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The symbol for the Fifth IBHA Conference, Changing the World, provides the cover artwork for this issue. The logo embodies the four-fold aspects of Big History – Cosmos, Earth, Life, Humanity – represented by the moon and sky, tree and leaves, trail tracks, and ground. all in a kind of yin / yang representation of nature / harmony. In the grooves of the tree bark are the Japanese kanji for yasumu. Yasumu means rest, and joy. It is an ancient and complex imagery, being made up of 人 hito - humans and 木 ki - tree. The combined kanji symbols for people show they are supporting each other beneath a tree. It reminds us that to change the world, we must acknowledge that change comes from engagement, mutualization and symbiosis with each other and with nature, around the world and in the multiverse. Appreciation to Yoshihiro Takishita of Kamakura, Japan for the concept and ideas and to our artist, Ishikha Jain, of the Symbiosis School for Liberal Arts, Pune, Maharashtra, India. —Barry Rodrigue

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Social Singularities in Cosmic Environments: Engendering Big History

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According to archaeologist André Leroi-Gourhan, *humanized space* can be understood on multiple levels – for meeting basic survival needs, to establish a social system, and as a starting point for understanding the wider conceptual universe.[1] In our own social ecology work, we have found that gender is integral to the spatial dimensions of human life, and so the question arises:

Is Gender also Central to the Study of Big History?
Can we represent gender, so it addresses synergies and symbiotic relationships of the cosmos, as well as concerns for the conservation of ecology and heritage? These questions correlate well with Big History's consideration of the universe's varied environments, making the study of humanized space a key factor in self-understanding.

At Saint-Xavier's College in Mumbai, big-historian Orla Hazra also believes this connection is possible. After teaching the course, 'Awaken to Cosmic Compassion,' as a form of Big History, she reported:

> The experience allows them (students) to reflect on issues in an integral way and to understand that they are part of the global bio / psycho / social / spiritual problem, but more importantly and inspiringly, are also the solution, through right action.[2]

Our article engages with such contexts and finds that there are gaps that need to be bridged. Environment, religion and culture intersect with gender to create vulnerabilities, taboos and marginalization on one hand, and identities, roles and knowledge on the other.

The need for peace, diversity and sustainability are significant, while food security, human space/s and reproductive health are interconnected and are not gender-neutral. As eco-feminist Vandana Shiva writes:

> The displacement of women from productive activity by the expansion of development was rooted largely in the manner in which development projects appropriated or destroyed the natural resource base for the production of sustenance and survival. It destroyed women's productivity both by removing land, water and forests from their management and control, as well as through the ecological destruction of soil, water and vegetation systems so that nature's productivity and renewability were impaired. While gender subordination and patriarchy are the oldest oppressions, they have taken on new and more violent forms through the project of development. This involves, a recognition that categories of 'productivity' and growth which have been taken to be positive, progressive and universal are, in reality, restricted patriarchal categories. When viewed from the point of view of nature's productivity and growth, and women's production of sustenance, they are found to be ecologically destructive and a source of gender inequality.[3]

Food is a powerful tool for studying the social and cultural fabric of communities. Let us look at India's historical landscape as an example. Forests had traditionally complemented agriculture and cattle-rearing, but British colonials and their allies destroyed forests, food security and sovereignty for economic gain, as officials forced farmers to plant indigo, opium and cotton for export, leading to a loss of land for sustenance. Soil degradation and food scarcity resulted, along with a crisis in animal husbandry, with decline in grazing land. Then commercial agriculture gave way to monocrops, as a result of the Green Revolution in the late 20th century.

Despite this legacy of ecological destruction, the cultural landscape of India is littered with food. Besides a biological necessity and an economic commodity, food is a primary ingredient of ritual and social transactions, a medium of family and social engagement, and a marker

Figure 1: Rice planting in paddies, Shakrori, Himachal Pradesh, July 2010. Photograph by Richa Minocha.

of social boundaries. Food is an ecological and socio-cultural reality. Different parts of the country have evolved their own cuisines and balanced diets. Diversity persists, as same-titled foods, such as *chutney*, are made of varying ingredients in different parts of the country. Cooking skills are central to the identity of Indian women.[4]

Besides being the ones who convert food into meals and feasts, women are central to agricultural production. Indigenous food knowledge lies with women, as they know that food eaten in the right season and cooked in a certain manner can be healing. They nourish, take care, and heal through food. During lactation and pregnancy, they convert their own bodies into food for their offspring.[5] Despite such a central role, women are barely acknowledged as farmers by the general public.

This cultural erasure of women's participation in cultivation took place through an eco-historical process. The shift from swidden to settled agriculture led to a decline in the status of women, as traditional matrifocal life led to patrifocal society. Food became a basis for this discrimination, with menstrual taboos and notions of what to eat / not eat during menstruation and pregnancy bringing about women's subordination. Women's ability to contribute to agriculture crucially depended on their access to land, but they were and are now disadvantaged because of male bias in inheritance laws and restrictions on their access to land through government land programs.[6]

Nonetheless, during ecologist Richa Minocha's field survey in Shakrori village in Himachal Pradesh in 2007, women celebrated the agricultural festival of *Bishu ki Sajji*.[7] The prime spring harvest day, it honours the crops, water and soil, giving thanks and hope for continued abundance, health, and fertility. After the harvest, water-filled earthen pitchers are gifted to married daughters and priests. The floor of the house is plastered with fresh cow manure and special meals are made of sugar, rice, pulses, and homemade clarified butter. The new agricultural produce is shared with Brahmin priests and married daughters, and the leftovers from the previous season are distributed among lower-caste communities.

While the festival itself does connect communities and celebrates fecundity and womanhood, it has discriminatory elements, since it excludes lower-caste women. In her pioneering work on Brahmanical patriarchy, historian Uma Chakravarti argues that women's sexuality was restricted in order to safeguard caste. Women were considered 'gateways' into caste, which needed to be policed to protect its 'purity.'[8]

Women in Shakrori expressed how much they relate to the Goddess Sita, who was worshipped at water sources and as an agricultural Goddess and daughter of the Earth. Sita had refused the fire test that her husband Ram wanted her to undertake in order to prove her purity, and, instead, she invoked Mother Earth and buried herself alive. Focusing on archetypical female figures from traditional Hindu texts can be problematic, whether they are goddesses, epic heroines like Sita, or *viranganas* (women warriors). This is because these accounts exclude women from minority religious communities as well as Dalit (lower-caste) women.[9]

In 2010, the women in Shakrori, however, overcame caste barriers and united to stop the French conglomerate, Lafarge, from setting up a cement plant near their village by giving evidence how it would destroy the ecology and their livelihoods. Another success for women's solidarity has been in how tribal women in Odisha mobilised to save their forests from being taken over for development projects, arguing that their woodlands were the source of their food security and sovereignty, so they had a vested role in conserving them. Kondh women in Odisha also took on the might of the conglomerate, Vedanta Resources, and protested when the government gave preference to bauxite mining over their livelihoods.[10] As the Kondh activists saw it, the forests are their means of life, livelihoods and space for their community, and specially the women.

The Feminine Principle and Menstruation Myths

There is an array of literature in the Shakta-Hindu tradition that explains the nature of the Goddess Sita as an all-pervading reality, manifesting herself in different and diverse, but interrelated, aspects of the world. She is especially revered by women.

> Sita is also worshipped throughout India as a spouse goddess, the wife of Rama, an avatar of Vishnu, the Preserver God of the Universe. Her story appears in the epic, Ramayana … when she is adopted by King Janaka, who finds her while ploughing the land of his kingdom during a drought. The drought ends and Sita's auspiciousness is established. Sita later marries to Rama, the crown prince of Ayodhya. She spends fourteen years in exile with her husband, during which time, she is abducted by Ravan, the king of Lanka. When Rama finds her, she is asked to enter fire, to prove her fidelity to him. She comes out of it unscathed, but, after their return to Ayodhya, she is abandoned again by Rama. Sita moves to Saint Valmiki's Ashram, where saints and religious people live, raising her two sons. It is a haven. When Rama finds out about this, he wants to take back his sons, but asks Sita to prove her purity a second time. She refuses and prays to Mother Earth to take her back to the place from where she was born before being adopted by Janak.[11]

There are many folk versions of Sita's story, and women relate to Sita as a goddess protecting water sources, a great preparer of foods, and a virtuous woman. This integration of existence is explained by Gargi, a historical woman philosopher in dialogue with a male counterpart, Yajnavalkya, in a convocation, about 800 BCE. She spoke about the connection of water and earth to the feminine principle. But she was silenced by the men and noted their refusal to listen.[12]

During *Raja Parba*, a menstruation festival dedicated to the Mother Goddess Earth in Odisha in June, when the hot weather is at its peak and the monsoon rains are about to arrive, the earth itself is said to be menstruating.[13] It is believed that to plow or dig the earth during Earth's menstruation period violates her and makes her unhappy. However, while this ancient festival honours women's fertility, nature and the continuity of life, dimensions of power changed. Male control over society, natural resources

(like land and water), and women's bodies (and labour) took place. It was no accident that this gendered power-shift was the result of increased agrarian commercialization and specialization, a trend that continued in modern industrial and post-industrial gendered disparities.

Art historian Ananda Coomaraswamy pointed out how the capitals of Ashokan stone pillars, erected across the expanse of India's first empire – the Mauryan – over 2200 years ago, represented an inverted lotus. (Fig. 2). He noted that the lotus had been drawn from the 'oldest Indian cosmology, that of water … ,' where '… we meet at once with the idea that water is the source and support of all things, particularly the source of life, and the support of the earth.'[14] In other words, the perception of water as infinitely potent and fertile had been built into these monumental structures.

The origin of the myth of women's impurity during menstruation and childbirth has its origin in the Vedic period. Sanskrit-scholar Wendy Doniger O'Flaherty states: 'The Rig Veda is a book by men about male concerns in a world dominated by men; one of these concerns is women, who appear throughout the hymns as objects, though seldom as subjects.'[15] Menstruating women in Indian societies came to be looked upon as filthy and unhygienic. Because they had little information and awareness of puberty, menstruation and reproductive health, it was difficult for women to overcome socio-cultural taboos and attitudes.

Women were prohibited from going to the mandir (temple) or masjid (mosque) to participate in prayers and religious ceremonies. They were forbidden from reading holy books and were told of the importance of bathing rituals after menstruation. Over time, the ancient, positive festivals were corrupted into events prejudicial to women – instead of a well-worshipping ceremony to celebrate the source of water and the feminine principle, bathing rituals

Figure 2a: Left – Top of the Ashoka pillar from Sarnath, Uttar Pradesh (India). Dated to 250 BCE, the inverted lotus provided a base for the circular abacus and lions. From Daya Ram Sahni, *Catalogue of the Museum of Archaeology at Sarnath*, Calcutta: India Government Printing, 1914: Plate 4; courtesy of Wikimedia Commons.

Figure 2b: Below – Ashoka pillar at Vaishali, Bihar (India), 2007. A view of how the Sarnath pillar might have appeared when standing. Courtesy of Wikimedia Commons.

became a purifying rite to cleanse women of their male-perceived contamination.[16]

The social stigma attached to menstruating women was highlighted by interviews with women in the village of Shakrori, who said that they were not allowed to cook or touch sweet and sour foods such as pickles. They couldn't enter kitchens and were sent food in their isolation from households. Many of the restrictions were said by Brahmanical prescriptions to insulate men from defilement. The women still spent their time working in the fields and resting in livestock sheds or backyard rooms. Anthropologist Mitoo Das looked into the world of menstruation and taboos among Hindu women in Simlitola, Assam. She writes that it is ironic that the menstruation of the Earth Goddess, *Mother Kamakhya*, is worshipped by men and women both, while the menstruating women themselves are forced into seclusion.[17]

The Indian courts, however, have agreed that how society sees menstruation is a problem. Public interest litigation (Nirjhari Sinha v. Union of India), in 2020, led to an order by the Gujarat High Court that the state should end menstruation taboos and discriminatory practices. The court proposed nine guidelines, the first of which read: 'Prohibit social exclusion of women based on their menstrual status at all places, be it private or public, religious or educational.' The guidelines also outlined the state government's responsibility for creating public awareness about these issues through campaigns for community sensitisation and by incorporation into school curriculums.[18]

While all women might *obtain* the same laws, socio-cultural traditions can still maintain discriminatory systems. For example, non-dominant-caste women can remain impure in the eyes of not only upper-castes, but even among themselves, as a form of internalised discrimination. Human-rights activist Deepthi Sukumar argues that, while upper-caste women might be seen as impure during their periods, she herself – as a Dalit woman – will always be seen as *impure*: 'At their core, the menstrual taboos are designed to maintain the systems of caste and patriarchy for the dominance of the touchable caste men. Menstrual behaviour and taboos are part and parcel of the caste and patriarchal design to maintain the hierarchy of caste structure by propagating and using the belief system of purity and pollution.'[19]

Abortion and Contraception: Gendered Contexts

Unintentional miscarriages were called *sramsana* and were accepted.[20] However, ancient Indian texts denounced induced abortion as a sin, as in the *Rig Veda*, *Dharma Sutras*, and *Smritis*. Aside from instances where abortion was permissible in order to defend pregnant women whose lives were in danger, abortion was denied.[21] Indeed, sexual relations in general were intertwined with spiritual concerns, such as *karma* (cause and effect), *dharma* (divine observance) and *ahimsa* (non-violence), along with reverence for human life and the environment.

The law of *karma*, for example, saw abortion as depriving a person of a cycle in their birth / rebirth, and so *brunahathya* and *garbhahatya* (abortion) implied the intentional act to be *hatya* (murder) or *hinsa* (extreme violence).[22] Attitudes towards contraception and sexual activity without reason were also seen as immoral, but the use of contraceptives and even surgical procedures were used to prevent conception in ancient India. This can be seen in the *Atharva Veda* (c. 1000 BCE), as contraceptives were advised for insertion in the *yoni* (female genital tract), which was a basic intrauterine device.[23] So, unlike abortion, contraception was ambiguous in its moral implications.

Rishi Charaka, a founder of Ayurvedic medicine and compiler of the *Charaka Samhita* (c. 100 CE), recommended contraceptive methods based on reproductive physiology. His text includes uses that we would today describe as safe periods, anti-implantation agents, inhibition of ovulation / spermatogenesis, intrauterine devices, and antizygotic drugs. Most Hindus accept the duty to have a family during their life-stage as a householder, but economist Sriya Iyer argues that, in Indian society, contraception use is neither controlled by women nor intended to further their autonomy; instead, contraception has classical roots that served to control women's bodies.[24]

In 1964, an Abortion Study Committee was established on the advice of the Indian Government's Central Family Planning Board. Their report, two years later, recommended legalising abortion for humanitarian and medical reasons, in order to protect women's health and lives. The law was approved, with some modifications. Then the Medical Termination of Pregnancy Act of 1971, a liberal and progressive abortion law, was enacted and is now part of the Indian Penal Code.[25]

Since then, it has undergone three amendments, the most recent of which was approved in March 2021. It permits increasing the upper gestation limit for abortions from

20 to 24 weeks for special categories, including survivors of rape, incest victims, the differently-abled, and minors. It also requires the opinion of one healthcare provider for the termination of pregnancies up to 20 weeks and of two healthcare providers for the termination of pregnancies between 20 and 24 weeks and includes a confidentiality clause. All reasons for abortions are permissible, and it ensures universal access to comprehensive medical, eugenic, humanitarian, and social care.[26]

However, there is still the issue of social stigma (particularly for single women) and there are major discrepancies in location and cost that compound the problem. India had 15.6 million abortions in 2015. Of these, 3.4 million (22%) took place in medical institutions, 11.5 million (73%) outside medical facilities but used medical techniques, and 5% by other techniques. In India, where 73% of abortions are unsafe, there is a high prevalence of danger for women. [27]

Conclusions

In his essay, 'A New Design for Living,' geographer Barry Rodrigue unambiguously calls for a revaluation of our priorities and ways of viewing ourselves and our needs on a planetary scale. He describes Big History as a paradigm that seeks to break down categorical knowledge and education domains, allowing us to see through the walls of nation-states and even our species. Likewise, big-historian Antonio Velez situates the production of knowledge in social systems and helps us understand the role of gendered hierarchies in what gets regarded as learning.[28]

Palaeontologist Nigel Hughes draws attention to the realms where Big History is characterised, as he outlines facts about the Earth's history and the evolution of the Earth's Life System. He writes how ancient changes demonstrate how important it is to understand the past for predicting our future. Ecofeminists have raised similar critical questions about the interconnectedness of all living beings, including humans, nature as a whole, and the evolution of biological and cultural histories. They see a feminine principle at the base of interconnectedness.[29]

Hence, big-historians and ecofeminists alike call for revaluations and a better understanding of our past in order to reconceive our present. In referring to the interlinkages and interconnectedness around the planet, big-history artist Paula Metallo talks of unifying geographical and historical extremities, to reveal as visible the things that were once invisible:

> To me, the most fascinating aspect of modern culture and Big History is the awareness of interconnectedness, the weaving of everything together on our planet and beyond, which provides a new place to contemplate. Our universe demonstrates this perspective, one that today's communication systems imitate, allowing us the vantage point from which to appreciate the fullness of things. Anything that one can point to in nature is composed of small patterns that are all part of larger patterns. The new age of communications can provide us – no matter where we find ourselves – with a means to transcend our own patterns and to stand back from a mosaic. [30]

Engendering Big History is important in any attempt to give meaning to our spaces and boundaries. Feminisms and grassroot initiatives foreground big-history's approach to such interconnectedness. As the Kondh women of Orissa testified, they and their ancestors have not only been conserving but have been belonging to the Niyamgiri forests and hill range for centuries, and often times it has been survival strategies of women and not technologies that have helped them survive through fierce weather and drought and rains. These women can be considered grassroot feminists who are practicing Big History, when they insist that policymakers should be posing questions differently, such as asking what survival strategies poor households adopt in order to survive, rather than just asking poor tribal households of what they have been deprived.[31]

Notable sights on the occasion of *Gudi Parwa*, the spring harvest festival in Maharashtra, include street processions, dancing, festive foods, and colourful floor decorations, or *rangoli*. There are also the *Gudi* arrangements kept by each household, as well as a special *Gudi Dvaja,* which is a saree or piece of cloth wreathed with flowers, mango and neem leaves, sugar-crystal garlands called *gathi*, and topped with up-turned silver or copper vessels. The upturned pot (*handi* or *kalash*) signifies achievement. The arrangement is hoisted outside each household and are believed

Figure 3: A *Gudi Dvaja* set up by Richa Minocha and Kanchamma in Dr. Minocha's house on the occasion of Gudi Parwa. In Pune, Maharashtra, India, 22 March 2023. Photograph by Richa Minocha.

to ward off evil, and to invite prosperity and good luck into the house.

According to the Hindu Jagriti Samiti, a conservative nationalist organization, the Gudi Parwa festival celebrates the victory of male Maratha warriors. It is also believed that, on this day, Lord Brahma (with Vishnu and Shiva) created the universe. However, the *Gudi Dvaja* is unmistakably a feminine frame representing fertility and productivity – with its pot, mango and neem leaves, and sugar garland representing the connections of life, water, food, women, and ecology.

Furthermore, the neem leaves are essentially bisexual, the mango leaves either male or bisexual, and the sugarcane reproduces through asexual modes or vegetative propagation. Hence, the *Gudi Dvaja*, in its manifestation and original interpretation accepts diversity in nature and looks at humans as complementary to nature. The bias of compulsory heterosexuality is challenged in this symbolism.

In this kind of analysis, archaeologist Sada Mire connects fertility and kinship rituals in Somalia, through the lens of Big History, with landscapes, objects, and the sufferings of women. She describes how relatively modern religions and ideologies attempt to manage disorder, by assigning meaning to almost every aspect of life.[32] Among these are patriarchal restrictions and taboos imposed on women. While these modern meanings still symbolically link women to productivity and fertility, they also impose an inferior status on them.

In the course of discussions with big-historians at the 2021 Global Big History Conference – the IBHA's Fifth Conference – we authors thought deeply how engendering Big History could be a way to not only better understand social singularities and empower singular groups, but to better spread the inclusive vision of Big History. How this might happen is a dialogue that needs to take place. Some issues are known but have been changing.

For example, at the start of the IBHA, there were few women big-historians – only one served on its first board of directors, now there are three from different countries and different disciplinary backgrounds, along with active members of parallel organizations.[33] The question arises, how might differently gendered perceptions effect research priorities, agendas and projects, not to mention our vision of Big History itself?!

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Big-Historical Environmentalism for the 21st Century

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The beginning of the 21st century witnessed terrorist attacks on the World Trade Centre in the United States. This incident changed global politics and brought new twists and turns in world history. The last two decades have seen the rise of identity politics, leading to the escalation of local conflicts across the world. At the same time, environmental challenges to human societies have become increasingly threatening, manifested on a planetary scale through global warming and loss of biodiversity. The effect of political and environmental challenges happening together is being felt in social-cultural-economic realms. All of these tensions have been starkly laid bare in the way governments and societies in different parts of the world have responded to the challenge of the global covid pandemic that we are currently facing.

The pandemic will ebb and flow, and reduce itself to a non-threatening form in a few years, but the challenges of global warming and loss of biodiversity just keep growing and will plague us for decades to come. While the battle against alarming changes in the environment around us will continue till the end of the century, many experts believe that the seeds of our success or failure will be sown in this decade. The actions we take and the social-economic-political systems we set up by 2030 will largely cast the die for the future of humanity beyond the 21st century. This situation underlines the importance of seeing the big picture that only Big History can reveal by connecting the dots of events in different spheres of human activity on a planetary scale. Our big-history thinking clearly shows interlinkages between seemingly independent crises that seem to be bombarding us one after the other.

Origins and Development

We can trace the origin of both the political and environmental challenges to the start of the use of fossil fuels and steam engines for rapid industrialisation in Europe in the 1850s. Till then, technology development and industrialisation was happening across the world in varied forms, but the pace was slow everywhere. The technologies were human or animal powered or used the power of air or water (windmills and watermills). The low power of the machines ensured that the manufacturing industries tended to be localised in terms of both raw materials consumed and markets for manufactured goods.

However, steam engines, powered by a high-energy-density fuel (mineral coal) changed the dynamics for European industries. The multi-fold increase in productivity demanded more raw materials and larger markets than ever before. The consequence was first over-exploitation of resources and humans in Europe followed by empire-building by Europeans. This mode of production and its associated social toll spread across the world. Industrialisation did bring prosperity and progress too, but its benefits were enjoyed only by a handful of people who were already holding positions of political and / or social power.

After the Second World War, political empires broke up, but economic imperialism continued in some form or other. What was triggered by mineral coal and the steam engine has been carried forward by coal-based electricity and the combination of petroleum fuels and the internal combustion engine. These are driving forces of the so-called globalised economy and connected world of the present day. The resultant socio-economic inequity is the root cause of most of the political strife in the world, whereas over-dependence on fossil fuels and excessive consumption of natural resources are the root causes of most of the environmental challenges.

Both the political and environmental challenges are manifestations of a single multi-sectoral challenge – the challenge of sustaining humans far into the future on planet Earth, the challenge of building a sustainable human civilisation. The environmental challenge has local (such as air and water pollution in developing-world cities) as well as global dimensions (as for climate change). There is also a growing consensus that we should call the present time, *Anthropocene* – the age of humans. This is because humans are irrevocably changing the conditions on the planet, making it uninhabitable for many living organisms. The corollary to this is that it is therefore in the hands of

humans to 'repair the damage' and 'save the planet'.

Many of the solutions being suggested also stem from this thinking. For example, a very large number of people believe that population control will solve the environmental problems, simply because, if there are less humans, then there will be less harm to the planet. Such arguments however ignore the fact that the world's top 20% richest people consume nearly 80% of the total annual resources. Thus, the planetary conditions are not being changed by all humans but only by those who are in the driving seat of the global economy. Data from across the world clearly shows that consumption by the rich has been a bigger driver of the over-exploitation of planetary resources than population size, especially since the 1980s.

Thanks to the hard work put in by many individuals and advocacy groups over nearly a century, population growth-rates across the world have been steadily coming down in the last decades. The absolute population number continues to increase because of improved life expectancy rather than the number of babies born. However, even this effect is levelling off and the global human population is likely to stabilise at around 10 billion by 2070. This should be celebrated as a great success since we have clearly averted the so-called 'population bomb.' It must also be stressed that the drivers of this global success are not based on control but instead on women's education, access to contraceptives, and improvements in health care facilities.

Big History Views

Taking a big-history view puts the environmental challenges in a different perspective. The solar system came into existence about 4.6 billion years ago. The Earth's planetary systems (atmosphere, geosphere and biosphere) have undergone drastic change since then. The continents as we know them were once part of a single land mass and at some future time may again form a supercontinent. Water arrived on Earth in the form of icy rocks that bombarded the Earth during its formation.

