é encontrada em contextos teístas ou sobrenaturais e não teístas; ela é única para cada pessoa. Assim, "cada um que atinge o pico descobre, desenvolve e retém sua própria religião".

Numinosidade e Ciência do Cérebro

E assim, o cérebro grande e complexo em nossos primeiros ancestrais processou as respostas a questões de sociabilidade, memória, imaginação, mas especialmente ao medo e ao perigo iminente, em que as estruturas límbicas acionam o sistema autônomo. Mas por causa do córtex cerebral, mais desenvolvido em humanos do que em qualquer outro animal, os humanos começaram a pensar abstratamente, percebendo o perigo antes que fosse iminente e resolvendo-o por meios inventivos, como fabricar ferramentas e unindo-se, tanto para segurança quanto para caça. Nossos ancestrais também usaram esse pensamento abstrato para vislumbrar um futuro melhor para todos. Eles promulgaram leis, moldaram civilizações, descobriram a ciência e a tecnologia, criaram arte e música e adotaram religiões para responder a questões existenciais. "Todos os lugares sublimes para os quais a realização humana nos levou - desde a primeira ponta de lança até a mais recente inovação na cirurgia de transplante cardíaco - podem ser rastreados até a necessidade da mente de reduzir a ansiedade intolerável que é o modo do cérebro de nos alertar de que não estamos seguros." Esses processos de pensamento de alto nível são chamados de operadores cognitivos. Esse processo adaptativo foi tão bem-sucedido que a evolução forneceu ao cérebro humano uma compulsão biológica para usá-lo, o que é chamado de imperativo cognitivo, que nos leva a entender

o mundo usando nossos cérebros para analisar a realidade. Nosso anseio ontológico, inspirado pelo imperativo cognitivo, levou nossos ancestrais a lidar com suas ansiedades sobre a morte e o significado, criando histórias e, finalmente, mitos para organizar suas percepções. "A narratividade coloca em jogo todos os circuitos cognitivos e emocionais evoluídos para lidar com a experiência real", diz o renomado biólogo E.O. Wilson."

Mito

Os mitos evoluíram das narrativas, a maioria dos quais é estruturada para apelar para o imperativo cognitivo. Uma preocupação existencial é identificada, e a preocupação é enquadrada em termos dualísticos, entre opostos em disputa e, finalmente, essa preocupação é resolvida, muitas vezes por deuses que aliviam o cérebro de suas preocupações existenciais, fazendo-nos sentirmos aliviados e felizes. Por exemplo, na mitologia cristã, um dualismo existencial é identificado por Agostinho, nomeando o céu como a cidade de Deus e a Terra como a cidade do homem. Os humanos são pecadores, então o céu é inatingível para eles, até que Deus benevolentemente sacrifica seu único filho Jesus que, com sua morte e ressurreição, proporciona a salvação eterna à cidade do homem. Outros deuses e homens escolhidos corrigiram a fenda entre o céu e a terra, incluindo o egípcio Osíris, o grego Dionísio, o sírio Adônis e o mesopotâmico Tamuz.

A criação do mito é mais fortemente influenciada por dois operadores cognitivos, o operador causal, que permite que nossos cérebros liguem um evento a uma causa abstrata, e o operador binário, que permite que nossos cérebros definam o mundo nas dualidades sobre as quais Carl Jung escreveu. O imperativo de Jung de que a dualidade cria ordem no universo é um truísmo evolucionário ligado ao operador binário, que não apenas identifica os opostos, mas que evoluiu para criá-los como um modo de conceituar espaço e tempo em unidades gerenciáveis. Newberg teoriza que o *Homo erectus*, nosso ancestral de várias centenas de milhares de anos, ostentava um cérebro complexo o suficiente para conter a rede neural para linguagem e fala, incluindo um lobo parietal desenvolvido para potencializar o pensamento causal e antinômico necessário para a criação de mitos. Muitos desses mitos foram herdados ao longo do tempo. Jung acredita que elas sejam expressões simbólicas de arquétipos: ideias e pensamentos herdados que são universais e que existem profundamente em todas as mentes humanas.