The Earth's atmosphere was once predominantly carbon dioxide. The composition of the atmosphere changed because of CO_2 absorption by the oceans and rise of blue-green bacteria – the first organisms to evolve the ability to do photosynthesis. Because of their life processes, carbon dioxide, which was nearly 80% of the Earth's atmosphere was reduced to a few hundred parts per million, and oxygen and ozone were introduced in the atmosphere. This was the first instance of life-induced climate change.

Life evolved and thrived for billions of years near hot volcanic vents on the ocean beds, and many of the ancient organisms still continue to thrive in niches. Even if the anthropomorphic global warming increases the average temperature of the planet by a few degrees, that shift would be insignificant for many life forms on the Earth that have evolved and survived harsher conditions. Life on Earth is not in danger at all from climate change, even if some species went extinct. The Earth as a planet will continue to exist and continue to support life in various forms for another about 5–6 billion years, which is estimated to be the life-expectancy of the sun.

The environmental crisis that we are worried about is therefore not a crisis for planet Earth but a crisis for our species. The goldilocks conditions that helped humans thrive over the last 12,000 years or so are under threat because of our actions. The 'ideal' conditions – from the perspective of an environmentalist – are planetary conditions best suited for humans. Examining the past from a big-history perspective also shows that this is not the first time that humans have faced a challenge of sustainability.

The shift from hunter-gatherer lifestyle to agricultural lifestyle was triggered, among other things, by band sizes outgrowing an ideal population size for a sustainable hunter-gatherer community in a region. Agriculture provides a way to improve the productivity of the land and waters, so the sustainability challenge was solved by changing the way of life. This indicates that, for any population size, there can be a corresponding set of forms of sustainable living. In other words, the Earth is capable of sustaining 10 billion humans without undue pressure on the planet's systems, if the 10 billion humans figure out a combination of consumption patterns or lifestyles to sustain themselves within the planetary boundaries.

The big-history considerations clearly indicate that to frame environmentalism as a 'moral duty of humans towards stewardship of nature' is an extremely arrogant form of human-centric thinking. This thinking often justifies the sacrifice of welfare of a few human communities for the lofty ideal of 'protecting the planet.' Ironically, the decision-makers are the drivers of the economy (which is the true cause of the environmental problems). The sacrificed communities are generally the most disenfranchised segments of society such as aboriginal peoples (who played the least role in causing the problems in the first place). So, what is often sought to be protected under the garb of environmental concerns is the economic status quo.

On the other hand, recognising the need to conserve the planetary systems in their current forms because they are ideal for human survival and progress is a humbler form of human-centric thinking. This thinking is tacitly in favour of protecting the entire biosphere – not because it is a moral duty but because healthy and thriving ecosystems are necessary for the health and progress of local human communities. This line of thinking leans towards a *sufficiency-based economy* – use only as much resources as are needed with the maximum efficiency possible to achieve a decent quality of life for all people.

This form of sufficiency environmentalism does not advocate protecting nature at the expense of human communities, which is based on thinking of humans as something separate from nature. Instead, it supports creation of more equitable and just human societies as a part of a larger vision of strengthening the biosphere and web of life. This kind of environmentalism that clearly highlights the importance of conserving planetary conditions for the benefit of the humans is more acceptable among the general public than moralistic environmentalism preaching altruism.

Practical Experience, Pragmatic Choices

A lot of this thinking has emerged from my own work over the past thirty years or so. In 1991, I worked on improved cook-stove design for my undergraduate R&D project. This gave me a glimpse of how scientific research can help address complex socio-economic problems. The challenge of designing an energy-conversion device that fulfils the daily cooking-energy requirements of a household has kept me fascinated.

After completing my PhD in Physics from the University of Pune in 1998, my first independent research project continued on eco-cooking strategies. It resulted in development of a process for converting agricultural waste into renewable charcoal combined with a highly-efficient and clean-cooking device that uses the charcoal as a fuel. This technology won the Ashden Award for Renewable Energy in 2002, presented at the Royal Geographic Society in London. Since then, I invented other biomass devices for cooking, seeking to reduce smoke in kitchens and dependence on firewood in rural areas.

A significant innovation was developing a preference mapping tool, which uses surveys and focus-group discussions to get a sense of features that kitchen-workers prefer or desire (such requirements are not usually considered when researchers design cookstoves). What we found was that women often are not concerned about the impacts of cooking smoke on their own health but will instead choose to use or not use a stove based on other preferences.

People can be unconsciously set in their ways, so we have to work with them to introduce the new technologies. This increases the chances of them continuing to use our improved stoves. For example, in many northern Indian communities, people want a cookstove with multiple pot holes, so that they can have gravy cooking in one pot

Figure 1: Left – Group discussion with a tribal farming community in the East Godavari District of Andhra Pradesh (India) to learn about their cooking-energy needs in 2018. Right – An impoved clay cookstove with chimney in a rural kitchen in Assam (India) in 2017. Photographs courtesy of Samuchit Enviro Tech.

while they cook rotis in a skillet atop the other hole. Our preference mapping brings out these requirements, and so we ensure that people get stoves that meet all their cooking requirements.

After 2010, as the impacts of climate change started to become more and more evident in a rapidly urbanizing India, my work has focused on devising and promoting scientific strategies for sustainable / climate-aligned urbanisation. One of these was an easy-to-use 'Samuchit Carbon Footprint Calculator for Urban Indians.'

I routinely conduct workshops on climate-friendly lifestyle and sustainable urbanisation that highlight the historical / political context of climate change along with scientific explanations. The objective is to make urban Indians realise: a) the link between lifestyle choices and greenhouse gas emissions and b) how lifestyle choices emerge from a combination of personal preferences, social norms, economic drivers and government policies. I consciously avoid guilt- tripping individuals about their contribution to climate change, while emphasising the need for a systemic change driven by individuals.

My work on biomass energy, household cooking, climate change and urbanisation pushed me to explore the history of cooking-energy technologies and land-use change associated with urbanisation. My scientific training also pushed me to look at climate change as a planetary phenomenon while charting its impacts on local ecosystems and socio-economic systems. I'm actively involved in national and international organisations for renewable energy, equitable sustainable development, climate resilience, and related topics.

My work has been published in peer-reviewed journals, as well as popular publications, and I have presented my views at national and international conferences and workshops. Several national and international awards resulted from this work, including the World Technology Network's Environment Award (New York, 2005), as well as several in India, including selection as one of *Leelawati's Daughters* (2008), a collection of articles on 100 pioneering women scientists in India by the Indian National Science Academy. I was a TEDx speaker and, in 2022, was invited to speak at the *Congreso Futuro*, an international event held annually by the Government of Chile to promote scientific thinking on global issues.

Since 2005, I've run a socially green, consulting enterprise, Samuchit Enviro Tech, which provides information about clean cooking, decentralised waste-to-fuel technologies, urban sustainability, climate change mitigation and adaptation. In 2021, I co-founded OrjaBox, which is focused on promoting fossil-fuel-free cooking for rural and urban populations. I'm a member of several boards of directors in my areas of work in India as well as internationally. I also teach as a part-time faculty member in several universities and institutes.

Figure 2: Left – Priyadarshini Karve talking about climate change and urban sustainability with citizens in a public garden in Pune, Maharashtra in 2017. Right – Priya speaking about climate-friendly technologies for women at COP 24, Katowice, Poland in December 2018.

The various threads of my work came into focus in 2017, when I was introduced to the field of Big History by Prof. Barry Rodrigue at Symbiosis International University. The next year, I began co-teaching a core course on 'Humanity and Big History: Our Challenge for Survival' with historian Afshan Majid and anthropologist Barry Rodrigue, and then became a member of the Board of Directors of the International Big History Association (IBHA).

My interaction with Big History, combined with my training in physics, has given me a unique perspective on local and global environmental and economic challenges. As co-editor of *Shaikshanik Sandarbh*, a Marathi language bi-monthly newsletter on science and education, we published the first Marathi article in an on-going series on Big History.[1] And, in August 2021, I was plenary speaker at the 2021 Global Big History Conference sponsored by the IBHA, the Asian Big History Association, and the Symbiosis School for Liberal Arts.

Conclusion

In conclusion, infusing environmental concerns with a big-history perspective is more likely to help humans deal with the 21st century sustainability challenge. This strongly underlines the importance of big-history education at all levels and making it accessible to all human communities.

Endnotes

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The Study of All Existence: Toward Global Symbiosis

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Crisis and Catastrophe

There is a long history of stories about events that threaten the end of the world or about life after a major catastrophe.[1] The Naxi *Annals of Creation* and the Mesopotamian *Gilgamesh Epic* tell of floods that all but end life on Earth.[2] H.G. Well's 1897 story, *War of the Worlds*, is about Martians invading Earth, but who themselves are killed by a terrestrial epidemic. The 1954 Japanese film, ゴジラ (Godzilla), is about a marine reptile mutated by nuclear radiation that attacks humans. We love to be horrified by such fantasies, but these stories also grab our attention because there is a strong element of truth in them: *Human life is precarious*.

Although real natural disasters frequently occur, causing major loss of life and a breakdown of society, their impacts tend to be limited and local, as with the 2011 Tōhoku earthquake and tsunami or the Maui wildfires of 2023. Of more alarming concern are mega-calamities of a global scale, as happened 250 million years ago, when climate change led to the 'Great Dying,' during which 96 percent of life on Earth went extinct. This was but one of several such events, including the asteroid impact that eliminated most of the dinosaurs 65 million years ago.[3]

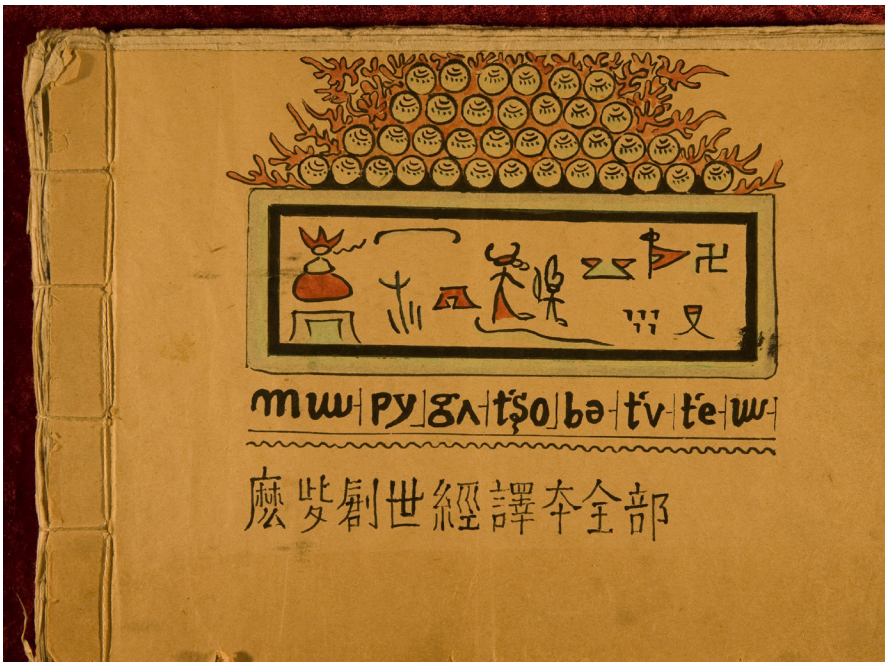

Image 1: Left – Cover of the *Translation of the Entire Text of the 'Yao Annals of Creation,'* c. 900 CE. This was the Naxi origin epic in the Dongba language (colour text) and Chinese (black text). It recounts the challenges their ancestors faced in south-west China and eastern Tibet in their struggles with natural forces. Courtesy of the U.S. Library of Congress and the National Library of China. Right – 'The Coming of the Martians,' an illustration from a French-language edition of H.G. Wells' novel, *The War of the Worlds*, by artist Henrique Alvim Corrêa. H.G. Wells, *La Guerre des Mondes*, Brussels: L'Vandamme, 1906.

Image 2: On the afternoon of 5 November 2015, the small town of Bento Rodrigues in the Brazilian state of Minas Gerais was engulfed by a wave of toxic mud when a nearby tailings-dam burst. The incident caused 20 immediate deaths and more than 600 people were displaced. The pollution spread downriver and into the Atlantic with ruinous effect on habitats, wildlife, and human settlements. It has been described as the worst single environmental disaster in Brazil's history. The local economy was highly dependent on mining, adding irony to the agony. Photograph by Tommaso Protti, 6 December 2015.[4]

In human times, the eruption of the Toba super-volcano in Indonesia 75,000 years ago led to the demise / transition of many human societies around the world, especially from the effects of ash ejected into the atmosphere. Bubonic plague wiped out over 50 percent of the Eurasian population in the 14th century CE, while European colonization of the Americas two centuries later brought Eurasian diseases and systems of oppression that killed, dislocated and marginalized Indigenous populations. These events led to a loss of collective knowledge that is still being reconstructed.[5] It is expected that such catastrophes will happen again, and scholars ask what we should remember so as to be able to re-establish our civilization.

Physicist Richard Feynman noted that a single premise from which society could rebuild itself is the atomic hypothesis, because of the huge amount of derivative information that can be expanded from it. Astrobiologist Lewis Dartnell sees encyclopaedias as primers for rebuilding society and has encouraged such a knowledge-base for modern society. Gender researcher Chaman Pincha advocates for the need to involve women and children in disaster plans – for a full range of social well-being. And educator William Grassie asks what concise template of knowledge would be best to start a 'civilization recovery plan.' He proposes a big-history framework.[6]

While thoughts about how to recover from major cataclysms are important, my own focus is on how to help us think about ways that a big-history perspective could help us to detect the approach of calamities and to at least mitigate their worst effects. I see it not so much as a recovery plan but a counter-measure, or, to phrase it in a more affirmative fashion – as a way to cultivate global symbiosis.[7]

The Great Provincials

As a geographer, I look at many global contexts, but, as an anthropologist, I focus on humans and humanity. Big History bundles these categories together, and so we have an on-going dialogue in our field as to what its key contexts should be. Many big-historians advocate for a strict universal holism, in which humans are just one relative component in the cosmos. This meta-holism is certainly key to understanding the complexities of existence, but, when it comes to actualizing such understandings, our focus needs to be squarely on humanity, since we are the root cause of the Anthropocene crisis. Political-scientist Lowell Gustafson elucidates many of these issues in his analysis of macro-polity in 'Big Politics.'

More specifically, it has been and still is the decision-making of many world leaders and their associates in business, government, education and other sectors of civil society that have brought about and deepen the looming catastrophes we face. As physicist Priyadarshini Karve notes: '… the world's top 20% richest people consume nearly 80% of the total annual resources [of the planet].'[8] Nonetheless, all humans are in this crisis together and everyone will suffer in varying degrees. A more positive side of this view is that all people, in all walks of life, regardless of their positions in society, have a key role to play in safeguarding our planet and its denizens.

Global contact between human populations has proceeded for centuries in a chaotic and violence-strewn fashion. As Caledonian leader Calgacus said 2000 years ago of the Roman Empire: 'To ravage, to slaughter, to usurp under false titles, they call empire; and where they make a desert, they call it peace.'[9] While we have global agreements, they often are limited and do not remedy the root causes of many devastating tragedies, from resource wars in central Africa to the Bhopal chemical disaster. Nor do treaties usually deal with basic or personal human values.

In the Palaeolithic, survival dictated choice, resulting in relatively egalitarian but isolated societies. Later settled communities, along with domestication of plants and animals, led to a greater growth of collective knowledge, surplus production, intercommunication, and work specialization. It gave rise to the *varna* and *jati* systems of South Asia, feudalism in Europe, Andean family-land networks of *ayllu*, and Fengjian governance in Confucian society. Social structures varied further with the rise of global idealism, as expressed by institutions as diverse as religion, corporations, nation-states, and scientific disciplines.

Among the lessons derived from studying social systems is how many traditions are of relatively recent origin. Only four sets of parents take us back a century. By such calculations, we are but 200 generations removed from the Egyptian pyramids, 400 from the rise of agriculture, and 8000 from the migration of modern humans out of Africa. Those 16,000 people are the size of a village – even the National Stadium in Beijing holds almost six times that number![10]

Nonetheless, in those few generations, humanity developed extraordinary social abilities that far surpass other life forms on Earth. Traditions also shift rapidly within and between societies. Think of how personal visits have been largely replaced by mobile phones, e-mail, webcams and other forms of digital communication in only the last thirty years.[11]

It is well known that we humans are prisoners of biology, as, for example, when more than 99.9 percent of the spectrum cannot be seen – so we need technological assistance from Geiger counters to detect x-rays and infrared telescopes to see the oldest stars in the universe. Likewise, we are prisoners of society – a handicap that is not given much thought. We live in a cocoon of customs fostered from birth by our family, neighbours, schools, and governments.

Medievalist Jacques LeGoff observed how western European historians six-hundred-years ago were *Great Provincials*, because they saw their rapidly-expanding world-view through the lens of their own local society. As a result, they misinterpreted situations in Africa, Asia and the Americas, which resulted in tragic colonial policies.[12] It is not much different today, as we still suffer from the disconnect that takes place between local, regional and international awarenesses.

The need for a cosmopolitan vision is of critical importance today, as we walk along a knife's edge of conflict in a world teetering left, right and centre, while juggling nuclear weapons and ecological biocides. But, at the same time, it is a profound challenge for us to expand in new social

directions to become global thinkers. The pressing issue of social reorientation also gets to the root of the political divide between *conservative* and *liberal* traditions, ones that seek to envision a pathway to intentional but carefully considered social change.

A conservative approach believes that traditions were established for important reasons, ones that might not be easily apparent today but that reflect fundamental aspects of human well-being. Indeed, traditionalists are concerned that a change in customs might lead to major disruption of individuals and their social systems.[13] A liberal strategy seeks change that will benefit current situations, ones that will lead in turn to wider and ever-changing transformations. Both approaches seek well-being for members of society.

Instead of seeing these two approaches in a dynamic process of participatory change, people tend to break into factions, defending one position or the other. This dualistic contest has especially manifested itself when political, economic and religious beliefs are involved – in elections, media, wars, and other forms of social expression.[14] Such polarization leads to conflict, despite attempts to harmonize factions. As a result, social change usually happens in a piecemeal fashion, with chance playing as much a role as reason.

There also are two broad layers of activism seeking global change. At the top are a few well-financed and publicised initiatives, from the World Bank to the Audubon Society. At the other end are a myriad of poorly-funded grassroots activities, from groundwater replenishment to urban ecology. The top NGOs know little of local projects, while community NGOs are challenged to connect with upper-level agencies. There is a crucial need to better network these efforts if there is to be remediation of current global trauma. But, in order to keep the positive trajectory of human self-awareness moving forward, we have to first … survive.

A Few Crises

Historical psychologist Akop Nazaretyan documented how humans managed to reduce violence over the last two million years, despite the development of ever more lethal technologies. He codified this phenomenon as the *Law of Techno-Humanitarian Balance*, by which human populations – those that managed to survive – advanced strategies to constrain the use of harmful instruments. He did not limit his study to just weaponry but included destructive mechanisms like chemical contamination, reduction in biodiversity and other behaviours that negatively impact humanity.[15]

The climate crisis is perhaps one of the most significant events in Nazaretyan's formulations, since it has resulted from a constellation of lethal technologies and social constructs. Mega-storms and coastal flooding of low-lying, populated areas is happening from Hong Kong to New York. Entire nation-states are expected to disappear under the sea, such as the Republic of Maldives in the Indian Ocean. Global summits have been held in Tokyo, Marrakech, Copenhagen, Rio de Janeiro, Sharm-el-Sheikh, Paris, and elsewhere. But no broad and secure agreements have been reached.

India, for example, is being dramatically affected in the climate crisis. Upwards of 300 million people will be forced by ocean flooding from the coastal peninsula onto the Deccan Plateau. As it is now, the plateau cannot accommodate such a migration and little attention is given to this impending emergency, and certainly no planning is being made for these climate refugees.[16] This is a pattern throughout India, the hazards of which have been recently seen in Shimla, the capital of Himachal Pradesh.

Shimla is a small city of 200,000 residents that runs ten kilometres along a steep ridge system in the southwest Himalayas. A few British settlers arrived there by the mid-1800s, building cottages in the forests between Pahari hamlets. The area grew into a summer capital for British colonials, and it continued to grow after Independence and Partition. Its alpine conditions provide refuge from Delhi and the parched Central Plains, while its spiritual landmarks and forests attract pilgrims and sport enthusiasts. Last year, fifteen-million tourists visited Himachal, and Shimla has become a major investment site for developers.[17]

Besides lying on steep inclines and in a high-intensity earthquake zone, monsoon rains also increase the potential for landslides. This had been mitigated by the dense evergreen forests that have held the slopes together with their deep root-systems. Dealing with landslides has been a long-term way of life in the Himalayas, as traditional settlements have accommodated such events with small, single-story dwellings made of natural materials on stable ground. It is the current development, coupled with the climate crisis, that has created imminent danger.

Warnings about development began fifty years ago, as traditional homes began to be expanded into hotels to ac-

Image 3: The city of Shimla on the steep slopes of the western Himalayas in the state of Himachal Pradesh. Photograph by Biswarup Ganguly, 2014. Courtesy of Wikimedia Commons.

commodate tourists, along with new concrete buildings and road extensions. This growth was compounded by deforestation, haphazard drainage, and the uncontrolled dumping of debris. Shimla's growth has been largely unofficial, as construction regulations were ignored and penalties for deviance were nominal or even approved retroactively. Although this lack of policy enforcement has been protested, state and federal appeals have been neglected or come to naught.[18]

Regional temperatures in North India have risen over the last 125 years, leading to more intense precipitation during the summer monsoons. As a result, climate change has combined with the reckless construction and administrative disregard to court disaster. In June 2022, Shimla resident and professor of ecology, Richa Minocha, wrote to the High Court of Himachal 'an urgent appeal to prevent the catastrophic environmental disaster which is as such dangerously looming over Shimla.'[19] Her call was prophetic.

In July 2023, heavy rains inundated North India and led to the evacuation of tens of thousands of people, while, the next month, major landslides washed away homes, a temple and roads in Shimla. Schools were shut and over 2000 people were evacuated to relief camps. Much of the disaster is attributed to unregulated construction. It is a pattern expected to worsen in coming decades.[20]

Other cities face similar dilemmas – Moscow, Delhi, Rio, Beijing, Nairobi ... . But this awareness does not deter development. Ventures are in the works to pump water 1000 kilometres from Lake Baikal in Siberia to Gansu in China, while Moscow has begun to intentionally double its urban footprint.[21] City growth not only destroys its own urban area but destabilizes its larger region and has global impacts.

Los Angeles has grown to be the second largest metropolitan area in the United States. There is not enough water to supply its almost 19 million people and their lifestyles.

Image 4: The Collapse of an eight-story building in Shimla, 30 September 2021. Video by Amit Kanwar. For the full video go to: <https://www.tribuneindia.com/news/himachal/multi-storey-building-collapses-in-shimla-no-loss-of-life-318316>. Bhanu Lohumi, 'Multi-Storey Building Collapses in Shimla,' Tribune News Service (Chandigarh, Haryana) 30 September 2021

As a result, a quarter of its water is drawn from the Colorado River, which is so depleted that 90 percent of its flow is extracted before it reaches Mexico, where its estuary at the Sea of Cortez runs dry. This situation is destroying biomes throughout the south-west region of North America and is compounded by the droughts and floods of the climate crisis, wildfires and mudslides, pollution and other spiralling events.[22]

The interdependence of such crises has been revealed by ozone studies. Ozone (O_3) is an ion of oxygen. The ozone layer is found in the stratosphere, 25 kilometres above Earth, which protects life from damage by the Sun's ultraviolet radiation. Excessive UV exposure causes cancer and genetic damage. In the 1970s, scientists detected holes in the ozone layer, which led to international treaties, such as Vienna Convention for the Protection of the Ozone Layer (1985), which reduced the use of chemicals that erode it. This was one of the successes of international treaties.

Excessive ozone closer to the Earth's surface, however, leads to problems with breathing, as seen in urban centres like Beijing, Lahore, Mexico City, and Cairo. This ground-level ozone is a by-product of pollution. The old industrial nations succeeded in reducing both the chemicals damaging the ozone layer and those that hurt respiration, but recent studies show a rise of ozone in the West and have revealed that its source comes from Asia, which had deferred status in the ozone treaties to help its developing economies. The ozone that is so devastating in Beijing and Delhi is now carried on the wind across oceans and is causing dramatic problems worldwide.[23]

These kinds of large integrated problems cannot be dealt with by just local or regional solutions. Global approaches are needed for global crises, but the international ability to resolve these situations is inadequate. Provincial identities inflame conflict around the planet and block resolution of problems. And this is happening at a time when we are running out of resources, fresh water and ... time.