Ritual

Junto com os mitos, os humanos primitivos que viviam em tribos ou clãs, baseados em ligações de parentesco, também praticavam rituais para ganhar o favor das divindades que eles adoravam, bem como por muitas razões pró-sociais, como o controle da tribo, sua hierarquia e sua estrutura de poder. Por muito tempo considerado um fenômeno cultural, o neurobiólogo Eugene d'Aquili nos anos 1970 propôs que o ritual humano tem raízes biológicas, assim como raízes evolutivas em comum com o ritual animal, ambos usados como formas de comunicação, para enviar mensagens de amizade, cumprimentos, submissão e intenção de acasalar. Rituais são comuns em nossa vida cotidiana, o aperto de mão é um exemplo, mas é o uso do ritual na transcendência em que nos concentraremos.

Nossa transcendência em algo maior do que somos é o objetivo primário do comportamento ritualizado. A transcendência religiosa usa o ritual para unir os adoradores a uma realidade espiritual mais elevada, a um Deus ou deuses. Os historiadores nos dizem que os rituais religiosos existiram em todas as culturas humanas de muitas formas diferentes, em nossa busca para entender o mistério de algo além de nossa realidade objetiva. Carl Jung afirma que essa busca é a busca humana inata por uma alma, porque a psique humana sempre desejou satisfazer necessidades espirituais profundas. "Toda a criatividade na esfera do espírito, assim como todo avanço psíquico do homem, surge de um estado de sofrimento mental, e é a estagnação espiritual, a esterilidade psíquica, que

causa esse estado. Apenas aquilo que é signifcativo que nos liberta." A santa mística medieval Teresa de Ávila descreve a experiência transcendente como uma jornada de contemplação em nossa busca de Deus dentro de nós mesmos. Há "um castelo magnífico dentro de nossas próprias almas, no centro do qual o próprio Amado habita", escreve ela no *Castelo Interior*. Nossa jornada aqui sobe do primeiro castelo onde enfrentamos o instinto básico, para níveis mais elevados que representam o coração começando a se encher de amor e empatia pelos outros, até o sétimo e mais alto castelo, representando o cérebro, no qual a transcendência nos transporta para o reino de conhecer e unir-se a Deus.

Já se pensou que o estado alterado de consciência alcançado em numinosidade fosse experimentado apenas por místicos e santos como Teresa, que muitas vezes foram tratados como fanáticos ou delirantes, mas Arthur Newberg acredita que o cérebro é realmente alterado quando alguém se concentra em uma ideia ou o pensamento religioso e a numinosidade, com a prática, é alcansável por todos os cérebros saudáveis. Newberg começou seus experimentos de numinosidade com monges budistas tibetanos enquanto eles meditavam e freiras católicas enquanto eles realizavam uma oração centrante datada do século XIV, *A Nuvem do Não-Saber*. Os resultados foram registrados usando uma técnica de imagem chamada tomografia computadorizada por emissão de fóton único, que mede o fluxo sanguíneo para o cérebro. Ele descobriu que a atividade nos lobos frontais aumentava para seus participantes, especialmente acima dos olhos no córtex pré-frontal, que desempenha um papel vital no processamento da linguagem, das memórias, da consciência auto-reflexiva, das funções sociais complexas, do prazer e das atividades religiosas. Ele observa que os lobos parietais, que nos ajudam a orientar para onde estamos no mundo físico, são retardados na meditação e oração, deixando o praticante sentindo uma sensação de atemporalidade e espaço infinito. "Desta forma, podemos demonstrar que experiências transcendentais, místicas e espirituais têm um componente biológico real. Além disso, as alterações neurológicas que ocorrem durante a meditação interrompem os processos normais do cérebro - perceptiva, emocional e linguisticamente - de maneiras que tornam a experiência indescritível, inspiradora de fascínio, unificadora e indelevelmente real. De fato, a intensidade de tais experiências frequentemente dá ao praticante a sensação de que existe um nível diferente ou mais elevado de realidade além de nossas percepções cotidianas do mundo". Embora essas experiências sejam mais frequentemente interpretadas no contexto de crenças religiosas, os praticantes não religiosos encontraram significado secular neles, como a sensação de estar conectado ao universo, à natureza e a tudo o que sempre foi.

Newberg explica que, na oração, o sentido de Deus se torna fisiologicamente real para as freiras, assim como a sensação de paz interior para os monges. E isso se deve a outra importante estrutura cerebral, o tálamo, que regula a percepção sensorial quando ela entra no córtex pré-frontal e se torna mais ativa durante a meditação e a oração. Embora as percepções sejam alteradas, o tálamo continua a trabalhar para torná-las lúcidas, comunicando um senso de realidade sobre elas ao córtex pré-frontal. Fiel ao sistema de crenças da pessoa, a experiência é interpretada pela freira, monge ou praticante secular como real; transcendente, pacífica e na presença de Deus.

Nossas emoções também estão ligadas à atividade neurobiológica no cérebro. Experiências agradáveis fazem com que o neurotransmissor do prazer, a dopamina, seja liberado no sistema, assim como vários hormônios do estresse são liberados quando nos encontramos em uma situação de ansiedade, que desencadeia sinais emocionais de luta ou fuga. Assim, meditando em algo que acreditamos ser agradável, a amígdala e outras partes do sistema límbico sinalizam para nosso cérebro que uma experiência é emocionalmente poderosa, levando-nos a aceitá-la como real. Buscamos essas experiências agradáveis e gratificantes porque a dopamina, e o núcleo accumbens, juntos, reforçam a motivação para buscá-las.

Existe um futuro para a religião?

Nossos ancestrais paleolíticos, quase 200.000 anos atrás, eram forrageadores que provavelmente se consideravam um elemento da natureza, possuindo espíritos que seriam reencarnados em outros animais ou plantas, o que compunha um sistema de crenças espirituais rudimentares. Pinturas rupestres retratando os espíritos, bem como a vida cotidiana, data até 70.000 anos ap. O sociólogo francês Émile Durkheim nos conta que esses primeiros espíritos eram considerados benfeitores. Ele diz: "É claro que eles punem um homem se ele não os trata de maneira adequada, mas não é sua função fazer o mal." Esse sistema de crenças simples foi a base de instituições religiosas posteriores, mais complicadas e diversas, incluindo a ideia de que os espíritos politeístas se assemelham ao Deus benevolente das religiões monoteístas posteriores. Durkheim também nos diz que, apesar das diferenças de doutrina e dogma, todas as religiões servem ao mesmo propósito, e todas são sistemas reais e verdadeiros de crenças para aqueles que aderem às doutrinas e rituais das várias denominações. "Todas as religiões respondem, embora de maneiras diferentes, às condições dadas da existência humana", diz Durkheim.

A transformação da civilização de pequenos bandos de caçadores e coletores para sociedades agrárias, marca o início de uma hierarquia de poder entre homens e mulheres, estabelecida porque as famílias rurais precisavam do trabalho de muitas crianças, cujo cuidado era relegado às mulheres em casa, enquanto os homens cuidavam da atividade política e econômica em centros comunitários conforme as populações cresceram. Uruk, aninhada entre os rios Tigre e Eufrates, é reconhecida como a primeira cidade da humanidade, estabelecida por volta de 3.600 AEC, no primeiro estado da Suméria (sul da Mesopotâmia). Arqueólogos escavaram dois centros cerimoniais em Uruk, teorizando que eram templos. "O menor, chamado de Templo Branco, a tempo se tornou associado ao deus do céu, An, o pai de todos os deuses, representando a autoridade patriarcal", outro precursor do monoteísmo moderno, escreve David Christian et al. Quando outras cidades da Mesopotâmia foram estabelecidas, foram erguidos templos especiais para atrair e cuidar de deuses especiais que protegessem os moradores e lhes garantissem prosperidade. Hierarquias adicionais foram estabelecidas; incluindo a possibilidade de que os padres vigiassem a construção dos templos com os quais estavam associados, bem como supervisionassem os sacrifícios aos deuses e transmitissem histórias celestiais fantásticas para as classes mais baixas. "Poder religioso, político, econômico e até militar pode, por um breve período, ter estado nas mãos dos sacerdotes", explica Christian. O astrofísico Eric Chaisson qualifica a afirmação de Christian explicando que o "breve período" em que os padres dominavam um público em grande medida analfabeto durou vários milhares de anos e incluiu os ancestrais dos antigos gregos, romanos, celtas, alemães e eslavos, que acreditavam que os deuses da Suméria governavam o mundo através da classe sacerdotal. "Aparentemente, os mitos se tornam verdades se mantidos por tempo suficiente", diz ele. Acredita-se que esses deuses criaram o *Me*, "um termo sumério para as instituições, formas de comportamento social, emoções e sinais de ofício, como um todo, vista como indispensável para o bom funcionamento do mundo." A religião e a política encontravam apoio uma na outra, com a religião promovendo a coesão social, inclusive com a legitimação dos líderes de um Estado, que por sua vez promoviam o sistema de crenças escolhido como religião do Estado. Durkheim reforça essa ideia quando diz que a religião é algo eminentemente social. "Representações religiosas são representações coletivas que expressam realidades coletivas; os ritos são uma maneira de agir que surge no meio dos grupos reunidos, e que são destinados a excitar, manter ou recriar certos estados mentais nesses grupos." O mesmo poderia ser dito da política, mostrando-nos que, historicamente, a religião e a política não eram estranhas uma à outra, o que levou por muitos séculos