Some Challenges

A challenge we face is how to empower the least developed

of our identities – our global character – and then arrive at a new kind of planetary civilization. Part of the difficulty in such complex problem-solving is that there are so many possible solutions, especially when we involve people from the world's diverse cultural traditions. Akop Nazaretyan noted this versatility of human adaptation in his *Rule of Redundant Variety*, which describes the many ways people around the globe accomplish the same purpose.[24]

Think, for example, about all the ways there are in the world to organize family life or to carry water from one place to another. The variety and flexibility of human societies could allow us to select from the bountiful traditions on the planet and then reconfigure them to resolve wider problems. Often though, we are not even aware of such options since we are such *great provincials*. And this is why economist Adam Smith described the system of production and exchange as an 'invisible hand.'[25]

So, how do we select solutions to global problems among humanity's cultural traditions? Some customs are benign, some neutral, some harmful. It is wise to move to safety when seeing snakes evacuate their underground dens, as ancient Greeks noted, since it can herald an earthquake. Other traditions are less grounded in fact but neutral in their impact, such as carrying talismans, like four-leafed clovers or *omamori* as amulets. But some beliefs are pernicious, such as how social stereotypes have led to slavery, the eugenics movement, genocide, and racial discrimination.[26]

Six years ago, we put together a basic exercise in this process between students at J.F. Oberlin University in Japan and Symbiosis International University in India. Two classes worked together to begin a *Guideline for Global*

Image 5: The Colorado River delta, which ends as a dry riverbed in the Sonoran Desert of Baja California (Mexico), 8 kilometres north of the Sea of Cortez. Photograph by Peter McBride, US Geological Survey, 12 January 2009.

Humanity by using an educational e-network to bridge the 7000 kilometres between our two campuses. The students discussed and began sorting through what traditions in their respective cultures encouraged global identities, in contrast to those that were at odds with or neutral to planetary visions.[27]

One of the traditions discussed was disposal of the dead. Students mulled over the waste of land where elaborate internments are customary, as in North America. In contrast, India and Japan both practice cremation, which is suitable since they have limited land in relation to their large populations. Burning of the deceased is also reinforced by long-standing religious traditions. A downside is that cremation leads to an increased carbon footprint and, in India, to deforestation and pollution of waterways.

One of the least intrusive practices of burial is surface exposure in remote areas, such as in the Himalayas … but it is a tradition has declined because of increasing population and urbanisation. Then the idea of natural decomposition led to a later ecological discovery: Fungi are a primary soil conditioner, and so fungi containers for bodies have been developed. These organic sarcophagi are placed in woodland parks, where they come alive when exposed to the weather and, in this way, human remains join the forest in a matter of months as a living memorial!

It is not that this exercise in 'heritage sorting' is so earth-shakingly important. I cite it to show that such a revisioning of the world can happen and that we can then make decisions in our own lives and in our own communities without waiting for governments, corporations or NGOs to act. We can do it ourselves, right now. It won't save the world, but it will start the process.

There are many other examples of meaningful networking that can serve as models and inspiration for the process of global decision-making. The International Council for Science, *Encyclopaedia of Life*, *University World News* and other projects all engage an international audience to develop inclusive goals. Their initiatives also use *network science* for volunteers to search out and share discoveries on distributed computing systems. The key issue is for us to become engaged in the process of planetary transformation at some level.

In our process of developing a global identity, it does not mean that we give up our other cultural identities but that we develop a super-identity that serves as an umbrella for us all. It would be a federation of traditions, a nesting of identities. The wider the choices, the better the opportunities for our future. We also have to always include compassion, as historian Sun Yue reminds us, otherwise, we run the risk developing a technocratic society devoid of the essence of humanity – altruism.[28]

This leaves the door open for us to more easily adopt new ways of seeing the world and ourselves. Such an agenda would lead us to a new pragmatism, one grounded in both local and global needs. This proposal is a process of *global unfolding*, or *mondalization*.[29] The process can also be referred to as *mutualization* – an intentional commitment to progressive transformation of our relationships, with each other, with the Earth, with other species, and within the cosmos. Such a proposition seeks to establish a new planetary way of thinking and feeling, a true *world view*.

Image 6: Two residents of the community of Santa Maria on the Uruará River, a tributary of Amazon, in the state of Pará, Brazil. They are heading to a community meeting to discuss actions to be taken against illegal deforestation and logging companies stealing timber from their land. Photograph by Ali Rocha: <ali.rocha@alfi xit.com>.

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Endnotes

1 This article is expanded from one I contributed to a Japanese publication seven years ago, and it is in the trajectory of others, as noted in the citations below. Rodrigue 2017. I express my appreciation to Nobuo Tsujimura, Hirofumi Katayama and Penelope Markle in their advice and friendship in its development.
2 Qi 2017.
3 Koshimura and Shuto 2015. Chen and Benton 2012. Alvarez 1997.
4 Photographer Tommaso Protti may be contacted via the following. Portal: <www.tommasoprotti.com>; Telephone: +55 11998863336; Email: <tommasoprotti@yahoo.it>; Postal: Rua Epitacio Pessoa 94, Apartment. 31,

01220-030, Sao Paulo, Brazil. For more information, see Fondation Carmignac <https://www.fondationcarmignac.com/en/tommaso-protti/>.

5 Yong and Xing 2020. Eastman 2009. *Cracking the Maya Code* 2008.

6 Feynman 1964. Dartnell 2014. Pincha 2008. Grassie 2016.

7 This paper continues the thinking of some of my earlier papers. Rodrigue 2012, 2015, 2016. Its trajectory is in the spirit of that laid out by other big-historians, viz. Hughes 2015.

8 Karve 2023: *.

9 Calgacus 98 CE.

10 These generational calculations are estimates, as there have been and are many variables in child-birthing.

11 The awareness of traditions as recent social constructs has been demonstrated in many works, such as those of Mitford 1963, and Hobsbwam and Ranger 1983.

12 LeGoff cited in Nazaretyan 2015: 126. LeGoff 1977.

13 I have argued elsewhere that there is a need to pay attention to ancient traditions that might hold utility from centuries of human evolution. Rodrigue 2014.

14 Among those considering such questions of dualism was philosopher Bertrand Russell 1948.

15 Akop Nazaretyan debuted his concept of techno-humanitarian balance in the Russian journal*, Social Sciences Today*, in 1993. Since then, it has appeared in numerous other publications. Nazaretyan 1993; idem 2010. Psychologist Steven Pinker later documented a similar trend. Pinker 2011.

16 Rodrigue 2022.

17 Kanwar 1984. Agnihotri 2023.

18 Sengupta 2023. Economic Times 2023.

19 Minocha 2022. Economic Times 2023.

20 Tiwari 2016. Rajesh and Goswami 2023. Sharma and Lekhi 2023. Ngashangva and Arasu 2023. Economic Times 2023.

21 Borrell 2015. Zhang 2017. Chalcraft 2012, Sun and Heung 2023.

22 Owen 2015.

23 Lin and others 2017.

24 Panov 2017. Nazaretyan 2004; idem 2017.

25 Smith 1776: Book 4, Chapter 2, paragraph 9. Rodrigue 2019: 119.

26 United States Geological Survey 2017. I use 'race' in its wider sense, not just biological. Race in this context also refers to any 'root' structure, such as religion, class, language, and gender.

27 Rodrigue 2017. Barry Rodrigue had proposed this project in a Japanese anthology about Big History and Universal Studies, so he and volume coauthors and big-history professors Nobuo Tsujimura and Hirofumi Katayama joined together in this inter-university project, which was administered via the Edmodo educational system by Rachael Guarnaccia in autumn 2017. One of the resulting essays was published by Symbiosis student Anaga Krishna in the IBHA bulletin. Krishna 2018.

28 Akop Nazaretyan addressed many of these deep changes made by Big History in his essay, 'A Quest for Immortality,' in which he ponders deep time and how our individual contributions to society take on a life of their own. Sun 2015; idem 2016. Nazaretyan 2016; idem 2017. In some ways, this call for establishing a global guideline by accessing big-history insights is similar to how the discipline of sociology opened up new ways of not only understanding how society functioned but led to the establishment of the profession of social work so as to implement the insights provided by the field of study.

29 While globalization is often used to refer to worldwide business networks, mondalization indicates global networks of a more humanistic, social and ecological kind. Eric Waddell, Le Vigan, Languedoc-Roussillon (France), personal communication (conversation) with Barry Rodrigue, 2002. Among the intellectual sources of this movement were the philosophers, Gilles Deleuze and Félix Guattari, who used the horticultural metaphor of a rhizome to describe horizontal and multifaceted links within and between societies. Deleuze and Guattari 2004. Eric Waddell, Québec, Québec (Canada), personal communication (e-mail) to Barry Rodrigue, 16 August 2009.

Regional and Curricula Contexts

End of the Oikumene:
A Very Short History of the Russian Far East

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There are many parts of the world that do not receive much attention outside of their own resident peoples. This is an anomaly of history and its measurements of value. Why should Niagara Falls or Victoria Falls have more name-recognition than the spectacular waterfall of Ilya Muromets in the Kuril Islands? Why Paris or Capetown instead of Irkutsk? Of course, this is a complex question involving population density, songs, and travel literature! But in terms of big history and universal studies, why should one place be privileged over others?

For example, the literary scholar, Gary Lawless, directly addresses this question in his article on bioregionalism and big history for his own geographic home in the Gulf of Maine, while historian Craig Benjamin assesses the significance and survival of an even more focused area – Jericho in the West Bank of Palestine.[1] So too, I wish to offer a contribution to the argument that our entire planet and all of humanity and life are of significance. Here, therefore is a brief but big history of my homeland.

The Russian Far East is an exotic part of our country. It makes up a third of the Russian Federation, but only about six million people live there, or just over four per cent of the overall Russian population. This territory includes the extreme northeast edge of Eurasia, from Chukotka and

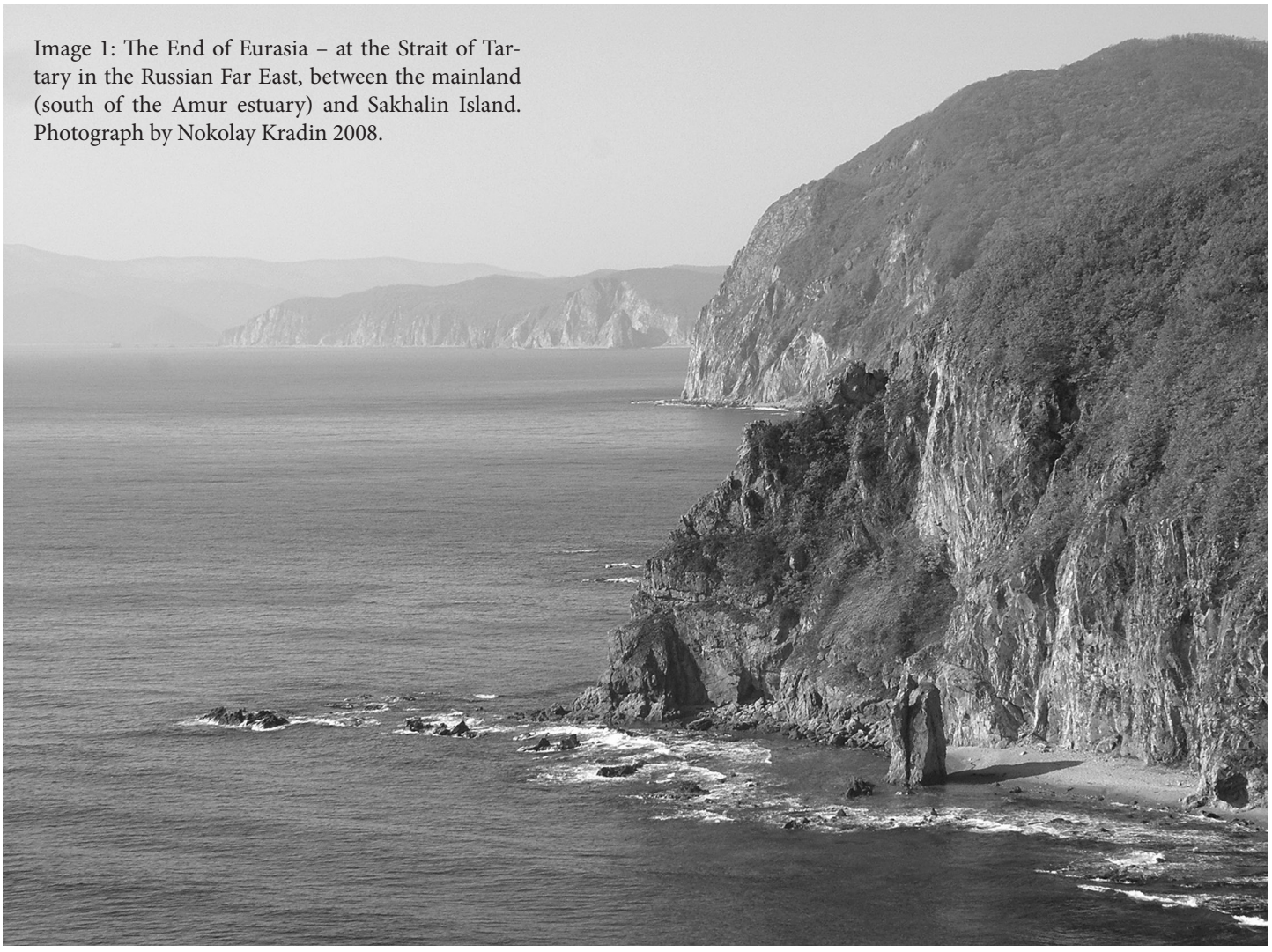
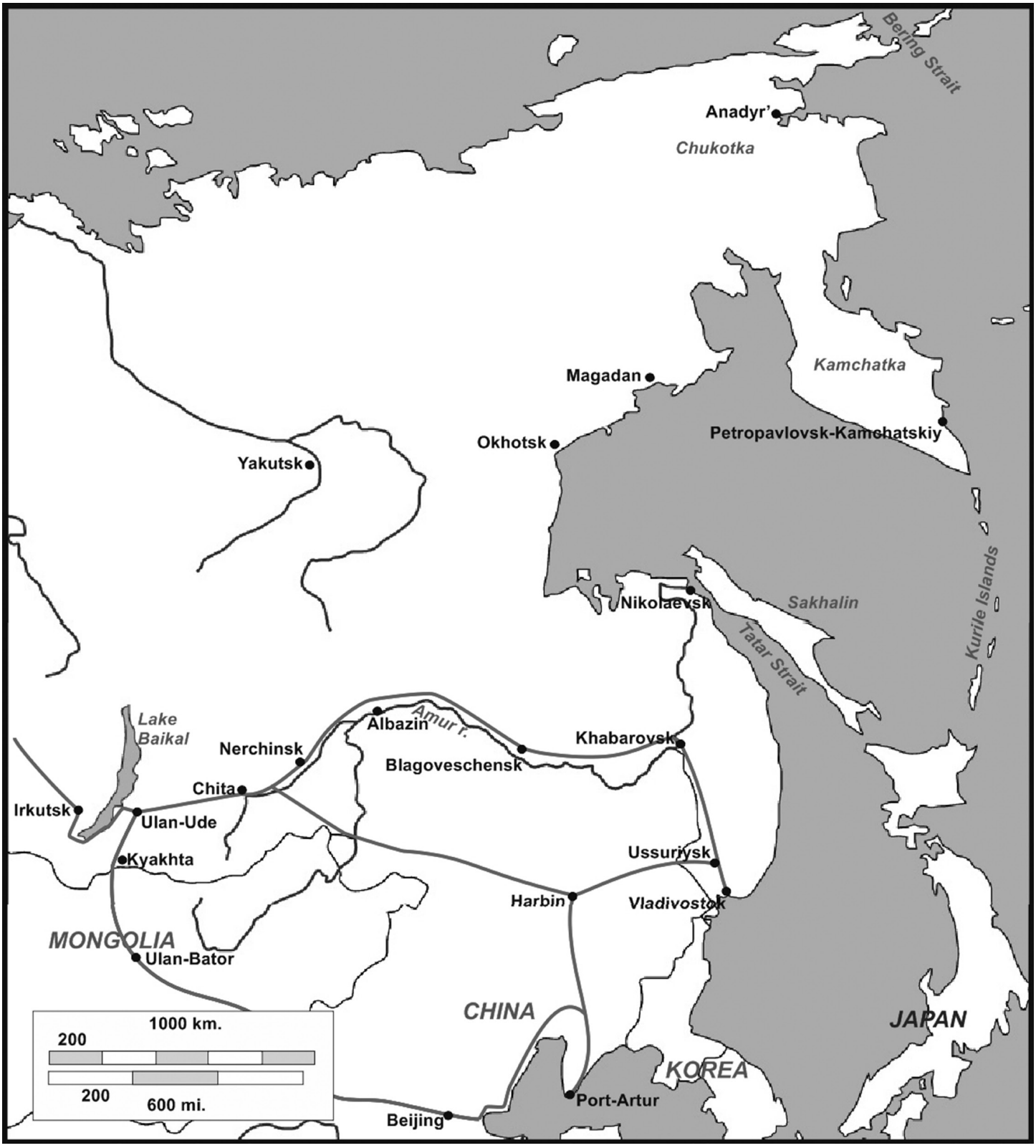


Image 1: The End of Eurasia – at the Strait of Tartary in the Russian Far East, between the mainland (south of the Amur estuary) and Sakhalin Island. Photograph by Nokolay Kradin 2008.



Map 1: The Russian Far East. Map by Nokolay Kradin.

Bering Strait to Posyet Bay and the border with North Korea. The Far East is long in latitude, stretching from Arctic tundra in the north to temperate forest and grasslands in the south. This is a country of eternal cold and polar bears, impassable forest (*taiga*), and tigers.

Unfortunately, there are few English-language books about this area. An exception is John Stephan's award-winning study, *The Russian Far East: A History* (1994).[2] Other books do exist, but they tend to deal with a limited period, from Russian colonization to the present day.[3] In contrast, there are many fine works by Far-Eastern Russian historians, who are little known to foreign researchers.

Local scholars have made many discoveries in the archaeology, anthropology, and history of the Russian Far East. In Vladivostok, for example, there is prominent Institute of History, Archaeology and Ethnology of the Russian Academy of Sciences, for which more than a hundred researchers study the past of Russian Far East.[4] One of their works is the multi-volume series, *The History of the Far East*, which was begun in 1989.[5]

The prehistoric and historical archaeology of the Russian Far East is practically unknown in the Western world. This region is critical to American and world archaeology because the land bridge between Asia and America existed here during the last glaciation, over which the settlement of the New World passed 15,000 to 13,000 years ago, and new research is pushing this date even further into the past.

Pottery is customarily associated with the Neolithic stage of social development. Nonetheless, over the last several decades, we have found evidence of the use of clay during the Upper Palaeolithic in various regions of the world. In particular, the most ancient ceramics have been found in sites dating from 14,000 to 9,000 years ago in the Far-Eastern region, such as at Sikachi-Alyan, Khummi in Priamurye (Amur River region), Ustinovka-3, and Chernigovka-1 in Primorye.[6]

Neolitization (the development of Neolithic culture) in the Russian Far East led to many unique societies that specialized in various ecological niches.[7] Along the Arctic coasts of the northern Far East were hunters for marine animals and fishing people, while, in the interior, were reindeer-breeders and taiga hunters. In the southern Far East, within the Amur River basin, fishers and hunters resided, and a part of the southern territory was even favourable to arable farming.

Fishing has been one of the most important branches of the economy for the pre-historical and traditional peoples of the Amur, North-East coastal, and Sakhalin regions. Their most important catch has been the highly productive salmon, chiefly the Siberian salmon (*Oncorhynchus keta*). The salmon are mostly caught during their mass-spawning runs in the late spring to early summer and in the autumn (different species of salmon migrate at different times). The salmon provided Siberian peoples with a large quantity of high-calorie food.[8]

The coast cultures preserved a Neolithic system of social organization until Russian colonization. They did not invent metallurgy. For this reason, a term *vestiged Neolithic* has existed in the Soviet archaeology.[9]

The Bronze Age began in the southern Far East with a small climatic transition, which is seen by a forest expansion connected to increased wetting (humidification). This eco-climatic period likely corresponds to the Subboreal / Subatlantic boundary of the European Holocene. By the beginning of the Early Iron Age, warming occurred, which caused the spread of a mixed coniferous and broad-leafed forest.[10] The numbers of bronze products is small, but stone

Image 2: The 'Amur Nefertiti', a carving of a woman from the Kondon culture, Lower Amur Valley, 3rd millennium BCE. Artefact held in the Museum of the Institute of Archaeology and Ethnography, Siberian Branch of the Russian Academy of Science, Novosibirsk.

imitations of bronze spearheads (*replika*) is high. For this reason, scholars have developed the terms, *Early Metal Age* or *Paleometal Age*, which we have found to be very useful concepts.[11]

During the Iron Age in the southern Far East, the population began to engage in agriculture and develop other related resources. The Chinese chronicles mention that the Ilou (Yi-lou) people grew 'five cereals' – rice, wheat, kaoliang, millet, and soy beans. They also bred pigs and had skill at trapping sables for clothing and trade, especially with China. Hunting, gathering and fishing continued to play an important role in their societies, along with an increased tendency towards local wars and the creation of complexity.[12]

In the middle part of the 1st millennium CE, the Mohe (Korean: Malgal) lived in Manchuria and the Russian Far East; they were related to the Tungus peoples. The Mohe had a large number of social ranks and seven large polities (chiefdoms or tribes), which differed in the number of fighters they could provide. The best known were the Sumo Mohe, who lived in the extreme south-west of the Mohe territory, while the Heishui Mohe inhabited the north-east, in valleys along the lower courses of the Sungari, Ussuri and Amur rivers. According to the Chinese chronicles, the Mohe sowed wheat and ploughed the soil with horses, as well as engaged in breeding horses and hogs.[13]

In 698, the Sumo Mohe chief, Da Zuorong, declared his establishment of the Bohai kingdom. Its territory included eastern Manchuria, part of North Korea, and the south-west area of Primorye. The state was divided into 15 provinces and 62 districts with 5 capitals, and maintained diplomatic relations with China, Silla, Japan, and the Inner Asian nomadic empires.[14]

Image 3: Excavation of a cooking area in the settlement of Chintolgoy-balgas in Mongolia, a site inhabited by the Bohai deported from the Russian Far East during the Liao Empire, 907–1125 CE. The excavator is Alexandr Ivliev, a professor from the Institute of History, Archaeology and Ethnology, Far East Branch, Russian Academy of Sciences. Photograph by Nikolay Kradin 2006.

Bohai was conquered in 926, after the nomadic Khitan people created the Liao Empire (907–1125). Liao then established the puppet-state of Dongdan (Eastern Khitan) on Bohai territory. The residents of Bohai were placed under tribute, but they almost immediately rose in revolt. It was put down, but new commotions soon started. In order to liquidate the discontent, the Khitans used the traditional strategy of resettling by force about half-a-million Bohai men to lands in the valleys of the Shara-Muren and Liao rivers, between 930 and 940. Another group of Bohai people was later deported to central Mongolia.[15]

After the Khitan conquest of Bohai, the Jurchens (successors of the Heishui Mohe) took over north Manchuria, Primorye, and the Amur valley. The Jurchens depended on the Khitans and paid a tribute to them in furs, jewels, medicinal herbs, horses, etc. Hunting falcons were especially valued and, at the request of the Khitans, the Jurchens regularly organized trips to the Ugo people (the Chinese 'five nations') to capture them in the lower reaches of the Sungari, Ussuri, and Amur river valleys.[16]

In the latter half of the 11th century, the consolidation of the Jurchens began under the leadership of the Wanyan lineage. In 1115, Aguda proclaimed the establishment of the Golden Empire of Jurchens (in Chinese – the Jin, 1115–1234) and took the emperorship. Over a period of ten years, the Jurchens defeated the Khitans and captured their entire territory. At the height of its prosperity, the Jurchen Empire held all of Manchuria, the southern part of the Russian Far East, part of North Korea, and a large part of north China. The population of the Jin Empire early in the 13th century reached more than 53 million men, of which about 10 per cent were Jurchens and not less than 83 percent Chinese. As with Bohai, the Jurchens had five capital cities, with 19 provinces headed by governors-general.[17]

In 1206, the superpower of Genghis Khan was established on the Mongolian steppes. After four years, the Mongols launched a war against the Jin Empire. The war was protracted and lasted a quarter of a century. The Mongols sacked many cities, slaughtered entire populations, and took many skilled artisans prisoner. In 1215, the commander of Jin troops in Liaodong, Puxian Wannu, declared the foundation of the Eastern Xia kingdom (in Chinese: Dong Xia) as a buffer state. After several military defeats, he resettled his army and people in the Russian Far East. His kingdom lasted only eighteen years. In 1233, Mongol troops invaded the territory of Primorye, and Puxian Wannu himself was taken captive. Two years later, the military

division (*tymen*) of Kaiyuan was established on his territory by order of Chagan Ögödei, the son of Genghis.[18]

After this conquest, Manchuria and Primorye were vacated, as Jurchen craftsmen and farmers were carried off to the towns of the Mongol khans.[19] Many of their agricultural skills were lost, which led to the collapse of their medieval civilization in the Russian Far East. It is also possible that a cold spell and forest expansion in the Late Jurchen period could have influenced their decline.[20]

During the Ming dynasty (1368–1644), the Jurchen again followed a nomadic lifestyle, engaging in cattle-breeding, hunting, fishery, and limited agriculture.[21] As China began to pursue a wider foreign policy, they sent a special expedition to the Lower Amur region in 1411, under the leadership of Yishiha, a Jurchen in the service of the Ming emperor. The mission numbered a thousand people and distributed gifts to local chiefs. In 1413, they built a Buddhist temple and stele on Tyr cliff, adding inscriptions in Chinese, Jurchen, and Mongol. After their departure, the temple was destroyed by indigenous people. A new expedition arrived twenty years later, again under the leadership of Yishiha; they restored the temple and added another inscription in Chinese. When Russian Cossacks arrived at this place, 222 years later (1655–1666), they found the ruins of the temple and stele.[22]

Image 4: Tyr stele, drawing by Grigory Permikin, as seen c 1860. In Ernst Ravenstein, *The Russians on the Amur*, London: Trubner and Company, 1861: 196.

At the turn of the 16th into the 17th century, the south Jurchen chiefdoms had a second chance to make history. Known as the Manchu by this time, they established the Late Jin state in 1616. The Manchu carried out depredations in north and east Manchuria and Primorye to draft people in their army, and, as a result, the majority of the native population was consolidated in Manchuria. The expansion continued, leading to their ascendancy in China as the Qing dynasty (1644–1911).[23]

In the 16th century, the eastward advance of the Russian pioneers into Siberia and the Far East began. In 1632, Petr Beketov established Lensky *ostrog* (fortress), which paved the way for today's city of Yakutsk. Soon afterwards, Semen Shelkovnikov established the port of Okhotsk on the shores of the Sea of Okhotsk. Vassili Poyarkov (1643–1644) and Yerofey Khabarov (1649) reached the Amur River, which became the important watercourse for the Russian advance to the Pacific Ocean. Finally, in 1648, Semen Deznev explored the strait between Eurasia and America, earlier discovered by Semyon Dezhnev and later reconnoitred by Vitus Bering.

In 1650, Khabarov established the celebrated fort of Albazin on the Amur River, as well as others. In 1682, a regional district (*voevodstvo*, from the Russian *voevoda*: military leader) was created. This expansion in the direction of the Amur resulted in conflict with the Manchurian Empire. In 1685, Albazin was besieged and the Russians forced to leave, but the fort was restored a year later. The next year, a new siege was begun by a Manchurian army eight times the size of the defenders, but the fort held out. After a truce in 1689, the Nerchinsky Peace was made, under which the Russians left and control of the Amur region remained with the Manchu and the Qing dynasty.

Despite a deceleration in the eastward movement, growth on the North Pacific continued. In 1697, Vassili Atlasov mapped a route to Kamchatka and constructed its first fort. Fourteen years later, Cossacks reached the Kuril Islands. In 1732, Mikhail Gvozdev voyaged to Alaska – the westernmost point of North America was named for him: острова́ Гво́здева (now the Diomede Islands). As businessman Grigory Shelekhov of Irkutsk expanded his firm's operations into Alaska, it was reorganized into the Russian-American Company (1799). It became 'a state within a state,' taking over colonial management (an analogue of the British East India Company). In 1867, Tsar

Alexander II sold Russian America to the United States for only $7.2 million.[24]

As a result, the geopolitical interests of the Russian Empire again shifted to the Amur, since the government understood the importance of this 'oriental Mississippi' to regional development. In 1848, Captain Gennady Nevelskoy surveyed the Amur estuary (*liman*) and proved its navigability, establishing the town of Nikolaevsk there in 1850. He also discovered the strait between the continent and the Sakhalin Islands, advancing southwards to survey the south-east frontier of the Russian Far East, now called *Primorye* or *Primorskiy Kray* (maritime region). In 1854, the new water road from west to east began with the first flotilla of soldiers, civilians, 'beans and bullets' sent aboard ships and rafts to the Lower Amur from Transbaikalia.[25]

Because the Chinese Empire fell behind in the 19th-century arms race, it became easy prey to European colonialism in the Opium wars, and was further weakened by the Taiping Rebellion.[26] Russia benefitted from this situation. Under the Treaty of Aigun (1858), the west bank of the Amur was ceded to Russia and, after the Convention of Peking (1860), all lands east of the Ussuri River became Russian.

As a result, the towns of Khabarovsk (1858) and Vladivostok (1860) were established. The etymology of the latter toponym reveals the ambitions of the Russians in the region. It consists of two words – control (*vladet'*) and east (*vostok*). In other words, it was meant to serve as guarded portal, similar to that of the Golden Horn and Bosporus at the Byzantine capital of Constantinople.

From that time onward, the Russian Far East saw greatly increased immigration. The availability of unoccupied land served as a special impetus for peasants to move there from central Russia. From 1861 to 1881, about 12,000 men arrived overland and, afterwards, via the Amur River. In 1882, shipping lanes were opened and, by 1900, about 180,000 settlers were in place, principally military personnel (more than 80 %), as well as Cossacks, peasants, and convict-laborers.

The Trans-Siberian Railway was of great importance and one of the progressive national reforms advanced by statesman Petr Stolypin. Begun in 1891, its 10,000

Image 5: Construction of the Trans-Siberian Railway, c 1895. Photograph by I. Iomashevich, from *The Russian Great Way: View of Siberia and Railways*, Krasnoyarsk: Akselrod & Company, 1899.

kilometres of rails allowed for travel between Moscow and Vladivostok. It is the world's largest railway but took only six years to build (except for a bridge over the Amur completed in 1916). By 1903, one could also travel to Vladivostok, and on to Port Arthur, via the Chinese Eastern Railway, which had been built from eastern Transbailakia, across Inner Mongolia and Manchuria, to Ussuriland.[27] The Trans-Siberian Railway facilitated the migration of more than 200,000 people to the Far East before the Revolution, where they derived improvement in their living conditions.[28]

At the close of the 19th century, the geopolitical interests of Japan and Russia came into conflict, resulting in the war of 1904–1905. Victory over Japan was thought to be easy for the Russians, but the war was lost. Most of the Russian fleet was destroyed or surrendered in the Battle of Tsushima, with the word 'Tsushima' becoming a byword for 'national shame.' In the Treaty of Portsmouth, Russia lost South Sakhalin and its military bases in China, including Port Arthur.[29]

In 1917, the Russian revolution erupted. A democratic government was first established in February, followed by a communist government in October. A deadly civil war broke out and lasted until 1922. As a result of these upheavals, a heavy task emerged for the Union of Soviet Socialist Republics to rebuild the ravished economy, strengthen borders and administration, feed people, and reorganize education and cultural institutions. The USSR actively carried out industrialization. Factories for processing resources were built and projects for production as well as the repair of marine and military equipment were carried out. New towns were established. Extensive campaigns encouraged the migration of young people to the Russian Far East. A policy of full education for the people was enacted, with new schools and higher-educational institutes opened.

At the same time, a new ideology of totalitarian society was formulated, and excesses were unleashed. The Russian Far East became a symbol of the Great Purge, as many more prisoners (*zek*) were sent by rail to Vladivostok than had been exiled by the Tsarist government. From there, the prisoners were carried to the frigid forced-labour camps of Magadan, perceived by many as a synonym of *GULAG*.[30]

Japanese intervention in China in 1931 was the actual start of World War II, and Japan became more aggressive after its annexation of Manchuria. Conflict broke out in 1938, when the Japanese army moved into Russian territory near Khasan Lake, on its frontier with Korea and Manchuria. These incursions were finally stopped at the Khalkhin-Gol River in Mongolia, a defeat that likely prevented Japan from launching a formal war against the USSR.

After the victory over Germany, the USSR entered the war against Japan on 9 August 1945. The Soviet Army had much experience and state-of-the-art armament, which led to the defeat of the Kwantung Army in less than a month. On 2 September, Japan's act of capitulation to the US and USSR, aboard the USS *Missouri* in Tokyo Bay, returned South Sakhalin and the Kuril Islands to the Soviet Union.

Although no major battles of the war were fought in the Russian Far East, the region still lagged behind in its living standards. Despite a policy of trying to keep a substantial population there, reverse migration to the west of Russia and an attitude of being just a 'temporary resident' took hold in the post-war period. This had been a recurring problem, and so the state again turned to address it. New

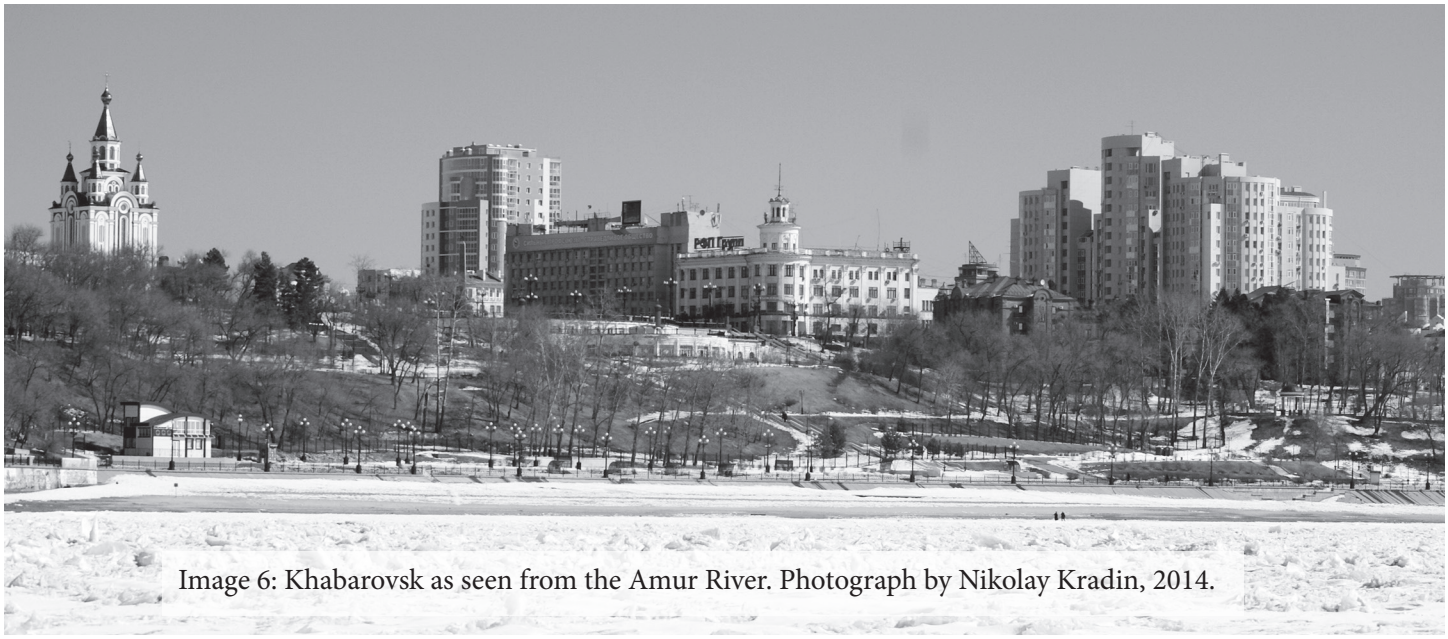


Image 6: Khabarovsk as seen from the Amur River. Photograph by Nikolay Kradin, 2014.

jobs were created, residential buildings were erected, and the extractive industry (metals, timber and fishery) was reinforced. Khabarovsk and Vladivostok became great centres with over a half-million residents each.[31]

Tensions mounted with China, resulting in a Sino-Soviet divide in the 1960s. Between 1974 and 1984, the Baikal-Amur Mainline (BAM) railroad was constructed to the north of the Trans-Siberian Railway as a backup network for transportation and communication in case of war with China. In its construction and operation, many young people from all regions of the USSR took part.

Perestroyka began in 1985 and led to a chain of events that resulted in the collapse of the USSR six years later. These events triggered profound change. During the first ten years of the new Russian Federation, the Far East was again neglected, and migration back to central Russia increased to 1.8 million people, a fifth of the population.[32] As a result, the Russian Far East has essentially become an appendage of China, exporting its resources to the south and obtaining its supplies from there.

The region is rich in resources. Significant mineral deposits exist, including antimony, stannic tin, mercury, tungsten, lead, titanium, diamonds, gold, iron ore, and coal. For this reason, the modern economy is oriented to extraction of minerals, wood production and fishery, which accounts for 31.2 per cent of the gross regional product. Transportation, communication, construction, trade and agriculture provide from 5 to 10 per cent, while a few per cent comes from energy, education, medicine, financial services, military security, and management. Nonetheless, the economy is irregularly developed and concentrates mainly in the south, while the northern and middle zones are nearly empty.[33]

In the new millennium, the Russian government began to focus its attention on the Far East. In 2012, a summit of the Organization of the Asia-Pacific Economic Cooperation (APEC) was held in Vladivostok at the new Far-Eastern Federal University. In this educational coalition are the four largest universities of Vladivostok and Ussuriisk. New construction has taken place, including theatres, cultural centres and a casino (near Nakhodka), along with visa-free tourism. The Ministry for Development of the Russian Far East was established in 2012, as a way for the state to address the great possibilities and the great challenges faced by its people.

As we can see from this quick overview of the history

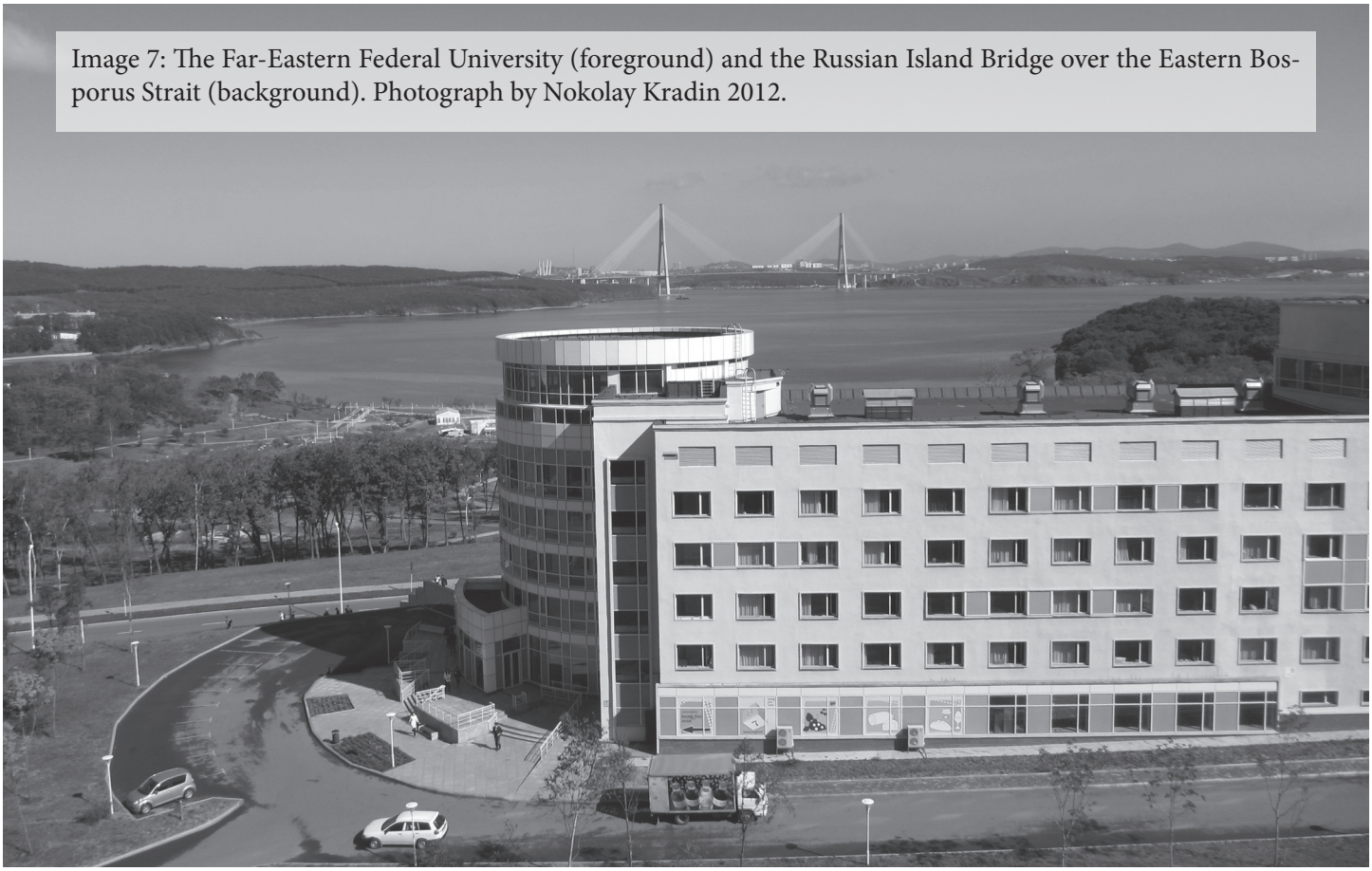


Image 7: The Far-Eastern Federal University (foreground) and the Russian Island Bridge over the Eastern Bosporus Strait (background). Photograph by Nokolay Kradin 2012.

of the Russian Far East, many events contributed to our modern identity, and will continue to do so in the future. We have a transitory consciousness of who we are today, and that will change tomorrow. It is an adventure in the process of humanity's voyage together!

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Endnotes

1. Lawless 2017. Benjamin 2015.
2. Stephan 1994. Stephan is an historian at the University of Hawaii at Manoa and won the 1996 Kenneth W. Baldridge Prize, sponsored by the Hawaii chapter of Phi Alpha Theta.
3. For example, see the following. Davis 2003. Hudgins 2003; Bassin 2004; Wood 2011.
4. From 1974 to 1979, our Institute published a preliminary version of the *History of the Far East of the USSR, From Prehistory to the Present*. It consisted of eleven small books, printed in a limited run for restricted discussion only. This is a style called *maket* in Russian. Now these copies are a rarity.
5. Krushanov 1989; idem 1991. Mukhachev 2003. Vashchuk 2009; idem 2016. Galliamova 2018. Tkacheva 2020.
6. Zhushchikhovskaya 2009.
7. Yanshina 2014.
8. Kradin, Nikitin and Kliuev 2009.
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28. Galliamova 2013.
29. The bibliography in this area is inexhaustible. For further reading see Kowner 2006; idem 2009. For fresh information see Likharev 2005.
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32. Motrich 2013.
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Free Thoughts

Painda Khan
with Peghla Khan, Hewad Khan Shalamkhel, Omid Khan, Meena Khan,
Atal Ahmadzai, Oishika Neogi, and Barry Rodrigue

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Just over a dozen years ago, Barry Rodrigue heard about a poet and teacher in Afghanistan, named Painda Khan, from his son [Hewad] and his future son-in-law [Atal], who were students in North America.[1] Professor Khan was described as a highly principled and inspirational educator, one who stood for free-thought in Afghanistan's communities and classrooms. He encouraged critical thinking, independent from dogmas of all kinds.

At that time, Barry and others were in the midst of founding the International Big History Association (2010) and were facing challenges from entrenched disciplines and administrators in universities around the world. While the IBHA struggle was not devastating as that in the Afghan countryside, these separate struggles for free thought quietly intertwined in Barry's mind. When he came to India, seven years later, to help set-up South Asia's first university program in Big History, he learned that Prof. Khan and his family had settled in Delhi.

One of his students [Oishika] had just finished an internship in Big History and Peace Studies at J.F. Oberlin University in Tokyo and begun work with NGOs in Delhi, so he asked her to visit Prof. Khan.

Prof. Khan and his daughter Peghla met with Oishika in Delhi in August 2020. They discussed their coming together in a park, along with a beautiful song that Prof. Khan had composed in the ancient *Landai* form of lyric poetry of the Pashto language.[2] Although addressed to the Mullahs [Islamic clerics] of Afghanistan, it is a universal call for freedom of thought and expression.

Figure 1: Painda Khan (right) and Oishika Neogi (left), Delhi, 26 August 2020. Photograph by Peghla Khan.

The poem is composed in the traditional *Landai* style of Afghan poetry, which is a brief couplet (sometimes joined together with others) to poignantly share affection, home, dissidence, or joy. Popular and often sung, *Landai* are also called *tapi* [healing], as they are said to give comfort.[3] While translation into another language cannot convey the beauty and depth of emotion, we offer a translation into English by Peghla Khan. We also share a recitation by Peghla and its singing by Prof. Khan at: <http://www.rodrigue-global.org/painda-khan.html>.

Free Thoughts

There is a saying that Pashtuns seek revenge even after 100 years,
but I am saying that they do not take revenge, they forgive easily.

Pashtuns quickly show their anger, while they hide their compassion.
They do not seek revenge from others.

Pashtuns did not take their revenge from Genghis Khan, or from the British,
Pakistan's army have been killing Pashtuns, but they did not seek revenge.[4]

Through time, when a hundred years pass, onetime friends become enemies, while a hundred years ago, enemies now are friends. Who then will seek revenge from whom?

Pashtuns, you should drop these unsubstantiated and boastful claims.
Remember, greatness comes with knowledge.

You have to make this lesson understandable and clear for the Mullahs;

They should seek all kinds of knowledge (not only religious).

Otherwise there won't be any progress.
Men and women both should strive to gain all sorts of education.

While Mullahs say that to seek knowledge is a divine command for both male and female,
They damage and destroy educational institutions and create chaos and suffering for others.

Why does an uneducated Mullah not realize this?
Knowledge has reached a high level, but they do not care and do not want it.

It is not the Mullahs' business if the people want to know about God or not.
They can enjoy heaven and contemplate heaven, but the people do not care about it.

Mullahs mislead Pashtuns.
They are the ones who prevent Pashtuns from seeking knowledge.

If someone is not educated, what is their respect and value?
The Mullahs are working day and night to prevent Pashtuns from gaining knowledge.

The Mullah's are destroying and ruining educational institutions.
They are killing teachers and professors.

Pashtuns have been accused of many wrongs.
They are not terrorists, but they are victims of terrorism.

Dear Mullah, do not be an obstacle to knowledge and prevent people from getting education.
God will take away his blessings from those who are against knowledge and education.