a lutas pelo poder, perseguições religiosas e guerras, como as Cruzadas, e ao genocídio, como no nazismo, persistindo hoje em países predominantemente islâmicos onde as duas instituições ainda estão inextricavelmente entrelaçadas.

O cisma que se desenvolveu entre a religião e a ciência ganhou sua posição durante a Renascença, embora o teste experimental e a evidência empírica tenham sido usados já na Grécia antiga. Um afastamento da religião institucional começou durante o período do Iluminismo do século XVIII, quando a razão humana questionou profundamente a doutrina religiosa que a ela se opunha, ampliado ainda mais um século depois, em 1859, com a publicação de *A Origem das Espécies* de Charles Darwin, que refuta conclusivamente as histórias da origem do mundo que foram apresentadas pela religião institucional. Sigmund Freud, no início do século XX, chama de 'ilusões' a natureza psicológica das doutrinas religiosas porque "derivam de desejos humanos" pela proteção do pai contra a brutalidade da natureza e pela promessa de recompensa após a morte (Freud refere-se principalmente à doutrina judaico-cristã). Ele atribui a perda de influência da religião sobre as pessoas ao espírito científico. "Quanto maior o número de homens a quem os tesouros do conhecimento se tornam acessíveis, mais difundido é o afastamento da crença religiosa", diz ele. E, nas últimas seis décadas, as estatísticas mostram uma mudança geracional de proporções sísmicas ainda mais dramática no compromisso religioso. Em uma análise publicada na revista PlosOne em 2015, os autores analisam respostas dadas por 11,2 milhões de respondentes a quatro questionários distribuídos nacionalmente sobre crenças religiosas, que vêm sendo realizados desde 1966. Após comparar pessoas de diferentes gerações em idades idênticas, a análise conclui que os *millennials* são a geração menos religiosa da história americana, seguindo a tendência cultural estabelecida na Europa Ocidental no início do século XX. A teoria é que a cultura ocidental moderna valoriza o individualismo e a filiação religiosa premia o grupo, dominado por um homem autoritário, de quem precisamos para orientação moral e a quem obedecemos por medo de represálias em uma próxima vida, se não o fizermos.