[Poem Recited by PeghlaKhan]

[Song Version]

كه سل كاله تېر پښتون خپل بدل اخلي

زه وايم ژر يې ښځې هېڅ بدل نه اخلي

خپل غوسه پډاګوی او رحم پټوي نو

نه بدل نه انتقام له چا څخه اخلي

نه چنګيز باندې داړه نه په انګريز

پنجاب تل پښتون وژلي بدل نه اخلي

كه سل كاله تير دوست دښمن او دښمن دوست شي

دا بدل او انتقام به څوک اخلي

دا بې ځايه باتې پرېږدئ پښتنو

كه څوک علم زدکړي ښه بلاس اخلي

د ښه والي راز همدغه زدکړه او علم

ملا پوه کړي هر علم پلاس کې واخلي

لدې پرته د بريا چانسونه لګ دي

ښځه او نر يو ځای هر علم پلاس واخلي

ملا وايي علم فرض په نر او ښځو

بيا د علم مرکز سوري غم را واخلي

دا بې علمه ملا ولې نه پوهېږي

تر آسمان علم ختلی دايي نه اخلي

خدای پيژني كه نه ستا يي پري څه

ته مزې كوه جنت كی دی يي نه اخلي

د پښتون لار دغه ملا پري وركه كړي

دا د علم تېر ده علم تري اخلي

كه په چا كي علم نه څه يي عزت وي

شپه او ورځ له پښتنو څخه علم اخلي

چې مرکز د علم سوزي پوهي ضد شو

د مكتب او پوهنتون استاد تري اخلي

هر تهمت هر ناروا پښتنو شي

تروريزم پښتون نه پښتون تري اخلي

ملا جانه علم مخيته خندِ نه شي

علم ضد وي خدای خپل ښګنې اخلي

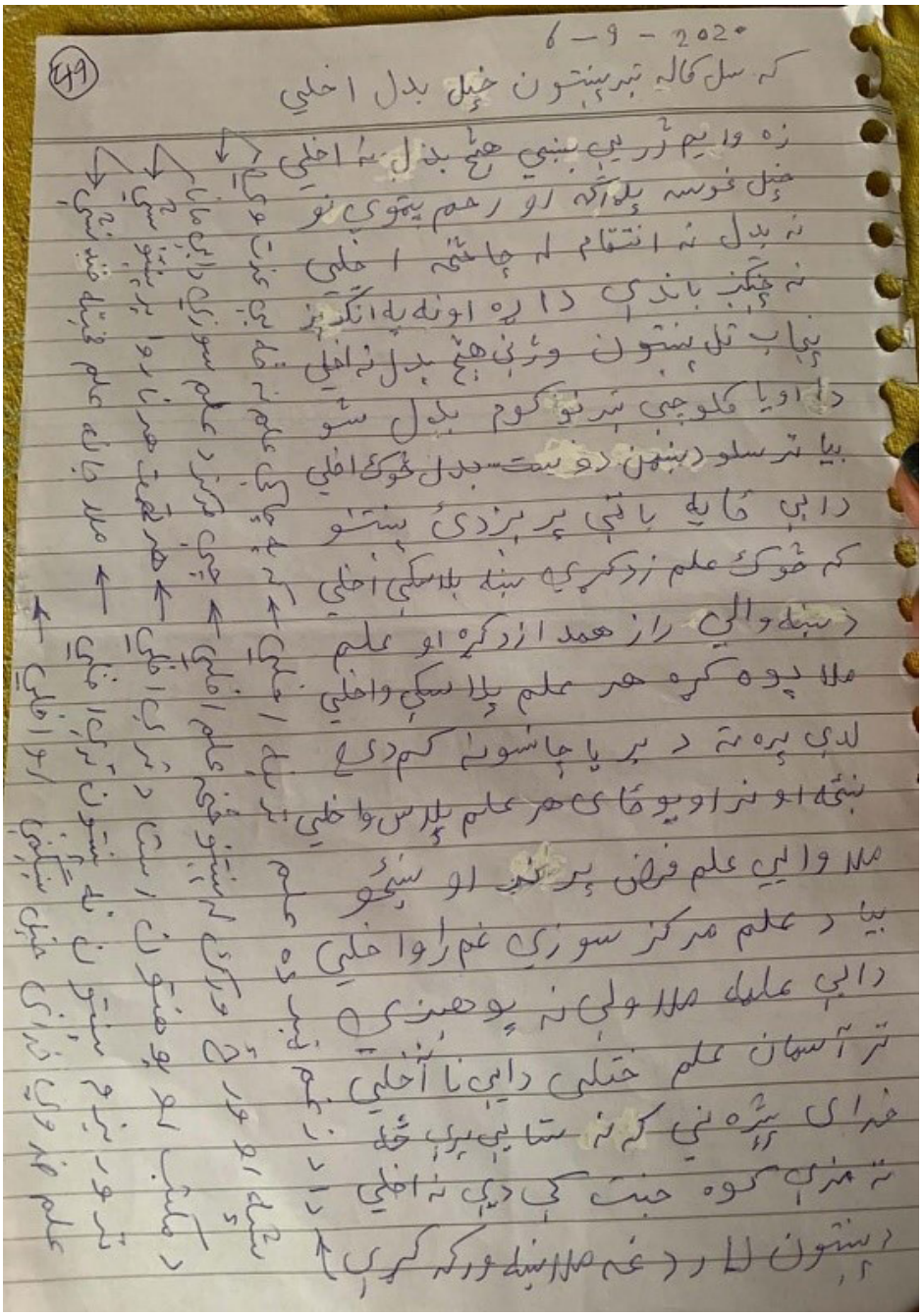

Figure 2: Professor Khan's poem, in Pashto, written in his own hand (above). On the previous page is its formal transcription in Pashto by his son, Omid.

As Prof. Khan notes:

> This is the ancient Landai kind of poem. It's beautiful and it's universal. Nowhere in this poem do I say that 'it's mine.' It's everybody's. This is like a shared experience for all Afghanis.[5]

Such universal connectivity is an important part of Big History, where humanity is often addressed as a holistic worldwide experience. As big-historian David Christian framed it, we need to develop 'the ability to assess claims of universal standards yet [remain] aware of human commonalities and differences; putting culturally diverse ideas and values in historical context, not suspending judgment but developing understanding.'[6]

From Nagaland (Northeast India), professor and poet Theyiesinuo Keditsu writes how folklore's connections to society 'direct us towards social action based on empathy and an awareness that all actions have consequences beyond the individual and even beyond the human.' Then, like Prof. Khan, she shares two of her own poems to illustrate this concern. As she concludes: 'I propose that folklore needs to be brought back into the sphere of the political and be reinstated as a frame of reference through which we can engage contemporary challenges.'[7]

Other big-historians engage in the use of culture and the creative process to encourage free thoughts and free thinking around the world. This big-history expression has especially occurred in conflicted areas, such as Sada Mire's archaeological recovery of women's heritage in Somaliland, Magomedhhan Magomedhhanov's ethnographic revival of textile art in Dagestan, and Iles Tataev's social expositions with sculpture in Chechnya.[8] Without free thought and education, the cosmos will remain imaginary, and we will be captives of myth. This is the down-to-earth message of Painda Khan's poetry.

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Endnotes

1. The text author is Barry Rodrigue. He met with Atal Ahmadzai and Hewad Khan, who first shared their close experiences about Prof. Khan as a family man and an inspirational teacher.
2. Painda Khan interview with Oishika Neogi, trans. Peghla Khan, Delhi, 26 August 2020.
3. Each *Landai* consists of a single, twenty-two syllable couplet. There are nine syllables in the first line and thirteen syllables in the second. In Pashto, the poem ends on a 'ma' or 'na' sound, but the lines do not generally rhyme. Daud 2017. Zaheer 2023. Professor Zaheer's article also addresses similar issues as those in Prof. Khan's poem and interview.
4. Panjab refers to Pakistan's intelligence agency, ISI..
5. Khan 2020.
6. Christian 2005.
7. Keditsu 2023: 3,4.
8. Magomedkhanov and others 2016. Mire 2016. Khadzhimuradov and others 2016. Rodrigue 2022: 23–26.

The General Law of Being. Article 2:
The Being of Differentiation and Its Arising Issues

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This is Article 2 in a series about the General Law of Being, a science philosophy introduced by Chinese scholar Wang Dongyue twenty years ago and then expanded upon by Chen Ye, who linked it to other scientific and philosophical traditions, as well as to Big History. We encourage readers to review the first article in the previous issue of the *Journal of Big History* 6 (1). As addressed in Article 1, all entities in the universe – *beings* – are finite, interdependent, and interrelated.

A being is any entity, living or not, that can serve as a subject or an object. Their position is determined by both vertical and horizontal conditions. Vertically, all beings originated from the 'One,' a *primal singularity* generated in the Big Bang from which everything is derived.[1] Horizontally, the *realization of existence* is how a being's *interactive-quality* couples with another being's *interactable-quality*. This bi-directional relationship determines a subject-and-object's evolutionary position in the cosmos.

The emergence of new *forms of being* is an evolutionary process rooted in a superposition of specific historical stages. Each stage represents harmonious states of *structural-coupling*. Unlike traditional evolution that focuses on biological transition, the evolution we address includes all beings, from the Big Bang up to human society.

In our system, no matter how space and time are extended, the *holistic being* (beings as a whole) remains invariant, according to the Law of the Conservation of Energy. The *finite interval of derivative beings* refers to this holistic being, which contains all forms of beings that are in interdependent and derivative relationships.

In this article, we delve deeper into evolutionary progression to explore the generation of new beings and the mechanisms through which beings evolve to form distinct species. By examining the relationship between the *being of equivalence* and Charles Darwin's theory of natural selection, we find common principles – such as how the *being of differentiation* fit into both theories and unifies all beings.

Conservation Force and Variation Force

If there is a more explicit way than *material transformation* to describe how new forms of being are generated, what might it be? Let us consider reproduction, the process by which an entity fractures into new derivatives of the same class. Reproduction is a distinctive ability of a *living* being that allows it to continue from generation to generation[2] **This reproductive ability enables living beings to be stable in evolutionary history, just as for abiotic matter.** Without this stability, living beings would be like particles that cannot keep their form, such as beryllium-8 in hydrogen fusion. The living beings in this case refer to a species rather than an individual.

Single-cell organisms reproduce through the simple asexual mechanism of *binary fission* (for prokaryotes) and *mitosis* (for eukaryotes). In this process, a single cell divides into two identical daughter cells. However, the sexual reproduction of multicelled organisms is more complex since it involves the participation of two cells. In this system of *meiosis*, each parent cell splits their intertwined (diploid) chromosome of DNA, giving one strand each to their progeny cell. These two single strands join together to form a daughter cell or zygote.[3]

Although asexual and sexual reproduction manifest major differences in detail, their fundamental mechanism is similar – in both cases, there is cell division and the new cell is traced back to its parent cell(s).[4] A key difference lies in sexual reproduction's allocation of reproductive responsibilities to two distinct cellular forms (male and female), necessitating the fusion of separate cells to form a new cell. Through reproduction, we can see how the transgenerational *conservation force* enables living beings to be relatively stable.

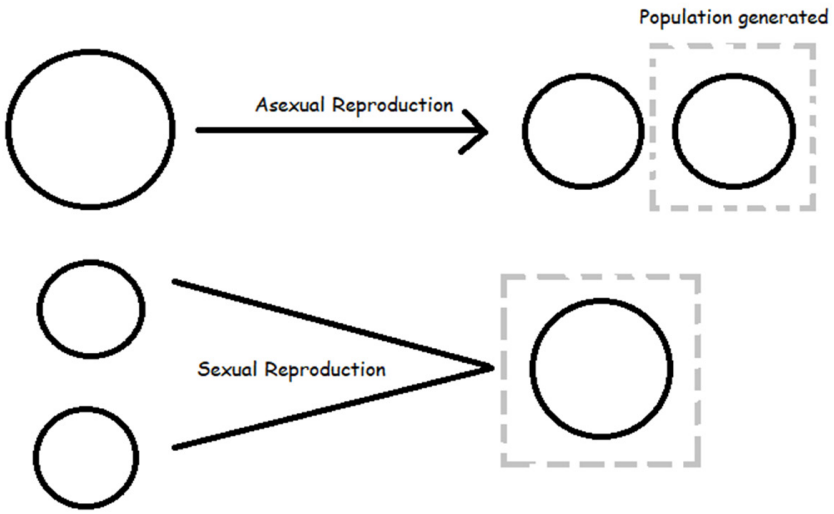

Diagram 1: Asexual Reproduction vs. Sexual Reproduction. Diagram by Ye Chen.

Another important aspect of reproduction is genetic variation, which is important to how a new *form-of-being* is generated. The main sources of genetic variation include mutation, genetic drift, non-random mating, and migration. Genetic variation is ultimately determined by *autologous mutation* (variation of interactive-qualities) in cooperation with natural selection (selection by interactable-qualities).[5]

Mutations are due to a permanent damage in the genome that may result from errors in DNA copying or from interactions with the environment.[6] Though most mutations are deleterious and get eliminated immediately, a few are retained when the species can better couple with its condition. This may lead to a single evolutionary lineage splitting into two or more genetically independent lineages.[7]

For example, a mutation may have allowed single-celled creatures to create complex forms, thus giving rise to multicellularity. In a study of choanoflagellates (single-celled organisms), researchers discovered that they often organize into groups to form a multi-celled colony to feed on certain foods. This suggests the expression of a successful genetic tendency enabling single cells to recognize each other and come together.[8]

Asexual reproduction involves only one parent and contributes little or no genetic variation, except when mutation occurs, since asexual reproduction involves only one parent. In contrast, sexual reproduction adds more variation, because the genetic material of different organisms is exchanged and recombined.[9] From this, we can see how this *variation force* has driven the evolution in which an enormous number of variant derivatives (species) have been propagated.

Natural Conservation of Non-Living Beings

Conservation is much easier for non-living entities than for living organisms, so non-living 'beings' occupy most of the universe. Their forms as dark matter and dark energy are the most pervasive, making up 96% of the total mass of the universe. Since dark matter and dark energy appeared in the early stages of the universe's expansion, they take on more elementary forms. The mission of the recently launched Euclid spacecraft (2023) is to better understand the nature of dark energy and dark matter.[10]

The older, more basic properties of non-living beings enable them to better conserve themselves. Although we do not see a strong 'willingness' to be conserved, as we do in living beings, **the immense proportions and age of non-living beings imply a more robust and powerful *natural conservation force* operating on them.**

Meanwhile, the other force – variation – also takes place in non-living beings and can lead to new forms of being. While mutation can change a DNA code and lead to rearrangement and re-coupling (re-combination) of cells in living beings, non-living elementary particles also interact, and their components (protons, electrons, neutrons) can be rearranged and recoupled. Thus, both a new species (living being) and a new type of particle (non-living being) are a result of variation. In either case, a mutation can be successfully retained.

Division-Coupling Process

The evolution of all beings takes place through the interplay of two opposite forces: conservation and variation. The force of variation must exceed that of conservation, otherwise the Big Bang could not have happened. All beings must go through the process of evolution, namely division (or divergence) and coupling: It is only through division that variation is possible and only through successful coupling that new forms are established.[11] All beings are products of this variation, including human beings.

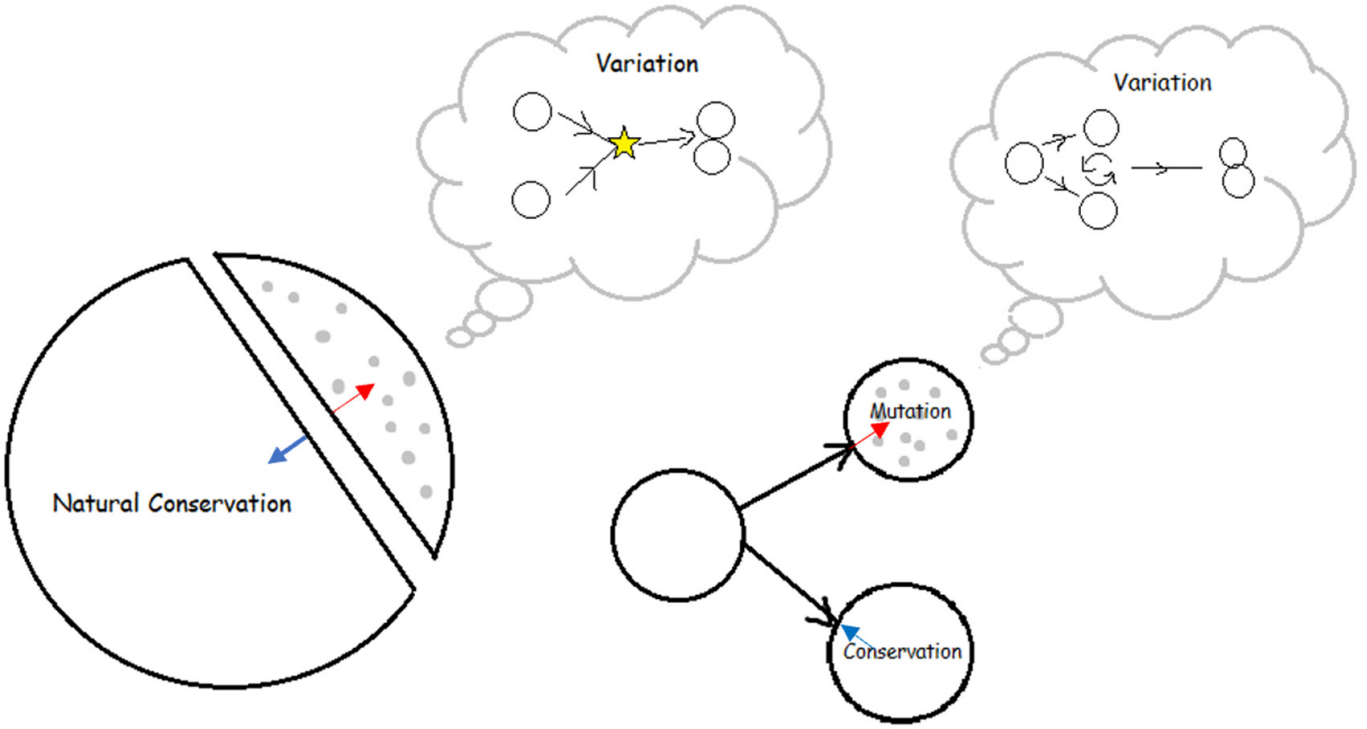

Diagram 2: A demonstration of the two forces at play on non-living and living beings. The left section shows the division-coupling process of non-living beings, while the right shows it for living beings. The blue arrows refer to the force of conservation, while the red arrow refers to the force of variations. Diagram by Ye Chen.

The term, *division-coupling*, therefore, can be used to describe any stage of evolution in the finite interval of beings. While the concept does pass over many detailed facets of existence, such as the diverse forms of reproduction and intricate composition of beings, it allows us to better comprehend existence, as the simplified concept helps us develop a unified rubric. This leaves us with the essential variables for a fundamental understanding of reality and allows us to generate a functional universal philosophy.[12]

We should not be surprised to find ourselves sharing properties with less-complex animals and plants as well as with chemical and physical substances, for we all belong to the *finite interval of beings* – the holistic unity of existence. In this interval, there are no environments, conditions, subjects and objects – there are only **beings interrelated with each other and derived from one another carrying on the conservation and variation that allows them to repeatedly diverge and couple into different forms.**

The Being of Equivalence

When we speak of the existence of a being, we mean that it is in a state of structural-coupling, in which its interactive-quality is coupling with a corresponding interactable-quality. This makes every being generally equivalent – as all of them meet this existence criterion. Dissatisfaction of this criterion indicates that a being is no longer in a state of adaptation. Losing an adaptive state does not mean that the being disappears in the finite interval of beings. Instead, it drifts to a different position in the interval, which also meets the existence criterion, but it loses its original form of existence.

So-called 'inferior' or 'superior' qualities (conditions) are an expression of humans' intuitive feelings. They are of little value in our paradigm. Instead, we should consider what makes a quality possible and how a being came to exist. This examination needs to include **the vertical evolutionary history that made**

it possible and the horizontal interactable-qualities that support its existence.

One may argue that a human is superior to a bacterium because they can do things a microbe cannot. But this only reflects different *realms of existence*. If a human loses their reasoning ability, they lose their realm of existence. A human without reason would be unable to function in society unless someone cares for them, which adds an extra interactive-quality to a disabled person. Only when this interactive-quality fulfils the criterion prescribed by a human realm of existence can they exist in that form.

Therefore, from the perspective of existence / adaptation, all beings can be considered the same. Whatever the varieties of interactive-quality, it is all for realizing the existence of a specific form-of-being. In the 20th century, Ludwig von Bertalanffy adopted this concept in biology as *equifinality*: how all beings maintain themselves by different means to reach the same final state of adaptation.[13] Humberto Maturana and Francisco Varela similarly adopted this concept in biology: 'All these variations … are equally adapted. They can continue the lineage to which they belong in their particular environment.' The phenomenon of evolution, they argue, is only an organism's effort to continuously couple with the environment.[14]

Darwin's Natural Selection

One of the theories of evolution that Darwin proposed in *On the Origin of Species* (1859) is natural selection. As he stated:

> The theory of natural selection is grounded on the belief that each new variety, and ultimately each new species, is produced and maintained by having some advantage over those with which it comes into competition; and the consequent extinction of less-favored forms almost inevitably follows.[15]

This conclusion was evidenced by observations of the survivability of different animals, competition taking place among animals struggling for existence, and the process of inferior animals being replaced by improved forms. His statement contains two paradoxes. On one hand, nature favours the adapted ones and kicks out the less adapted, which is consistent with our criterion of adaptability.

On the other hand, it suggests that species are always evolving to be *more adaptive*. This implication is reinforced by Darwin repeatedly calling endangered species 'less improved' or of 'inferior quality,' as well as being replaced by 'improved' or 'superior' species.[16] This is a misleading if we consider living conditions to be a *variable* factor.

Old species, with their old traits, may have adapted well to their living conditions for millennia, yet with a change of conditions, such as environmental resources, climate and other factors, they lose their advantage. More adapted species may occur at that time, but, when we say the words 'more adapted,' we actually mean more adapted to the changed condition, which is no longer the original condition.

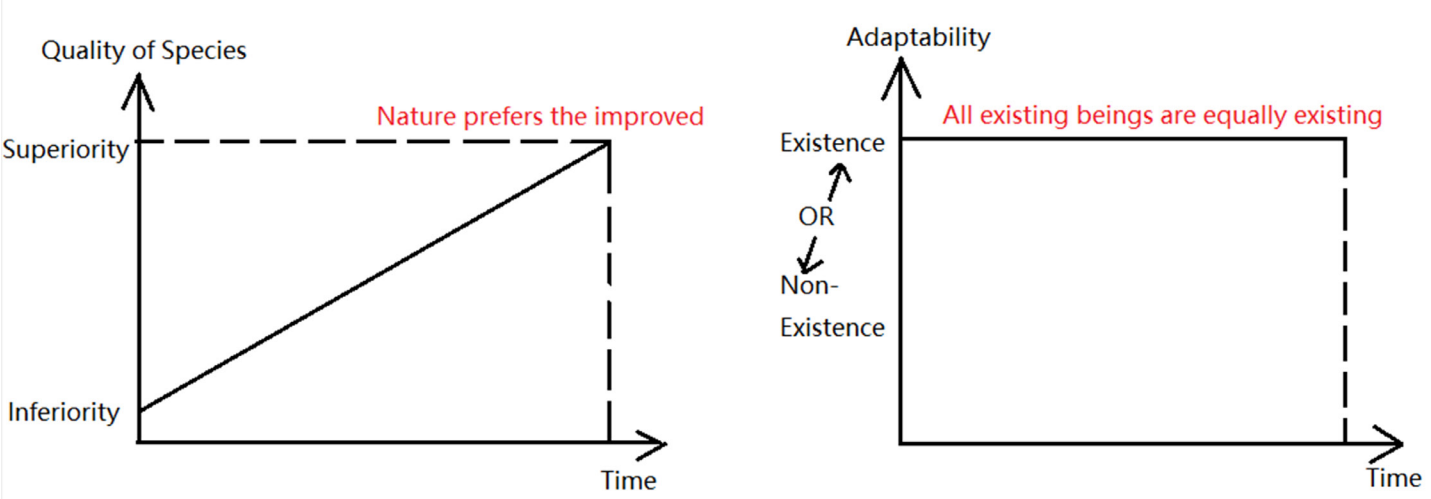

Diagram 3: The left coordinate demonstrates Darwin's natural selection, and the right Existence of Equivalence. Diagram by Ye Chen.

If we compare the adaptability of the old and new species to their respective conditions, it is the same – both can adapt to it. Based on this, the equivalence theory shifts the traditional evolutionary model that Darwin hypothesized, which can be illustrated as in Diagram 3.

Efforts to evaluate adaptability are incongruous. Suppose, for example, that a species develops new and more 'advantageous' traits in reproduction; it can then evolve into a new species that may outcompete the older species. In this case, the environmental conditions in which the older species thrived has changed (due to arrival of the new species), which causes the older species to 'lose adaptation.' Nonetheless, we cannot attribute a new species' overall success to only a narrow range of factors, such as its new reproductive ability.

The new species will not be more adaptable to the new conditions than the old species had been to the earlier conditions … both were successful in their own environments. We cannot simply assess the mechanical value of a new productive trait, because such a change can affect the entire living system and may even lead to negative results. A hypothetical 'advantageous factor' does not exist independently, but instead it is interconnected with many other factors. Therefore, the survival of an 'improved' species (in Darwin's words) is ambiguous, since it depends on complex, interactive circumstances, not single, simple factors.

However, what we can be certain of is that both species (before and after an added trait) were adaptable in their own formative environments. If we apply a common standard – whether an interactive quality matches up with overall conditions (interactable quality) within a given period, **natural selection can be redefined as 'a selection between species whose interactive quality can couple with certain conditions and those species that cannot.' Those who 'win' stay on this equivalency line, until interactive and interactable qualities of beings fail to couple.**

Lifespan of an Average Species and the Limitation of Darwin's Natural Selection

Being of equivalent adaptability does not negate the fact that species evolve from having simple structures to more complicated structures that allow superior functions. However, are those beings with superior functions superior in their existence? If we expand our vision from Darwin's occasional scenes of inter-species competition to a larger-scale evolutionary tree, we might even find clues suggesting the reverse.

Although the statistics for evolutionary life-forms can be quite inexact, due to a limited fossil record, they do imply a general relationship between lifespan and body plan. For example, invertebrates have existed much longer than vertebrates and account for 97 % of all species, while single-celled organisms have existed much longer than multi-cellular organisms. This tendency becomes clearer when we compare fundamentally-structured lifeforms with those that are more complicated.