Como discutimos anteriormente, a moralidade é anterior à religião em incontáveis milênios. Em uma explicação de Eutífron, de Platão, Sócrates filosofa que seríamos livres para apelar diretamente às boas razões que os deuses nos dessem para julgar atos morais, e se determinarmos que as razões não são boas, não precisamos seguir seus ditames. "Afinal de contas, pessoas atenciosas podem dar razões para não matar, estuprar ou torturar outros que não o medo do fogo eterno do inferno, e eles não se tornariam estupradores e assassinos de aluguel se tivessem razão para acreditar que as costas de Deus estavam viradas, ou ele disse que estava tudo bem ", escreve o psicólogo Steven Pinker. E no Antigo Testamento, Deus certamente diz aos israelitas que cometam estupros em massa e genocídio, enquanto ferem de morte blasfemos, homossexuais, adúlteros e aqueles que trabalharam no sábado. Nosso dilema é encontrar algo que tenhamos perdido na religião, algum significado que transcende um universo hostil, onde cada um de nós é apenas uma partícula de matéria cujo tempo gasto em um planeta indefinido registra apenas infinitesimalmente na linha do tempo de 13,8 bilhões de anos do cosmos. Freud acredita que "a relação entre civilização e religião deve passar por uma revisão fundamental. Retirando suas expectativas do outro mundo e concentrando todas as suas energias liberadas em sua vida na Terra, (as pessoas) provavelmente conseguirão alcançar um estado de coisas em que a vida se tornará tolerável para todos e a civilização não mais opressiva a ninguém." O poeta alemão do século XIX Heinrich Heine escreveu: "Deixamos o Céu para os anjos e os pardais."

Como deve ser o futuro da religião? Talvez uma *combogênese* , emprestada do biólogo Tyler Volk, na qual uma combinação e integração de coisas previamente existentes formem algo inovador. Algo como a religião cósmica de Albert Einstein, cujo Deus impessoal é fortemente influenciado pelo filósofo do século XVII Benedito de Spinoza. Combinado

talvez com pensamentos de numinosidade discutidos anteriormente e do místico indiano e Prêmio Nobel de 1913 Rabindranath Tagore, que em *The Religion of Man* falou das muitas vezes em que a "música e o brilho de um pôr-do-sol trouxeram aos nossos corações a pulsação do mundo ilimitado." Temperado com as ideias de Andrew Newberg de que nossos caminhos para os nossos deuses serpenteiam através de nossos cérebros, e a realidade é o que cada um de nós percebe que está em nossas mentes. Algo para todos. E em harmonia com a abordagem hermenêutica de William de Grassie, em que todas as religiões contêm elementos de verdade, e todas as perspectivas, incluindo a ciência, podem ser adotadas e tecidas em nossa história humana, um não-violência intelectual em que Deus- por qualquer nome - é "o conjunto de todos os fenômenos - passado, presente, futuro - bem como o que também pode, em certo sentido, preceder e transcender este universo." Todas as nossas histórias, todos nós, contribuem para a narrativa do futuro da religião.

A religião cósmica de Einstein não reconhece o dogma, nem um Deus feito à imagem do homem, mas aceita todas as denominações que o fazem. E milhões de pessoas fiéis, de mente aberta, participam de inúmeras formas de religião; não é a religião que é o inimigo. "O verdadeiro inimigo é a substituição do pensamento, da reflexão e da curiosidade pelo dogma", escreve Frans De Waal. A religião cósmica não é religião baseada no medo da punição, nem reivindica ter recebeu lei moral inflexível de uma fonte divina. A lei moral deve ajudar os seres humanos respondendo às suas necessidades sociais em constante mudança, em vez de atrapalhar os seres humanos, porque se propõe incontestável. Einstein escreve: "O comportamento ético do homem encontra melhor base na simpatia, educação e relações sociais, e não requer apoio da religião." A religião cósmica é humanista e encorajadora. "O indivíduo sente a vaidade dos desejos e objetivos humanos, e a nobreza e ordem maravilhosa que são reveladas na natureza e no mundo do pensamento. Ele procura experimentar a totalidade da existência como uma unidade cheia de significância." Não temos culpa por sermos humanos, e somos, com todos os animais, plantas e matéria inerte, unidos como um ao universo.

Einstein nunca vacilou em seu respeito pelas sinceras convicções religiosas dos outros, uma tolerância que tem faltado nas crenças religiosas institucionais tanto historicamente quanto hoje, embora certamente faça parte da religião cósmica. A aceitação de Einstein das miríades de opiniões religiosas dos outros foi expressa numa carta que ele escreveu em 1929: "Nós, seguidores de Espinosa, vemos nosso Deus na maravilhosa ordem e justiça de tudo o que existe e, em sua alma, revela-se no homem e no animal."(Assim estabelecendo nossa conexão com todas as coisas vivas, incluindo os bonobos de De Waal.) "É uma questão diferente se a crença em um Deus pessoal deveria ser contestada. Eu mesmo nunca me envolveria em tal tarefa. Pois tal crença parece-me preferível à falta de qualquer perspectiva transcendental da vida, e me pergunto se alguém pode, com sucesso, oferecer para a maioria da humanidade um meio mais sublime para satisfazer suas necessidades metafísicas."

Mircea Eliade acrescenta que o cosmo é uma coisa viva e sagrada, e a experiência religiosa cósmica pode ser tão simples quanto observar o céu, com seu poder transcendente de evocar a eternidade. "A categoria transcendental da altura, do supraterrestre, do infinito, é revelada ao homem todo, à sua inteligência e à sua alma".