Prokaryotes (such as blue-green algae) have existed for 3.5 billion years. Hydrozoans, a kind of cnidarian located at the basal stock of the metazoan line, have existed for more than 540 million years. Trilobites, one of the dominant groups of Arthropoda throughout most of its history, existed for about 269 million years. Megalodons, regarded as one of the largest and most powerful predators, existed for less than 20 million years. The once dominant terrestrial reptiles, dinosaurs, existed for less than 180 million years.[17]

Most dinosaurs perished during the Cretaceous-Paleogene (K-Pg) extinction[18] In contrast, lower-form, small species – such as diatoms, brachiopods, amphibians and most marine invertebrates – did not suffer such a degree of extinction. Although more complex life-forms have a longer individual lifespan than less-complex species, they tend to go extinct faster. Hydrozoans depended on fewer conditions than dinosaurs to survive, resulting in less of a possibility for them to go extinct.

More fundamental non-living beings – organic macromolecules, molecules, atoms and subatomic particles – can also be included in this evolutionary picture. Compared with living beings, their mass in the universe is much larger, which indicates their much stronger ability to exist than living beings.

This principle uncovers a limitation of Darwin's natural selection. If there is any 'inferior' or 'superior' adaptability between beings, the criterion should not be whether one can defeat the other, as suggested by Darwin, but for how long they can conserve themselves in evolution – in other words, **for how long their interactive quality can stably couple with the interactable quality of changing conditions.[19]**

Taxonomy	**Lifespan, millions of years.**	**Kingdom / Phylum / Class**	**Body architecture.**
Cenozoic Mammals	1–2	Animalia/Chordata/Mammalia	Vertebrate; large brain and sensory integration, high metabolism and endothermy, flexible skeleton.
Mammals	1	Animalia / Chordata / Mammalia	As above.
Silurian graptolites	2	Animalia / Hemichordate / Pterobranchia	Chordate plan indicated by gill slits and restricted dorsal tubular nerve cord.
Marine animals	4–5	All kingdoms	All types of body plan, from unicellular to vertebrate.
Echinoderms	6	Animalia / Echinodermata	Mesodermal skeleton, few specialized sensory organs, water vascular system, simple digestive, radial nervous and reproductive systems.
Planktonic foraminifera	7	Protista / Foraminifera	Unicellular body plan in single-celled eukaryotes.
Marine invertebrates	5–10	Animalia / in several phyla, from sponges to mollusca	All body plan types, except vertebrate; 97% of animal species (May 1988).
Diatoms	8	Protista / Ochrophyta	Unicellular body plan, single-celled eukaryotes
Cenozoic bivalves	10	Animalia / Mollusca / Bivalves	Soft, unsegmented body; shell; muscle, simple nervous, open circulatory and digestive systems; sense organs for touch, smell, taste and equilibrium; occ. vision, usu. one or two kidneys.
Dinoflagellates	13	Protista / Myzozoa	Unicellular body plan; single-celled eukaryotes

Table 1: Comparison of the average lifespan between species in simple to complicated structures. Table organized by Ye Chen.

Differentiation Progress of Beings

Even though all beings, as long as they exist, are relatively stable and equally adaptive in the micro-scale, their overall lifespan shows the relative superiority / inferiority of their adaptability in the macro-scale.

When we introduced asexual and sexual reproduction at the start of this article, we noted its common goal is the continuation of species. Asexual reproduction is carried out by a single cell, while its sexual form is between two entities – male and female. Reproduction is a form of the larger process of differentiation throughout evolution, from single-celled to multicellular organisms. Therefore, **evolution can be regarded as the differentiation by beings to adapt in their existence**.

The evolution of body architecture by organisms can be divided into five levels, as shown below.

> A. The protoplasmic level of organization is observed in single-cell organisms. Within a plasma membrane, protozoa (for example) are differentiated into organelles that carry out specialized functions. Marking the beginning of specialization: **The evolution of protozoan groups heralds differentiation of more evolved locomotive, sensory and reproductive systems**.[20]
>
> B. The cellular level of organization is transitional between single-celled and two-germ-layered organisms. Cells in this case are ordered in a general manner but have a higher level of morphological / physiological integration. Some of their cells are differentiated to take on the role of sensing, circulating, and plasticizing (body-shaping). In other words: **The 'adaptation task' is distributed to various cells, and each cell no longer functions on its own – it must cooperate with other cells.**[21]
>
> C. The cell-tissue level of organization is an aggregation of similar cells to form better-defined patterns / layers as in tissues (but most other cells are scattered and not so organized). At this level, cells differentiate as they organize into diploid tissue layers, and subsequently, the adaptation task is further divided into more specialized parts controlled by different cell groups.[22]
>
> D. The tissue-organ level of organization is when tissues aggregate into organs, which further increases an organism's complexity. The development of three germ-layers results in most cell-groups being sealed off from each other, causing them to lose direct contact with the external environment. This accelerates cellular differentiation and many of them transform into distinct tissues or organs. **Only in this way can nutrition be well distributed to each part of a body, ensuring the operation of functions to maintain existence**.[23]
>
> E. The organ-system level of organization is a further differentiation, one that constitutes the most complex level of organization – organ systems. These perform all sorts of body functions, such as circulation, respiration, digestion, and others.[24] The complexity and variability of this organization gives rise to the diversification of animals from the simplest nemertean worms, molluscs, and arthropods to fish, reptiles, large-sized mammals, and humans.

Evolution is fundamentally a process of differentiation. The initial single-cell protozoan is a complete organism capable of performing all the basic functions of life. This is commensurate with the progressively specialized functions that emerge within species of escalating complexity. The escalating complexity of species is expressed through the increasing layers of cells (germ layers) that give rise to tissues, organs, and systems. Therefore, the diverse specialized functions and their supportive cell organizations can all be ultimately traced back to the corresponding primitive functions and organization of a single-cell organism.

Inevitably, animals must face the surface / volume ratio problem as their size gets larger. Since surface area (length^2) increases more slowly than volume (length^3), the surface area of larger animals may be inadequate for respiration and nutrition of cells deep within their bodies[25] This necessitates the growth of a nervous system to coordinate communication between cell layers as well as circulatory and respiratory systems for allowing sufficient oxygen and nutrients to pass through their bodies.

In this regard, a protozoan cell, with no germ layer, possesses the most advantageous ratio of surface / volume. Its vast ratio enables it to take in nutrition and interact with the environment, stimulating its metabolism and granting

Level A		Level B		Level C		Level D		Level E	
Cell Division	Functions	Cell Division	Functions	Cell Division	Functions	Cell Division	Functions	Cell Division	Functions
Only specialized organelles	All basic functions needed	Epidermis	Sense	Sensory cells	Tactile, optical	Sensory organs	Better tactile, optical	More sensory organs	Touch, smell, hearing, taste, balance, and vision
		Collar cells	Circulation	Gastro-vascular cavity	Feeding, digestion, excretion	Digestive system: mouth, pharynx, intestine	Digestion	Developed digestive system: liver, stomach, intestine, and other organs	Digestion
				Gland cells	Engulfing and digestion	Excretory system	Excretion and osmoregulation	Developed excretory system: kidneys and other organs	Excretion and osmoregulation
				Simple nerve cells	Links between sensory and muscular cells	Nervous system: neurons organized into sensory, motor, and association types	Sensorimotor association	Modified nervous system: brain and nerve chains	Sensorimotor association
				Muscular cells	Locomotion	Muscular system	Active locomotion	Strengthened muscular system: limbs / wings	Rich behaviour patterns
		Mesohyl	Skeleton	Mesoglea	Skeleton	Connective tissue	Give structure to other tissues and organs in the body.	Respiratory system: gills or lungs	Oxygen moves throughout the body; break-up of size limitation
								Circulatory system: heart, blood vessels and sinuses	Oxygen and nutrient delivery between cells; take-away of wastes
								More complicat-ed connective tissues	Structure given to other tissues and organs in the body.
		Amebocytes	Other functions needed	Interstitial cells	Reproduction and nerve cells	Well-organized reproductive system	Reproduction	Matured male or female organ	Reproduction

Table 2: A rough summary demonstrating the role differentiation progress accompanied by cell division from the lowest to the highest level of biological organization. Table produced by Ye Chen.

	Level A	Level B	Level C	Level D	Level E
Body architecture	Single cell	Aggregation of Cells	Two germ layers	Triploblastic	Triploblastic
Organization	N/A	Loose	Most cells scattered, some organized into tissues	Tissues aggregate into organs; more complexity	Organs work together and form systems
Required condition	Nutrition of any type	Nutrition from water currents	A variety of organisms	Small organisms e.g. protozoans and rotifers	Specific portfolio of nutrition
Response to stimuli	Simple reflexes, instincts	Local and independent	Various stimuli such as light and pressure	Better response to stimuli e.g. light, pressure	Acute sense for faster response
Reproduction	Asexual	Hermaphrodite; asexual/sexual	Sexes separated in some: asexual/sexual	Hermaphrodite; cross-fertilization	Sexes are separated; sexual; end of asexual
Energy take-in mode	Autotrophic	Little locomotion; change shape	Some locomotion and initiative to prey on cnidocytes	Active locomotion	Strong locomotion

Table 3: A demonstration of typical change in the interactive quality and interactable quality of beings with the gradual complexification in levels of organization. Table produced by Ye Chen.

them strong vitality.[26] It is not difficult for sponges either to overcome the surface / volume ratio problem with the second simplest body architecture. Since their cells are loosely organized, sponges can change their body shape to ensure a regular supply of local water currents.[27] However, after cells are organized into diploid-tissue layers at the cell-tissue level of organization, specialized functions must be developed to counter this surface / volume ratio problem.

The growth of an organism's composition must be supported by the absorption of more energy to ensure its functioning. This necessitates the transition of an organism from the life of an autotroph to that of a heterotroph, which means that a given environment alone can no longer satisfy the organism's existence. Organisms, at the cell-tissue level of organization, must turn their passive living state into one that is more active. To find food themselves, sensory cells must be differentiated to enable them to generate signals in response to various types of stimuli, such as light and pressure. Sensory cells differentiate into eyes in more complex organisms to satisfy more demanding food requirements.[28]

Likewise, the development of specialized functions, such as locomotive and digestive systems, express enrichment of an organism's 'interactive quality,' giving rise to expansion of the behavior patterns of organisms. Such progression is only to couple with the organism's increasing 'interactable qualities.' As a result, the process of differentiation also implies harmonious coupling between interactive and interactable qualities.

Principles Drawn from the Differentiation Process

Comparing the variables of the organisms from A to E in the above subsection, we can see the following evolutionary transformations at work:

(i) A radical increase in cell diversification and organism functions.
(ii) An organism's structure becomes more complex, and it tends to be more tightly and systematically organized.
(iii) The required conditions to support an organism are more and more demanding.

(iv) An increase in the interactive quality of an organism, as its response to stimuli becomes richer and faster.
(v). The reproductive task of more complex organisms is differentiated into two gender roles, which complicates the breeding procedure.
(vi). The organism's locomotive ability becomes stronger to align with increasing required conditions.

Evolution of non-living beings also follow the being of equivalence criteria and differentiation mechanism. For example, the single point of origin of existence – the Primal Singularity – differentiated into elementary particles that played different roles in constituting atoms. These atoms aggregated to play different roles in composing a molecule. 'Cooperation' between the particles preceding the genesis of living beings is not as complicated as the cooperation of cells functioning in an organism, which applies to principle (ii).

Evolution of the social domain also follows the differentiation mechanism, in which every individual plays a part in maintaining society's structure. The society itself is a product of differentiation.

The principles of differentiation indicate the *being of equivalence*: **For any level of a being, its properties** (interactive, reproductive, locomotive …) **are consistent and correspond to its realm of existence**. But that being said, the beings are not equivalent, considering their disparity in the overall lifespan of species. This is related to the increasingly intense differentiation of roles in an organism, as shown by (i) differentiation of functions, (ii) complexity of structure, and (iii) increase of required conditions. We will discuss the riskier existence state of higher-level entities, especially the complicated social domain, in a following article in this series.

To sum up, the progress of evolution / variation is a process of differentiation, by which one role is differentiated into additional roles, which then couple with each other to maintain their respective, on-going realms of existence. This provides us with a clearer view of the 'division-coupling' process.

Relationship between the Interactive Quality Layers

We now understand the relationship between the four layers of human beings' interactive quality: **Each layer is an enhancement of its lower layer, yet each layer is also a differentiation – a derivative**. Enhancement therefore

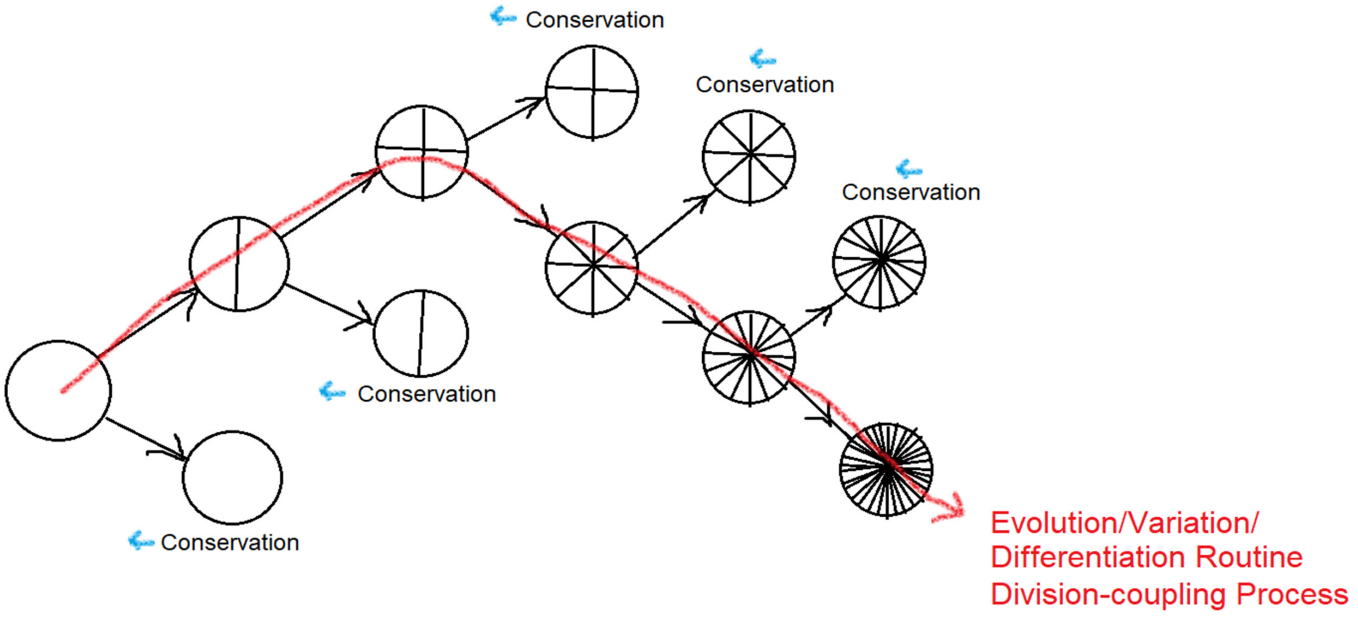

Diagram 4: Sketch illustrating the division-coupling process, showing how the role of existence is differentiated into more and more roles that couple with each other along their evolutionary pathway (shown as a red curve). The circle on the right with the most segments represents a being with the most complex structure and richest functions (interactive quality). The circles for 'conservation' reflect the force of conservation among all species. Diagram by Ye Chen.

means an enlargement of the interactive quality (compared with the lower layer), which enables a being to couple with more interactable qualities.

In diagram 5, layer D is derived from earlier differentiations of layers A–C. The quality acquired from that layer is thus an enhancement / enlargement of the lower-level interactive quality that belongs to the A–C layers. To make an analogy, a difference between layer A and layer D is like spreading glue on a single fingertip versus on an entire palm – one can stick more things with an entire palm.

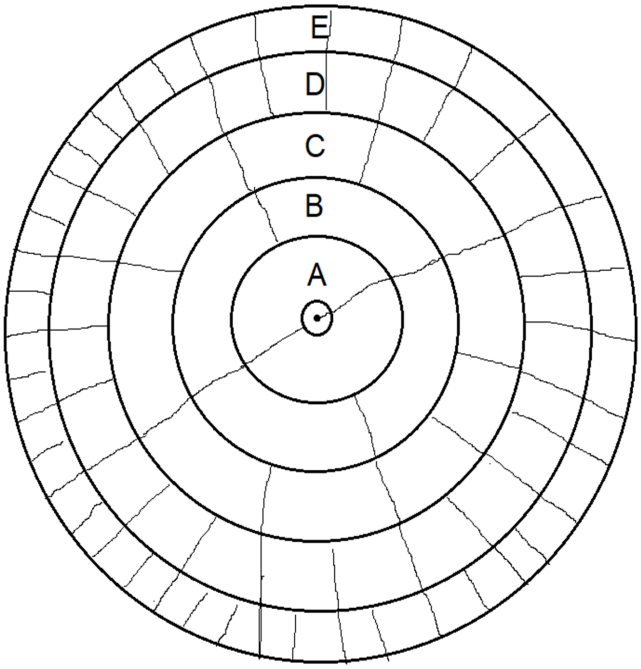

Diagram 5: A schemata of how a being evolves from levels A to E with more and more differentiated segments. The centre of the circle, a dot, with its simplest interactive quality (functions) and structure, symbolizes the being closest to the Primal Singularity, at the very beginning of the differentiation process, which is the least differentiated. All circulars around the centre are enlarged versions of it and surround the same centre. This reflects 1) Derivative relationships from the Primal Singularity through A to E., 2) Quality to maintain existence is differentiated and expanded level by level, 3) All differentiated functions (segments) of the circles aim to serve the same goal of existence (adaptation), which makes them equivalent. Thus, all circles are **in commensurate relationship**. Diagram by Ye Chen.

The concept of derivation and differentiation emphasizes that although the primitive interactive quality is differentiated and thus enhanced, the central theme does not change – namely to maintain its state of existence. While a particle uses layer A to maintain its existence, animals must possess layer D to maintain their state of existence.

The act of 'knowing' is a result of structural-coupling between an interactive-quality and an interactable-quality. **The enrichment of a being's interactive-quality increases the contact points of its interactable-quality**, thus enabling humans (with a higher-level interactive-quality layer) to couple with more interactable-qualities than say prokaryotes (with a lower-level layer). This results in the phenomena of 'knowing more.'

Yet 'knowing more' does not mean getting closer to the 'truthfulness' of an object simply because of the common essence of higher and lower levels of interactive-quality. Higher-level of interactive-quality are only an enlargement of lower-levels and can be evolutionarily traced back to them. The difference between a protozoon and a human merely reflects their different realms of existence and states of structural-coupling.

Required Conditions for Progressive Beings

Besides the differentiated and enlarged functions (interactive qualities) needed to support the evolving nature of beings, the interactable qualities – under the principle of *horizontal interrelation* – are also vital to how a being functions. So, it is necessary for us to examine conditions in the progressive level of beings, so that we can understand how they reach their existence criterion.

The lowest level of being in the universe lies with elementary particles – quarks and leptons, which are currently considered to be the ultimate constituents of matter, and bosons, the force carriers of fundamental interaction.[29] Unable to be divided further, these particles possess the strongest structure that is not possible to disintegrate, which means that the required condition to support their existence is almost nil.

Through differentiation and coupling, these elementary particles construct simple, composite particles, such as protons, neutrons, and other hadrons. They possess the second strongest structures, with a relatively high binding energy of 280 MeV for bottom quarks. The temperature needed to separate quarks and gluons is about two trillion degrees Kelvin (the expected conditions for their particles to disintegrate).[30]

As these composite particles differentiate further into more complex forms, such as atomic nuclei (protons and neutrons), their structure again weakens, and it is possible to separate nuclei. The average binding energy of a nucleon (from the elements hydrogen to nickel) is about 6 MeV – almost fifty times less than that of simple, composite particles.[31]

The next step of differentiation generates atoms in the universe, which are composed of electrons, protons, and neutrons. Again, as the structure evolves to become more complex, it also becomes weaker and more vulnerable to disintegration. The energy required to remove an electron from an atom, namely ionization, is lower than that needed to split atomic nuclei … by several orders of magnitude – 12 keV for copper.[32]

As atoms further differentiate and form molecules, we now enter the world of chemistry. The energy that binds atoms together, known as its chemical bond, decreases again (compared to ionization), generally varying from 10eV to 0.03eV.[33] We then arrive at the level of organic chemistry – compounds based on carbon – signifying a next stage of evolution just prior to the advent of living beings.

We can therefore conclude: **As structures complexify and differentiate, the conditions required for a being to disintegrate becomes less**. In other words, a being disintegrates more easily. This also means that along the unidirectional evolutionary / differentiation route shown in Diagram 4, the required condition for a being to maintain its form is more and more demanding.[34]

When macromolecules evolve into living beings, this tendency continues. A being then shifts from an energy-releasing to an energy-consuming mode, in order to maintain its existence. Instead of paying attention to the condition required for non-living beings to disintegrate, we now focus on the condition for living beings to conserve.[35]

Level A organisms, like single protozoan cells, accept all types of nutrition and can gain energy simply from sunlight. This means that the organism relies on very few conditions, as its interactive quality / structure is so simple that ambient conditions are enough to sustain it. In comparison, more complex forms of animals demand more conditions (interactable qualities), with which they need to couple for their survival.

This trend is prescribed by phylogeny – without certain preconditions in its evolutionary pathway, a species cannot come into existence. For example, it was only possible for flatworms to appear when microorganisms had evolved to provide food for the flatworm ancestors' interactive quality / structure. **There must be right conditions for an organism to exist … and there must be right conditions for the right conditions to exist.**

The occurrence of increasing conditions makes a being's interactive quality / structure possible and determines on what the being must depend on to survive. This means that a being's interactive quality (such as sensing, digesting and hunting) couples with the conditions, while the conditions also ensure that the being can acquire sufficient life material, thus supporting the continuous operation of its interactive quality.

So, to support the functioning of a more differentiated being, conditions must be of a greater quantity and a more demanding quality. That is why higher animals depend on a much larger number of conditions to maintain their existence. Adaptive radiation, addressed by many evolutionists, evaluates species' ability to create new zones when facing a change in conditions.[36] This approach is effective when comparing species at similar levels on a relatively small scale, but it is less relevant on a larger scale, because the quantity of the conditions required by different levels of being are so disparate.

For example, an ancestral E level organism may be lucky enough to adapt to a variety of possible changes through speciation. But its vitality cannot be compared to organisms of A, B, C levels, because they *do not need* to challenge themselves to adapt *so frequently* as an E level organism, since the conditions they require are much less and hence more easily sustained.

This is easy to understand if we compare the condition complex between different levels of particles. Logically, **a random change has a greater probability to threaten a condition** on a level that molecules depend than at the level

of atoms. Such change may either cause molecules to disintegrate into atoms (or other forms) or force a molecule to mutate in order to adapt to change in conditions. This explains why the level of molecules is more likely to mutate compared to the level of atoms, giving rise to the genetic variation on a molecular basis.

Based on the above, three issues aroused by the being of differentiation can be drawn:

> (1). **The being of differentiation is accompanied by an increase in conditions**.[37]
>
> (2). **The process of differentiation is also a process of structuration, which means more and more specialized roles are differentiated and can couple with each other to make more complex, yet *weaker* structures.**
>
> (3). **Higher-level beings, which depend on increased numbers of conditions, mutate and diversify at a faster rate than lower-level beings**.[38]

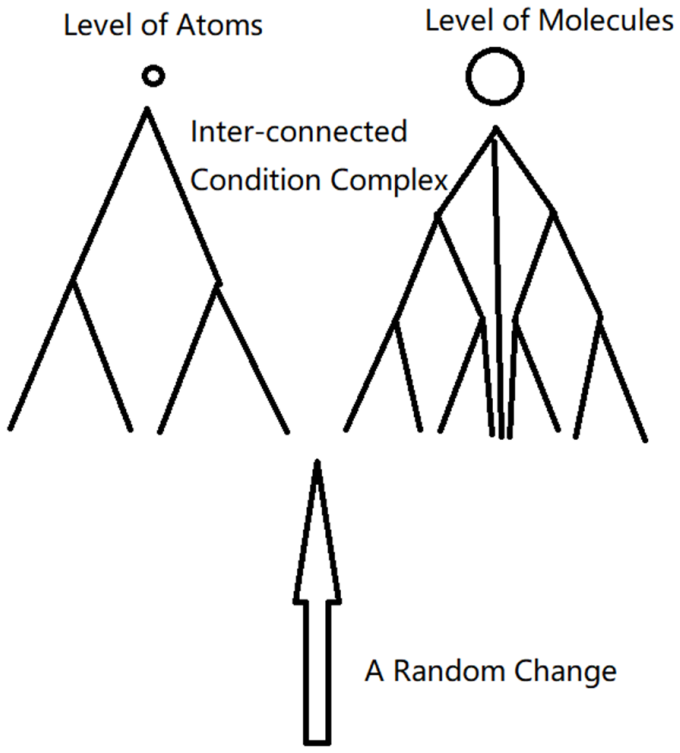

Diagram 6: An analogy of the conditions on which different levels of beings depend. The line segments represent superposition of interconnected conditions. When more conditions appear, some atoms differentiate into molecules, which means that the molecules must depend on more conditions than atoms to occur and maintain their existence. Diagram by Ye Chen.