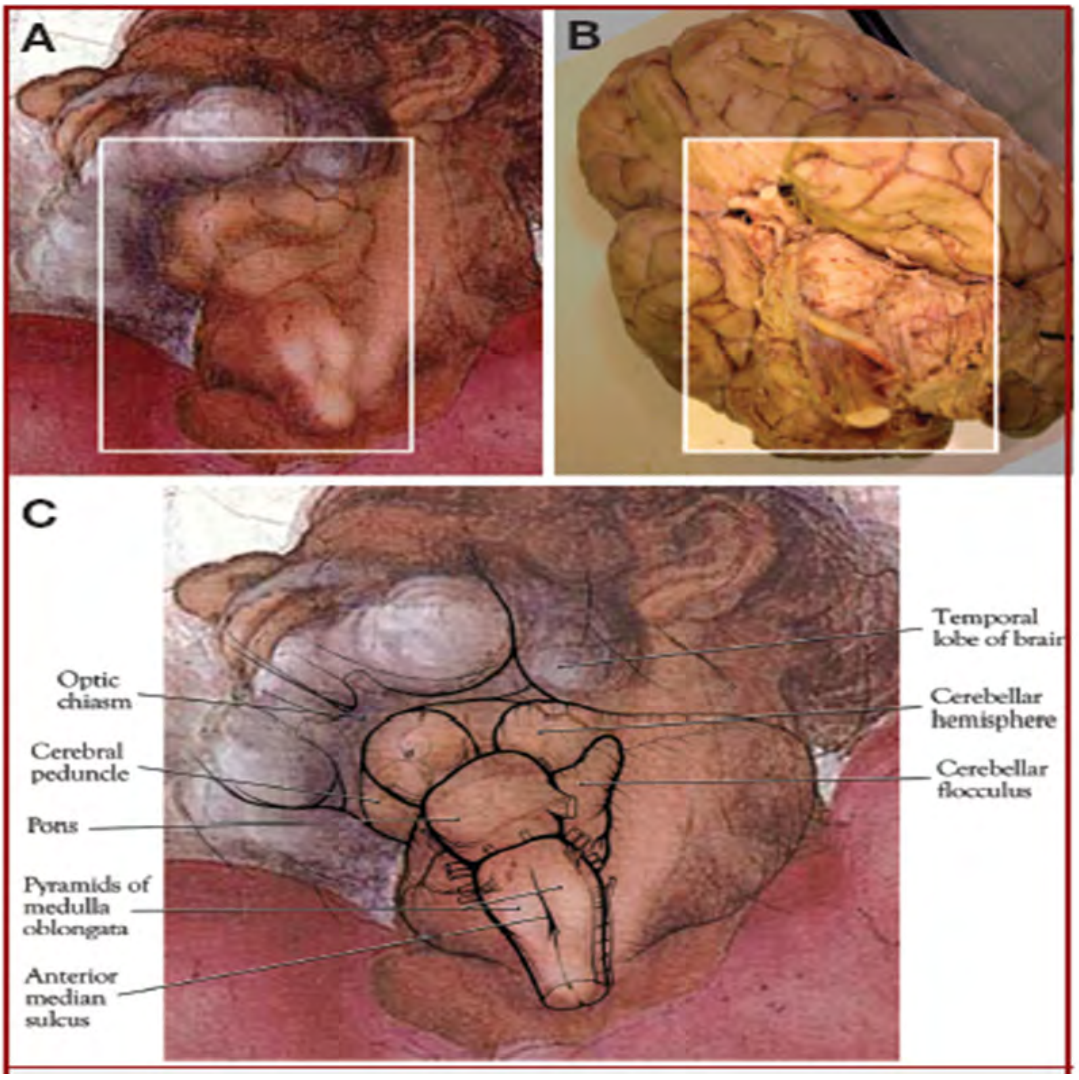
Conclusão

Buda costumava dizer que os humanos interpretam a realidade de muitas maneiras, e não há uma verdade definitiva. Portanto, é improvável que um único sistema de crenças religiosas seja adotado por todas as pessoas, em parte porque as crenças religiosas são cultural e biologicamente enraizadas em nós e não podem ser provadas cientificamente para a satisfação de todos. Nossa busca para saber as respostas às questões existenciais é muito parecida com a tentativa de conhecer o sol, que é parcialmente revelado quando seus raios perfuram as nuvens para nos aquecer. Mas

nós nunca podemos olhá-lo de frente, pois isso nos cegaria. Somos deixados a continuar a usar nosso complexo cérebro com seu córtex frontal altamente avançado, e nossa mente racional mais elusiva, a consciência que pode ser pensada como nossa psique ou alma, para contemplar o divino e dar sentido a este mundo, já que é o único objetivamente real. De fato, o filósofo francês barão D'Hobach descreve o cérebro como integralmente relacionado à alma. Ele escreve: "É pela ajuda desse órgão interior que todas as operações são realizadas, que são atribuídas à alma." A chave para a verdade é a perseverança, a tolerância e o respeito por toda a vida e pelas jornadas e realidades invocadas nas mentes dos outros enquanto nossos cérebros ignoram as percepções sensoriais profanas e se concentram nas forças sagradas que buscamos. O tempo e o espaço estão suspensos e nosso senso de nós mesmos desaparece à medida que a liberação de dopamina contribui para nossos sentimentos numinosos e pacíficos. Newberg diz: "Voilà! Um novo sentido da realidade - isto é, a verdade - desperta em nossos lobos frontais."

Epílogo

Adornando o teto e as paredes da Capela Sistina estão as pinturas de Michelangelo di Lodovico Buonarroti Simoni do início do século XVI, incluindo "A Criação de Adão", "A Separação da Luz e das Trevas" e o "Juízo Final", todos os afrescos pungentes retratando um Deus antropomórfico. Michelangelo, antes católico devoto, voltou-se para o espiritualismo mais tarde, custando-lhe a pensão quando o papa Paulo IV o acusou de blasfêmia por sugerir no "Juízo Final" que o caminho direto de Deus não envolve religião institucional. A mensagem oculta de Michelangelo nas outras pinturas pode ter inspirado algo que Spinoza escreveu mais de um século depois: "Porque tanto a razão quanto as crenças dos profetas e apóstolos evidentemente proclamam que a palavra eterna, aliança e religião verdadeira de Deus estão divinamente inscritas nos corações dos homens, isto é, na mente humana." Assim, a investigação inteligente, possibilitada pelo cérebro, é o verdadeiro caminho para o próprio Deus ou deuses. Séculos antes do neurobiólogo Andrew Newberg nos dizer que Deus e a religião residem no cérebro, e psicólogos notáveis nos dizerem como eles são uma função da mente, Michelangelo nos mostra em "A Criação de Adão", Deus, cercado por humanos, está envolto em um cérebro humano anatomicamente preciso, e em "A Separação da Luz e das Trevas", pode-se ver na garganta de Deus uma réplica perfeita da medula espinhal e tronco cerebral humano , com lóbulos frontais intactos, o telencéfalo, a artéria basilar, a glândula pituitária e o quiasma óptico, no que pode ser explicado como uma conjunção metafísica de Deus e nosso cérebro. Michelangelo sabia.



(4) From Michelangelo's The Separation of Light from Darkness.

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