These conclusions align with matter's distribution in the universe: **The total quantity of each form-of-being reflects its stability – its conservation ability, so the diversification of various levels of being reflect its evolutionary momentum.**

Coordination Between Sense and Reaction at Different Levels of Beings

The fourth issue derived from the being-of-differentiation is related to coordination between sense and reaction. The interactive qualities of the lowest level of beings (elementary particles) stay at the level of particle-particle interaction, where **the functions of 'sense' and 'reaction' are unified.** There is no division at the most basic level of being – sense and reaction occur simultaneously within a particle.

This situation is quite similar with the Big Bang, when the four fundamental forces were unified as one entity in the primal singularity. The coordination between sense and reaction of higher-level living beings, as usually studied by biologists, actually originated from this unified sense-reaction function of particles. Thus, particles' interactive functions can be viewed as most ancestral, a latent sense-reaction function.[39]

For A-level organisms, sense and reaction occur almost simultaneously, since unicellular organisms, with their perceptual layer of interactive quality, respond to a stimulus by simple reflex. This means that their response is virtually automatic and instantaneous.[40] In this process, though, sense and reaction are somewhat separated since sensing and reacting are distributed to different components in the cell.

This process suggests the seed of a cognitive act by which a being detects an interactable quality with which it couples. At this level, a being's interactive quality is quite limited and so the interactable qualities with which it can couple are limited. The law of identity (A=A) applies to this situation, as the being is not able to sense interactable qualities other than 'A.'[41] This is enough for that being, though, because 'A' has provided everything needed to maintain its existence at that level.

Since a being only needs to sense 'A' and react, at this level, evaluation needs not to be complex. It is only when a being can sense interactable qualities B–C–D–E does it need to identify and evaluate those qualities to which it must respond. The act of evaluation only starts at higher intuitive layers. At the perceptual layer, once an A-level organism senses 'A,' it has completed the simplest dependent process and satisfied the demand for maintaining its realm of existence.[42]

For 'B' to 'E' level organisms, sense and reaction are increasingly separated as they are distributed to specialized functions in an organism. The cognitive function / nervous system gets more complex as the form of movement / behaviour is enriched to enable a being to react to its cognition. **A being's interactive quality therefore rises from the perceptual to the intuitive layer to make distinctions and judgements, otherwise it cannot survive the larger number of conditions it encounters.**

As a higher-level being, an organism must be able to sense more interactable qualities (conditions), such as the scent of other animals or the sight of a predator. Among the interactable qualities A–B–C–D–E (and so forth), an organism needs to utilize the three laws of thought – A=A, A≠non-A, and A=B or A≠B – to make distinctions, decide to which it must respond, and coordinate how it should react.

The more conditions there are, the more difficult it is for a being to make judgments and coordinate its reaction to these interactable qualities. If a being makes a favourable decision and reacts to conditions, it accomplishes *a completion of the dependent process*, which also means a realization of the demand for its realm of existence.[43]

Although completion of the dependent process in higher-level organisms is equivalent to that of lower-level organisms, the distance between sense and reaction is larger for them and the process becomes more complex. A being's wrong judgement or reaction to conditions may put it in danger, leading to a *failure in completing the dependent process*.

So, for any given species: **The interactive quality must reach a certain standard that matches up with its realm of existence**. If that interactive quality is below this standard, interactive failures (sense-reaction errors) will occur too frequently for a species to thrive. This may lead to extinction, unless a beneficial mutation appears, one that modifies the interactive quality of the species.

The more numerous the interactable qualities, the harder it is for a being to handle them, just as it is also

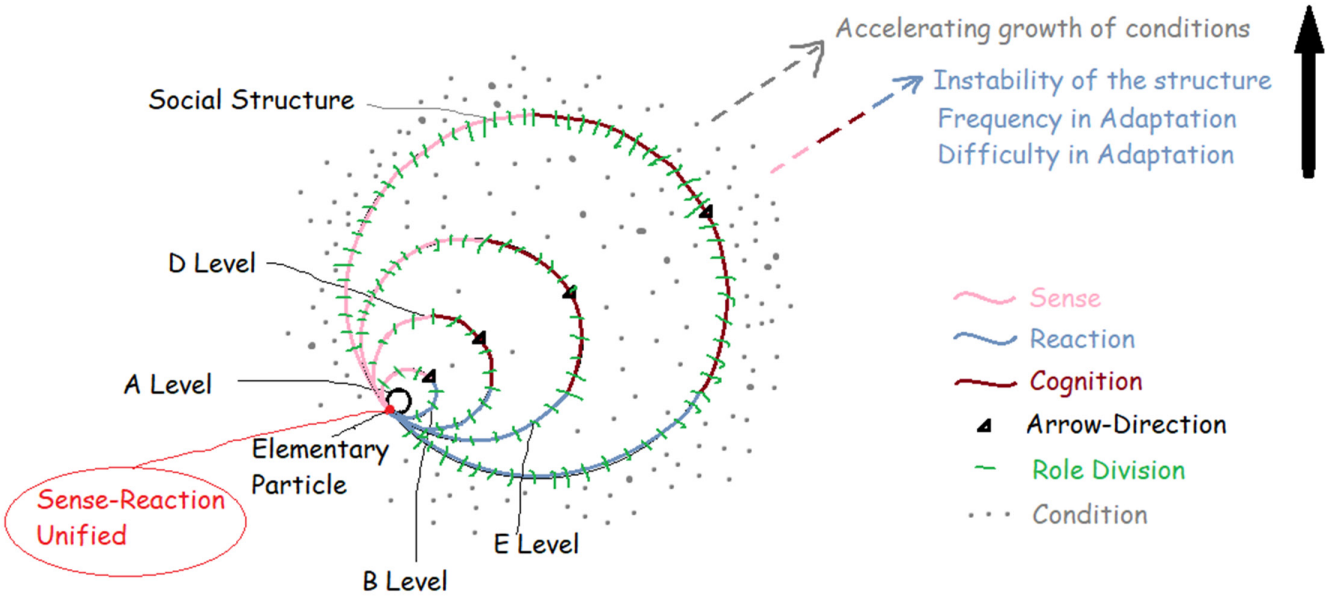

Diagram 7: A metaphor of the evolving sense-reaction process – from one red spot to bigger and bigger loops through which a being must go. A complete loop from the start (sense) to the end (reaction) means a completion of the dependent process and thus fulfilment of existence. More and more conditions (grey points) are generated when a being goes around the loop with its enhanced interactive quality, with more and more of its roles divided. Diagram by Ye Chen.

more difficult for it to complete the dependent process. Hence, more advanced interactive qualities are required. In this way, the original sense-reaction process expands to complex sense-cognition-reaction.[44]

For human beings, the distance between sense and reaction has been pushed even farther apart. We ponder on what has been acquired from our intuitive layer with more complicated forms of reasoning. **This is because our conditions are so diversified and complex that a more advanced 'information processing system' has evolved, which allows us to realize our own existence.**[45]

Therefore, human realization of the dependent process is complicated, flexible, and diversified. Compared to lower-level animals' uniform sense-cognition-reaction that copes with limited conditions, humans function with all four layers integrated together to handle a large magnitude of them.

This multifarious situation is seen in the many 'realities' described by psychologist George Kelly.[46] When studying this magnitude of conditions, peoples' way of organizing, defining and demarcating their experiences are diverse. The ever-changing views of so many objects explain the many models we implement to describe the world.

Conclusion on the Fourth Issue

We could perceive that sense and reaction are two sides of the same dependent process, but, along with the process of differentiation, **an increase in the number of conditions also confuses the process**, which gives rise to a nervous system that allows more cognitive patterns to coordinate the process**.** Nonetheless, however distant and complex this new system is from sense to reaction, they share the same goal of existence – a completion of the same dependent process.[47]

Meanwhile, as the gap between sense and reaction gets broader, **it also becomes more and more difficult to complete the dependent process and realize the state of existence, due to the accelerating growth of conditions (mass information) that one must deal with to make judgements favourable for existence.** This constitutes the fourth issue aroused by the being of differentiation.

However, is it possible for us, the highest-level of being, to reach a state of equilibrium where our interactive quality can overcome all conditions with which we face?

Preview of the Next Article

In my next article, I will answer this question by focusing on the evolution of society –how society is formed, balancing social structure, growing structuration and function, and the hardships of complexities human society needs to survive. Then readers will be guided to reflect on the phenomena that we have addressed – variations, differentiations and increasing conditions, then to contemplate the underlying mechanism that gives rise to them – the ultimate cause of evolution …

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Endnotes

1 While the concept of an originating source – the One – is derived from classical Chinese and Greek philosophy (Laozi and Parmenides of Elea), we can more accurately express it in scientific cosmology as the 'Primal Singularity.'

2 Maturana and Varela 1987: 61–69.

3 Smith and Szathmáry 1995: 149.

4 Maturana and Varela 1987: 65–66, 80–81.

5 Hickman and others 2002: 31.

6 Betram 2000.

7 Kimura 1983.

8 It drives a mutation in the single-celled organism, which changes the way certain proteins function – that is, proteins can link to other proteins. Pennisi 2018. Anderson and others 2016.

9 Scoville 2021.

10 Oks 2021. For example, the Sun makes up more than 99.86% of the total mass of our solar system, and, according to statistics from the Wilkinson Microwave Anisotropy Probe, the universe is made of 4% of regular baryonic matter, 23% dark matter, and 73% dark energy.

11 Wang 1998: 77. In Wang's theory, division does not simply mean something is fractured into two in a horizontal and static sense, rather they are derived from one in a vertical and evolutionary sense.

12 While more and more details appear in scientific research, this information is largely secondary to our goal of understanding the unified force driving existence. Properties can also be called information, as they both refer to what we know of objects, which is a product of our interactive quality coupling with the interactable quality of the objects. While the notion of 'information' became prevalent with the arrival of the Information Age, 'properties' were more commonly used in an earlier low-information time. Fundamentally they signify the same thing.

13 Jackson 2019: 30–31.

14 Maturana and Varela 1987: 107, 115

15 Darwin 1859: 343.

16 Darwin 1859.

17 Schopf and Packer 1987. Park and others 2012. Boessenecker and others 2019. Holtz 2007.

18 Overall, the K-Pg extinction killed most tetrapods over 25 kilograms. Muench 2000: 20.

19 Wang 1998: 285.

20 Protozoa locomotor organelles enable it to move, handle food, reproduce, excrete, and conduct osmoregulation; simple endoskeleton and exoskeleton are provided in some; true sexual reproduction with zygote formation is found in others; the response of protozoa to stimuli such as light or the presence of food represent the simplest reflexes and instincts; all those functions are important for higher animals. Hickman and others 2002: 52, 86–87.

21 Sponges, the simplest multicellular animal that adopts this level is merely an aggregation of cells that are coarsely assembled into two thin layers – 1) an opening epidermis layer bearing myriads of tiny pores and 2) an interior layer containing flagellated collar cells and a system of canals. In the middle of the two layers, a gelatinous protein matrix, mesohyl, is located. This functions as an endoskeleton that prevents the canals from collapsing. Sponges possess unspecialized cells called amebocytes that can differentiate into any of the other types of more specialized cells to carry out necessary functions, such as reproduction and digestion. Hickman and others 2002: 107.

22 Cnidaria have two well-defined germ layers – 1) the epidermis of the ectoderm (external layer) includes muscle, nerve, sensory, gland, stinging and interstitial cells; 2) the gastrodermis from the endoderm (stomach layer) contains gland, nutritive-muscular, interstitial, and stinging cells. Like the sponge, there is a gelatinous matrix (mesoglea) between the two layers, which functions as hydrostatic skeleton. The gastrovascular cavity is surrounded by two layers for digestion, with a single opening at the end serving as both mouth and anus. Hickman and others 2002: 53, 121-122.

23 A typical example of this is the flatworms, a phylum derived from a radial ancestor, probably the cnidaria. Flatworms' gelatinous mesoglea is replaced by a cellular mesoderm in the form of muscle fibers and mesenchyme (connective tissue). This adds an extra middle layer to the prior two germ-layers of cnidarians, which makes them triploblastic. Their muscular system is more developed since the added mesoderm makes more elaborate organs possible. To complement their active locomotion, a nervous system is formed, consisting of a pair

of anterior ganglia with longitudinal nerve cords. The neurons are organized into sensory, motor, and association types – an important step forward from cnidarian nerve cells. Sensory organs are advanced to cooperate with active locomotion, such as ocelli (light-sensitive eyespots). Hickman and others 2002: 52–53, 140–142, 152. Wang 2002: 43.

24 Hickman and others 2002: 53.
25 Hickman and others 2002: 52.
26 Wang 2002: 43.
27 Ruppert 2004: 83.
28 Hickman and others 2002: 122.
29 Braibant and others 2011: 1–3
30 Karliner and Rosner 2017. Gupta and others 2011. In this discussion of binding energy, it is important to point out that it is variable, according to the specific matter and energy under discussion.
31 Kraine 1988: 67.
32 Lang and Smith 2003. Wang 1998: 71.
33 Margulis and others 2021.
34 Wang 1998: 80, 85.
35 For non-living beings, we often use descriptions such as 'stability', 'separation', and 'fusion'; while for living beings, we use 'conservation', 'extinction' and 'evolution'. But ultimately, these descriptions signify the same situations from the perspective of being's evolution: either a being stays in a certain form, disintegrates, or differentiates into being with a more complicated structure.
36 Hickman and others 2002: 29–30.
37 Wang 1998: 70.
38 Wang 1998: 21.
39 Wang 1998: 185.
40 Purves and others 2004.
41 'A=A' is the act of demarcation, the most fundamental epistemological process existing in even the simplest beings. In Spencer Brown's perspective, "a universe comes into being when a space is severed or taken apart. The skin of a living organism cuts of an outside from inside." (Brown, 1972, p. v) "A=A" implies the concept of severance as A is an object that is extracted from a chaotic background, through which the being's dependent process and realm of identity is realized. If a being has a condition to depend on, 'A=A' functions in it in a way that it distinguishes itself from the condition, it lives on.
42 Wang 1998: 174.
43 The dependent process refers to the process in which the being tries to acquire various sorts of dependent conditions taking advantage of its interactive quality. It runs through the entire lifespan of the species, rather than one or multiple instances.
44 Wang 1998: 129–130.
45 Wang 1998: 157, 176.
46 Midgley 2000: 26.
47 Wang 1998: 167.

Big History Teaching and Learning

The Anthropocene and Academia: Reflection and New Approach

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Many friends and colleagues asked why we were so motivated to introduce a new interdisciplinary framework like Big History to our core course on sustainability / climate change at the Hong Kong University of Science and Technology. The reason is a mixture of intuition, observation and teaching experience. Often, our students, as our future leaders, do not see themselves as agents of change and they feel great despair by the complexity of problems we face.[1] So, we recognized the desperate need to introduce a new macroscopic perspective for our students to step back and see better opportunities and ways to approach the challenges.

We are Toddlers

Looking back to the Big Bang and the evolution of life on Earth, Big History shows that *Homo sapiens* are different. Collective learning has allowed us to leap from the middle of the food chain to its top in only a few geological nanoseconds. On that geological timescale though, we are still toddlers. This concept of infancy was introduced by economist / planner Bill Barron (2009) to examine the term 'development' and 'growth' in an environmental context. (Fig. 1).

The path of physiological development proceeds from baby to teenager and then to adult. But when we focus on technological growth, our social abilities have developed into those of just a toddler. We do not have the capacity or time to adapt to the changes that we have created. And, as toddlers, we love to play with 'toys,' from genetic and nano technology to artificial intelligence and rocketry.

We have a lot of toys. (Fig. 1). Some, like the COVID-19 vaccine, are put to global good, but others, like autonomous drones, could easily become weapons of mass destruction. Often, we do not really understand the impact of these techno-toys and we overestimate our ability to manage them and their unexpected consequences.

Specialization and the Great Acceleration

Social and human systems used to take millennia to develop, from hunter-gatherer systems to villages and agrarian societies. Now the time for such restructuring has shortened from millennia to centuries and then to even

Figure 1: Development versus growth (left). Toddlers and toys (right). By artist Betty Yuen, Hong Kong.

Figure 2: Ultimatum to humanity (left). Compartmentalized collective learning (right). By artist Betty Yuen, Hong Kong.

decades, years, and months. Humans used to be able to adapt, manage, control and utilize their innovations, but society cannot keep up with the rapid developments of science and technology, which turns out our new toys faster and faster in our age of the Great Acceleration. We are not able to comprehend the immense power of many of these toys.

With collective learning, we are able to make big progress in many areas, but we are still very much compartmentalized. (Fig. 2). Hyper-specialization in academia is 'silo-ing' our best minds, so our science and tech people don't talk much about the nonlinear impact of their work. Our financial experts don't think much about the disruptions they are funding, and our humanity and social science experts focus mainly on the problems of today but know little about the sweeping problems that are emerging, down the road, in the future.

While we were all enjoying these new toys in the last half of the 20th century, meteorologist Paul Crutzen and ecologist Eugene Stoermer sounded an alarm, in 2000, by popularizing the term 'Anthropocene' to highlight the dominant human influence on Planet Earth.[2] This was at the time we also began to talk more about multidisciplinary, interdisciplinary and transdisciplinary learning.

In order to give future generations a chance to prosper, we urgently need a new paradigm that highlights multidisciplinary understanding, one that acknowledges the Anthropocene and emphasizes the responsibility of all disciplines to help solve the sweeping problems of today and tomorrow. We understand that we are toddlers and that we have to equip ourselves with even more tools to prepare for the ever-accelerating changes of the Anthropocene.

Despite this awareness, many academics are not confident in transforming their curriculum for their students or they are bounded by a rigid institutional structure. So let us share some background of how we managed to innovate in our programs.

Indispensable for Sustainability Education

We understand that we are toddlers and that we have to help each other develop more tools in order to prepare for ever-accelerating changes during the Anthropocene, even though many academics are pessimistic about transforming their curriculum for students or are constrained by academic institutional structures. So here we share our experiences in adapting our pedagogy in 2016, our teaching experience and student feedback from 2018 to 2020, and our STEM program for both gifted and general secondary students in 2021.

John Lee Ka-Chiu, the Chief Executive for Hong Kong, expressed his ambition to advance STEAM education – Science, Technology, Engineering, Arts and Mathematics – in his 2022 Policy Address. He enunciated the incorporation of STEAM components into secondary-level curriculum and the designation of STEAM coordinators in schools, so as to holistically plan STEAM education, both inside and outside the classroom. We regard this as a hugely beneficial opportunity for us to introduce an interdisciplinary framework like Big History and embed it into our school system as an official school subject, not just as an interest-class elective.

This distinction is important. Although an elective allows for flexibility in planning and organizing, its influence on

society – students, teachers, parents, school administrators and officials – is much less. An official subject, however, is long-lasting and is engrained in an educational system, so that topics, classes, seminars and other forms of pedagogy are structured around it. As a result, the importance of Big History as an organizing system of awareness is brought about.

While faculty and our students are directly housed in the Hong Kong University of Science and Technology, we have developed a new program for secondary-level students (Form 1 to 3) and will involve our big-history undergraduates as student-teachers to instruct the younger students. In this way, we will be able to help all students better prepare for changes we will encounter in the 21st century. Below, is a description of this new program for secondary students.

We believe that the many problems we face today cannot be addressed or even well-articulated by a single discipline. One of the important skills in this century is an ability to integrate knowledge, and so there is a need for people with pluralistic expertise. In order to help students prosper in a 21st century environment, we hope to strengthen their ability to integrate and apply knowledge and skills across various disciplines and to foster their innovation. A critical challenge to our school curriculum is the absence of a systematic approach to nurture these skills.

In order to enhance the opportunity given by the latest Policy Address, we are proposing a new interdisciplinary framework called *Science, Environment and Society* (SES) – a chronological cosmic-evolution sequence, from the beginning of the universe and the development of the Earth's physical environment through the development of human society. We wish to utilize the power of narration, telling the story of everything to our junior secondary students, so as to arouse their interest in science and to equip science-process skills throughout the course of study.

The overarching goal of the SES program is to rejuvenate junior-science education with sustainability-education components via a curiosity-driven and evidence-based approach. Through examining the evolution of complexity as a common phenomenon, we aim to enrich junior-science and STEAM education. Secondly, we hope to address the importance and the role of scientific approach for information analysis. Lastly, we encourage proactive and a positive-thinking mindset for potential sustainability solutions. After implementation, we will then assess the impact of using the SES framework for student motivation in studying science and other disciplines.

We expect three major areas of deliverable products. The first is *knowledge* – students should be able to use evidence-based thinking to develop a macroscopic understanding and to be able to articulate key concepts in an interdisciplinary framework, including changing temporal and spatial scales, complexity, fragility and emergent properties. The second is *skills* – students should be able to develop science-process skills and readiness for multi- and interdisciplinary learning and information analysis skills. Finally, *values* – we hope that students can articulate the role of science and its relationship with other domains, including the environment and society. Furthermore, students should be able to build up a global citizenship and to think proactively about the outlook of sustainable development.

The SES program will follow a chorological order, but it will be divided by three themes. Secondary One – Science and the Universe, which will cover the big bang, the formation of stars and Earth's early environment. Secondary Two – Environment, which will include early life on Earth and its evolution to the appearance of *Homo sapiens*. Secondary Three – Society and Technology, which will engage with the cognitive revolution and collective learning to the agricultural and scientific revolutions. Then, students will have opportunity to discuss societies' responses to crisis, from which to foster a sustainability discussion beyond just the environmental.

We propose to implement the program in three phases. Phase I will be a demonstration period to local schools on the content of the SES framework. Phase II is expected to be a localization period that local schools can adapt and transit the teaching plans and materials for their students under our supervision. Phase III will be dissemination of program results and promotion to other schools.

We believe this interdisciplinary framework is indispensable for sustainability education, because it is not just showing the multiple layers of connections and non-linear effects, also important for highlighting how recent and changeable our social, economic and political systems are. We need to make students feel empowered, otherwise no matter how much knowledge we impressed upon them, they do not have the drive to solve our problems. It is also fundamental knowledge and way of thinking. The toddlers need to go to "preschool", where we learn to work with each other and also learn to understand what behaviour is dangerous and why.

We are at 'the best of times and the worst of times.' If we can do it right, we have a real potential to go for the moon

and even into the galaxy. However, dismay and disasters could be just around the corner, if we can't. Homo sapiens are smart and adaptable with both old and new institutions that encourage us to interact and learn, so as to adapt and prosper (Fig. 3). Last but not least, we believe even the sky is no limit and there are galactic potentials.

Figure 3: Aspire to Inspire. By artist Betty Yuen, Hong Kong.

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1. Wong, Lau and Gibson, 2020.
2. Crutzen and Stoermer 2000.

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Between What Was and What Will Be: Big History Insights from the Philippines

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What Was

... like a child bravely taking the initial steps,

we tremble at the possible mishaps and

later delight at the glaring feat ...

Being a Philosophy professor for eighteen years and then a Big History professor for three, I fell in love with Philosophy long before I fell in love with Big History. But, similar to St. Augustine's attribution of his relationship with God, I also say: 'Late have I loved thee, beauty so ancient yet so new.'[1] This exciting love affair with Philosophy and Big History is a marriage that came along and brought forth many splendid realizations. It introduced a dimension that existed from the very start but was never really pondered upon nor ventured into simply because they were never seen as part of a coherent whole. I used to be intimidated with numbers and chemistry but, suddenly took a different liking, once I was re-introduced to them in a big-history way.

I was intrigued by future-studies scholar Joseph Voros' remark: '… Big History provides an ideal basis for engendering futures / foresight thinking … .'[2] I wondered, what is so special about this academic endeavour? Lo and behold, through Big History, I am wearing a different and better lenses now; I hope I am looking at things better than how I looked at them before. A big-historian sees it this way: Today, it is necessary to go back to yesterday, link it to what we have in the here-and-now, and see how it can change our tomorrow. Between what was and what

Figure 1: Holy Angel University, Angeles City, Philippines. Photo courtesy of Holy Angel University Office of Public Relations.

will be, that is the best position for us to be at. We are spectators of what has transpired and what is to unfold, but with a chance of altering or modifying them for the better, now. Everything is connected. In fact, more than being connected, we are interconnected, interdependent, interwoven, intertwined.

How can someone take all of this in? My reply will echo that of journalist Sydney Harris, '… [T]he whole purpose of education is to turn mirrors into windows.'[3] My take on his statement is that mirrors reflect an image of the self. It may focus on the mundane and superficial aspects at times. I'm not saying it is altogether useless, because many are convinced that the best assessment begins with the self. But, if the intent is to merely focus on 'me' and 'myself,' we might fall prey to dwelling on the microcosm – a minute (but important) part of the entire picture, from the cosmos to atoms.

Instead, I suggest that we look out into the 'many windows' and the many 'possibilities' of reality. The windows then can represent a whole new paradigm or perspective we thought never existed, a whole new picture of reality. Hopefully, a bright and delightful window for *awakenings* that will prod us to *act* and do something, anything, towards change – change that transforms and inspires. The beauty about Big History is that, it is an ever-evolving subject; it evolves as we discover new things around us.

Our first attempt to introduce Big History at Holy Angel University (HAU), a Catholic University in Angeles City, Central Luzon (Philippines), received a lot of push and pull. The idea had been initiated by HAU President Luis Calingo, and, in 2017, the first big-history course was taught to selected classes, so we could see how it would be welcomed by the students and the teachers. The next year, it was officially offered to around 3500 first year students as a six-unit general education course, aptly called 'The First Year Experience.'[4]

As big-history coordinator for the academic year 2019–2020, my efforts were geared towards pedagogical training, a learning plan and educational resource development, along with assessment tools revision. Every teacher's discipline and expertise were utilized and incorporated into the learning plan, so as to ensure we had a full grasp of Big History within our wider institutional framework. At HAU, we welcome novel things without compromising our Catholic roots. It is our spiritual belief that welds all these realities together. The late Dr. Calingo left a profound legacy to our university and the Philippines as a whole. His vision to introduce a phenomenal course like this paved the way for many 'firsts and feats.'

What Is

... a child, more confident and competent,
walks along with others – amazed and
dumb-founded ...

Educator and poet Oliver Wendell Holmes Sr. elucidates these bits and pieces of inspiring accounts when he said: 'A moment's insight is sometimes worth a life's experience.'[5] When we are jolted from our seats and suddenly feel a gush of newfound realization, we are presented with a chronicle of life itself; its paradox and purpose. An architecture student in our course wrote about such insights, in relation to the concept of beginnings:

> Big History is one of the most peculiar subjects I came across in the entirety of my school years, because I initially thought that Big History pertained to just the history of how the world started. But as I attended more and more classes, I came to the realization that Big History teaches us one extremely important thing that most of us overlook … The beginning …
>
> I remember doing a particular plate [assignment] that required us to make a three-dimensional cube using these complex patterns that were stressful to look at on the reference paper. I spent a good day racking my brain, trying to make sense of these patterns. It was only when I started that I realized that every complex pattern started from a line and every line started from a dot. A singular dot on the tracing paper.
>
> I was dumbstruck, telling myself that I focused on the complexity of the patterns too much that I forgot an essential question: "What is the basis of this cube?" It then hit me, that such complexity came from a single dot. Humans underestimate beginnings, and most of the time, we overlook them. But if we think about it more, the "dot" is present in every aspect of our lives.
>
> An author's "dot" is their initial idea for a story they later developed and published. A

> doctor's "dot" is their first readings on a patient's status and evaluating the treatments needed for the patient's wellbeing. An architect's "dot" is their design concept for a building to be later discussed with the engineers. A tree's "dot" is a small seed that sprung.[6]

Big History is the 'dot' that prompted me to think even deeper, loftier. From beginnings, we delve into what beginnings can produce, the birth and death of stars. Indeed, it is a beautiful disaster that is a prelude to another wondrous phenomenon. We take part and marvel at these events every single day. This brings us to a deeper appreciation of the things we know, yet take for granted. We are a speck of dust; minute yet significant, vital, essential. That smallness points to a grander existence that created us – to marvel at the world (not destroy it). I am hoping that through the study of Big History you get to appreciate how lucky you are, how you are a part of the entire story, you are a witness to the grandeur of the cosmos.

With the death of a star comes the birth of abundant and important chemical elements. But the sad reality about resources being abundant and free is that we assume we have full control over them. We develop a mindset of taking more than what we need because 'it is free anyway.' We reached a point where we waste and abuse them, thinking they will never become scarce. I pose the challenge on you as a big-historian, be the spark that will ignite others to see themselves as stewards rather than masters, as co-creators rather than destroyers of the abundance bestowed upon us. I hope we won't wake up wondering why resources are nowhere to be found and what used to be free and abundant already has a big price tag – our planet, our own lives.

So, what is it like teaching and learning Big History in a Catholic institution that welcomes students of diverse religious backgrounds? Development-scholar Jayeel Cornelio's study of Catholicism in the modern Philippines notes how young people have a more individualized approach, seeing it as a personal and experiential relationship with God. This new perspective 'involves a solid, enduring commitment and a strong view of their own Catholic, religious identity.'[7] They are accepting of varied approaches to understanding and professing their faith.

I have observed this too, how, in the physical and virtual classroom, students' views are respected simply because it matters. It is not solely about looking at one's religious belief but, assessing what ideas and convictions may and can help improve their own. Big History, I think, provides an avenue for diverse ideologies to converge. They are, after all, part of the unified whole; these are unique and varied ways to concretize what is abstract. Call it a 'dot,' 'God' or an 'ultimate threshold' –all these are humans' attempt to know and explain where we all came from.

Interconnected, interdependent, interwoven – much of what we think and do is contributing to a larger reality. We can see how the human condition reflects society as a whole. How planet Earth is a vital factor to complete the solar system. Each component is diverse yet unified. For now, we can take a peek into what we can fathom (at the very least). Imagine the wonders awaiting us, be struck by the awe-filled wonders of galaxies and other celestial bodies. But even if we may know them or not, even if we may witness it during our lifetime or by the next ones to come, the fact remains that a creative being intricately positioned and orchestrated them to make a masterpiece. We are a part of that masterpiece.

What Will Be

... like a child, we remain yearning to know;
wanting to take strides ... in spite of, because of ...

We may find answers to a few of the questions, but, mostly, the answers are nowhere to be found. Be delighted with not having the answers most of the time, because it heralds the probability of knowing more in the future. This is an invitation to every human person in the cosmos to give Big History a try. You might initially take the role of a spectator. In time, you will find yourself taking part in writing the 'narrative.' You will always find yourself being part of the whole story. Just like our big-history experience here at HAU, may you find the courage to take the first step. I hope you will plunge into the waters rather than merely testing it because it is worth the toil. And once we do that, we begin our journey towards being a big-historian and, most importantly, educators.

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Big History in Action: Explorations in Multimodal Communication Strategies for Different Audiences in Taiwan

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Ever since I began teaching Big History in 2018 in Taiwan, the most frequently asked question is: 'How is Big History relevant to me?' For high-schoolers, we connect cross-disciplinary knowledge and learning strategies so they can process knowledge with diverse media. For lifelong learners, we combine problem-solving competency and complex big-history case studies so that they can apply competencies in multiple contexts. For our Executive MBA program, we help business leaders focus on organizational complexity and facilitate a discussion of structural change.

Educator David Perkins proposes that education should fill the gap between knowledge and the lives that students are likely to lead, rather than just building a vast reservoir of information. Health educators Christen Rachul and Lara Varpio suggest that a multimodal communication strategy can shape professional education by using multiple modes. In this article, we identify how a specific learning theme for different groups and elaborate how multimodal communication can address a variety of big-history topics and contexts.

Big History with Technology: Connecting High School Experience and Emotions

Learning is all about how humans process and store information. In order to enhance cognitive processing and active learning, educator Stephen Kosslyn proposes a set of principles that can be organized under two general maxims: 1) Think it Through and 2) Make and Use Association. We found that Virtual Reality and Augmented Reality (VR/AR) technology is effective in helping students integrate information and abstract concepts, which in turn enhances their understanding and memory. An analogy can be seen in how visually-impaired people learn to read braille.

When sighted-learners read, they activate a part of the brain known as the 'visual word form area' (VWFA). Research suggests that when blind learners read braille about things for which they have had no visual experience, they activate the same area. The VWFA is a multisensory integration region that recognizes shape-descriptions and connects to the brain's language area. This allows learners to achieve high-level perceptual representation. In sum, the brain acquires information through reading, regardless of the sensory input (visual or tactile).

In the world of scientific phenomena, symbols and equations, we are like blind people. With our limited sensory abilities, we cannot 'see' a magnetic field, a gravity wave, or the formation of a star. So we try to recognize the symbols and construct a representation of the world in our mind. IT educator and engineer Yiyu Cai suggests that VR/AR technologies not only provide a new way to perceive scientific concepts but also engage students to learn in an immersive environment.

In this case, students try to use prior knowledge to recognize items from the virtual world. In addition, they often feel excited to use technologies like VR/AR, so their emotions are activated, which enhances their memory. For instance, if we have students create the virtual reality of a living cell's environment, they will use their own experienced self-explanation to represent what they have learned from textbooks, then apply it in a different context.

I used Google Expedition to provide VR/AR content in my big-history class. Image 1 is from our class on human evolution, where I explain by using augmented reality how neurons transmit information in our brains. From the 2019 class survey, all of the 120 students gave positive feedback for the experience, and two-thirds (80) added qualitative descriptions (not required in the survey) about how it changed their concept of learning.

Problem-Solving Competency: Big-History for Lifelong Learners

Big History is a powerful thought-tool that provides multiple viewpoints across a variety of time frames and scales. Lifelong learners look for inspiration and insights to improve their decision-making and enhance their life quality. Big History can provide a framework for understanding and solving the challenges of our time, especially through its ability to zoom into details and zoom out to a big picture. This being said, lifelong learners can find the big-history narrative remote from daily living, so we combine competency-based training with big-history case studies to provide diverse contexts.

Competency-based education is the sum of information, abilities and attitudes a person should possess for engaging in daily life and tackling future challenges. Core competency should provide bridges between different domains of action

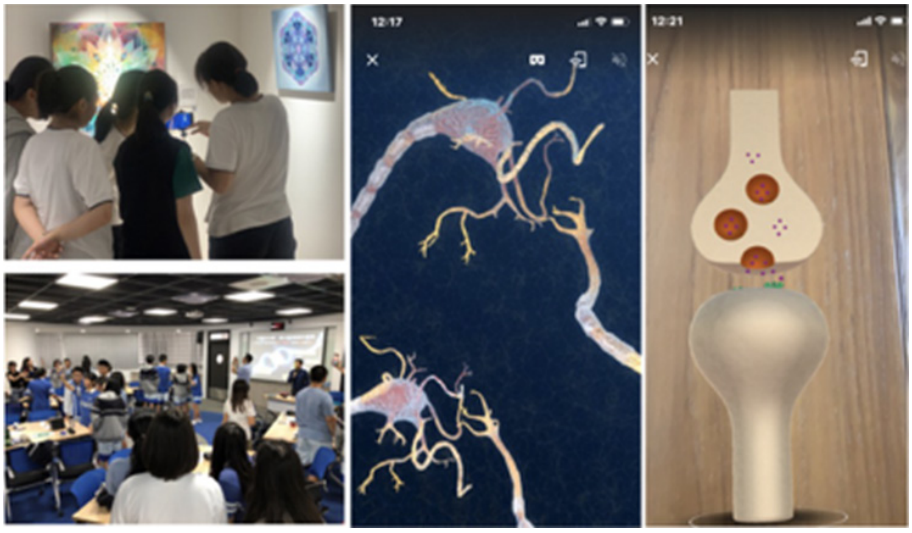

Image 1: Use of augmented reality (AR) technology in our big-history class to demonstrates how neurons transmit information in our brains. Ming Dao High School, Taiwan, 2019. Photographs by Gavin Lee.

and bring together integration between them. One of the best aspects of competency-based education is that it gives students choice in how they learn and how they demonstrate their learning. In order to accomplish this, we use rubrics to help students track their progress.[1]

Politician and education-reformer Robert Kerrey describes the pedagogy of Minerva University as a successful example of competency-based education, which is dedicated to 'provide students with a set of intellectual tools that is applicable across a wide range of situation.' Minerva's tools to reach this vision are 'habits of mind and foundational concepts (HCs).'[2] Each HC has its own five-point mastery rubric and is illustrated with content from multiple domains.[3] Inspired by these HCs, we identify thirteen problem-solving competencies (Table 1 provides three of these, as examples).

In our big-history class for lifelong learners, students do pre-class work relating to one or two competencies. They then have to apply those competencies in solving big-history problems. For example, they might work on a hypothetical reform in 19th century China after the First Opium War. Participants role-play the Grand Minister of State, the Minister of War, and the Emperor. They define the problems that China faced, establish the goal of reform, then identify the constraints to making the reform happen and the major obstacles that need to be removed – all from different perspectives.[4]

The most frequent feedback we receive from students in this class is that previous history classes criticized why historical figures were so short-sighted, even repeating their own mistakes. It was not until they imagined themselves in that era and in that official position that they realized it was not so easy to make the right decisions, for example, there were too many constraints that make them reconsider the priority and reallocate resources. To their surprise, even those students who are not history fans still find analogies to problems that occur in modern life and learn practical wisdom from these case discussions.

Competency	Proficiency Level
Define the Problem	Characterize the core problem by specifying obstacles between the present situation and the goal, while also identifying the problem's scale (to avoid distraction).
Constraints	Specify boundaries and needs for solutions, while being able to weigh pros / cons between constraint satisfaction and transformation strategies.
Gaps in Analysis	Identify if there are adequate solutions or gaps to be filled between the present situation and the goal in order to determine if a new solution is required.

Table 1: Competencies and proficiencies for habits of mind and foundational concepts (HCs).

Rethinking Management: Experiencing Self-Organized Complexity for Business Leaders

As for business leaders, they are looking for inspiration to improve their management skills. Currently, I teach two Executive MBA programs in Taiwan. The students are all fascinated by the idea of new, emerging complexities in their organizations. In order to provide more experiences and reflections, we work on a redesign of the classical video game, *Pong* (1972), with an in-depth discussion of complex system theory.

IT graphics scientist and Pixar-cofounder Loren Carpenter famously reinterpreted *Pong* at a crowd-experiment in the 1990s.[5] We modified this virtual ping-pong game into a mobile version. The rules are simple. Participants use their smartphones to control the paddle. They press green to make the paddle go up or red to make it go down. Each move of the paddle is the average of all players' intentions. Everyone is aware of each other's thinking, but they can only respond to an overview of themselves as they co-form a new complexity. In fact, the participants do what birds, ants and bees do, they flocked self-consciously without speaking a word.

Self-organization can be defined as the process by which complex systems, consisting of many parts, tend to achieve some sort of stable, pulsing state in the absence of external influence. Within a self-organizing structure, teams own the 'how' to do the work, along with deciding 'who' does the work within the team.[6]

This educational gaming component makes a huge impact on most students and causes them to reflect on how they can create an environment with Goldilocks conditions to facilitate such self-organization in their own organizations. The discussion is associated with the big-history concept of how emerging properties push the world through different thresholds with new complexity.

Conclusion: Towards a Whole Gamification Experience for Big-History Education

Big History provides good frameworks for thinking across fields, disciplines and scales, but the scientific knowledge involved is still inaccessible to many teachers and students. In order to overcome this barrier, we use a multimodal communications strategy to furnish experiences for students from different group backgrounds, so as to enhance their most-needed learning outcomes. Only when students are willing to engage in such classroom interactions can we deepen their learning and get them to apply their new knowledge. This is the mark of excellence in education.

In addition to the application of the VR/AR technology, problem-solving case studies and social gaming discussed in this paper, we are also working on how to revolutionize the learning process of big-history education through a series of other games. Instead of just learning knowledge in the classroom, students will become facilitators of different games, all of which will be designed to help them and their teams understand the mechanics of the game. The final outcome of the semester will likely be hours of continuous gaming marathons. Our goal is to reshape the big-history learning through gamification and to trigger students' interests to discover more in an upward spiral of achievement!

Image 2: The Pong game and follow-up group discussion on applying self-organization in management at National Taiwan University Executive MBA program, 2019. Photographs by Gavin Lee.

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Practical Experiences from Big History: Middle School in Taiwan

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From the Big Bang to the recent development of human civilization, we are exploring the future and examining the past. Big History includes knowledge about the universe and the composition of the chemical elements, which represent the macrocosm and microcosm for the whole picture. In the frame of Big History, we connect everything that seems irrelevant to the relevant, bringing it all together. At Mingdao High School, we focus on multi-performance and development, so we introduced a big-history course to our tenth-grade students. Instead of accepting knowledge passively in a classroom, we train them by cultivating their concept-creative ability and problem-solving skills. For such a course, it represents an unprecedented step forward in their lives.

Learning the meaning of learning is a crucial lesson in one's life. Under Asia's traditional education system, students are used to assimilate knowledge passively. As a result, thought has been limited. During the fifty years of Mingdao High School's operation, we have cultivated the solid root of student's learning, because we believe that 'besides the scores, there is something more important!' In addition to the requirements for student performance, we develop student's multiple abilities outside of the curriculum, including logic and critical thinking, problem-solving skills, and diverse interest development, etc.

With reading speculative expression as our central axis, students are able to face future challenges and develop abilities to carry around after they graduate. As Mingdao's concept says: 'You must discover yourself first in order for others to know you more.' The Big History course is like a piece of the puzzle, appearing at the right time and place, stimulating and helping the students to think outside of the box in Mingdao's campus.

In the big-history class, you need to leave your comfort zone as the very first step. The students have to not only study the course materials independently before class, but the group discussion during the class encourages students to see the world from a different perspective. Learning is no longer limited to textbooks. A peer's different viewpoints are indispensable nutrients that help students construct multi-thinking. In the two years of the big-history course, we have seen student's abundant investment in this course. Although this elective does not count for a high proportion of overall grades, students not only work hard, they actively absorb knowledge in different fields in the classroom, cultivating and deepening their cross-field abilities. Moreover, they have also learned how to be a practical learners. At the end of the course, students have to utilize what they have learned from this course to complete a case study, such as a marketing project for a family company / booking system optimization / hosting a forum for youth from Taiwan / setting goals for the school magazine's / Mingdao United Nations Sustainable Development Goals Summit.

As an educator, I'm dedicated to discovering problems and embracing new knowledge. At Mingdao, encouraging learning is not only for students, we also encourage our colleagues to actively absorb new knowledge. Just like multiple levels of knowledge brought to us by Big History, which let us think about how knowledge acquisition should focus on the cultivation of cross-domain capability. With the core purpose of Big History, 'thinking from the big picture,' even under the influence of the covid epidemic, Mingdao is still a pioneer of online learning, including for the Asia Pacific Youth Leaders Summit, Mingdao Model United Nations, and United Nations Sustainable Development Goals. Those activities reflect core perspectives from the Ministry of Education: autonomous action, communication and interaction, and social participation, each corresponding to the other. In the era of endless learning, the potential of every student is like an iceberg under the water, full of tremendous possibilities. With the guidance of multiple activities, students can also reflect on and adjust to the upcoming future.

Just as the planets in the universe affect each other to form outer space, so too is the cultivation of every student's ability to the world. We must break away from the frame of traditional thinking style, see the world from a global perspective, and learn how to be a learner.

As a pioneer big-history course in Taiwan, I hope this course can be implemented in the rest of Taiwan's education system and can take education in Taiwan to the next level. Therefore, more students can be leading under the non-traditional teaching of 'global thinking' and 'discovering and solving problems,' which will stimulate different sparks and become global citizens who have to break their comfort zone. In the future, we hope that we will gain more big-history exchange opportunities with high school students from different cultures around the world.

Scenes of Big History at Mingdao High School. From the authors' collection.

Contributors

Ye Chen (Zora) did her undergraduate degree in economics and arts, followed by a master's in the social sciences. Zora has always been passionate about literature, art, and philosophy. Composing poetry and prose, and analysing literature and art / pieces cultivated her aesthetic worldview. Her aesthetics however were challenged by philosopher Wang Dongyue's text, *A Unified Theory of Evolution*, a book that lit up her curiosity about the ultimacy of beings, a topic that covers multiple disciplines of nature and social studies. Through Wang's model, the world (with its chaotic and fortuitous phenomena happening at every instant) turns out to be reasonable and clearer than ever. Currently, she is planning to do a PhD on mega-evolution, philosophy and nature, which would contribute to the final completion of her book, *Introduction to the General Law of Being*. Zora may be contacted at <nighton352@gmail.com>.

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Nobuo Tsujimura is a big-historian in Tokyo who has played a major role in activating the field at home and abroad, especially as President of the Asian Big History Association. He also served as a board member of the International Big History Association as well as the Institute for Global & Cosmic Peace, and as adviser for the Oberlin Big History Movement at J.F. Oberlin University in Tokyo. In 2019, he co-organized the first international big-history symposium in Japan with Professor Hirofumi Katayama at Oberlin, where he is currently teaching three big-history courses as adjunct lecturer. He may be contacted at <palettehole@gmail.com>.

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Humanity and Ecology: An Inter-Faith Philosophical Reflection

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As humans increasingly dominate in the Anthropocene epoch and become more powerful with rapid advances in technology and science, they are also seeing the consequences appear in Nature, such as global warming, rising sea levels, melting glaciers, pollution, deforestation, and violent storms. These natural disasters contribute to complex social, political, economic and health problems … challenges that are international, since we live in a largely borderless world and share a common home, one planet – Earth.

It is imperative that we take a fresh look at how humans are connected to other species and learn how to work together to address environmental issues. For me, as a philosopher at a Catholic university in the Philippines, I am seeing how this can be done through the lens of philosophy. We need to comprehend the inter-connectedness of science and spirituality in order to achieve a new harmony. Philosophical reflection is a crucial starting point for an attempt to comprehend Nature.

Nature should be the underlying core of any academic study seeking knowledge and of any institution searching for truth, goodness, and beauty. Such reflection needs to be grounded in the core capacities of intellect, rationality, and freewill. This is reflected in the human ability to ask questions, especially as to the *why* of things. Philosophy, religion and science are interconnected, since they lead us to knowledge and wisdom. Even if there are those who dismiss aspects of these ways of knowing, we need to engage all three of them in human understanding of Nature.

Science has brought obvious benefit to humanity, from medical advances to home comforts. Likewise, since more than 80 per cent of humanity follow an established religious tradition and the remaining 20 per cent follow a code of moral conduct, we similarly see the comfort that applied philosophy has brought humanity.[1] As a result, to reach out to humanity on behalf of Nature, we must do so through these three traditions.

There is a type of knowledge that is 'super-natural,' which is also called *faith*. As a result, knowledge can be divided into *natural knowledge* and *supernatural knowledge*. It is through the combination of natural knowledge and supernatural knowledge that philosophers attain wisdom (*sophia*) or what the Buddhist calls 'enlightenment.' All wisdom is knowledge, but not all knowledge is wisdom. Wisdom is knowing the differences in things, so it is essential that we engage in philosophical reflection and dialogue to successfully inquire into humanity and ecology.

Science deals with ecology on a bio-physical level, while religion engages with it from a moral standpoint. The environment must be viewed in both the bio-physical and eco-spiritual dimensions so that we can achieve holistic awareness. Science and religion should unite to form an effective and united front, notwithstanding their differences, in order to achieve unity in diversity, so we can reach a common ground or common position with respect to the world's ecology.

Ecological Dialogue and the Mystery of Nature

The progressive nature of knowledge and the rapid advances in science show that everything is in flux, or, as the ancient Greek philosopher Heraclitus said: We never step in the same river twice.[2] Despite the differences among us, it is amazing that we are able to talk together! That is why we should trust in the process of *human encounter*. Likewise, it is our belief that it would be wise to take notice of how Nature manifests itself, and to engage with the knowledge that science and religion provide it. The pluralities of expression give us the possibility of attaining wisdom in regards to Nature.

There is much that Nature reveals, but, in order to assemble and interpret this knowledge, it requires an attention to detail. As philosopher Jacques Derrida's said: *All we have are traces*. He refers to the ambiguity of images and the various pathways of learning.[3] These traces rarely

give us a simple, comprehensive awareness and it is this complexity to which Heraclitus alludes when he said that Nature 'loves to hide.'[4] Nature is not really hiding, but the problem is that we fail to see it as it is, the way it is, and how it operates. This illustrates how Nature and human perception is an ongoing, emerging process.

According to biologist Edward Wilson in *Consilience: Towards Unity of Knowledge*, it is just a matter of time before everything will be known.[5] This implies that things appear to be hidden simply because humans have not yet discovered them, a premise based on the etymological meaning in the Greek word, ἐπιστήμη / episteme, one of the forms of thought outlined by Aristotle and embodied in the word *epistemology*, the process of knowledge processing. But, is it really the case that Nature is just there and that everything will be known and can be known? Or are humans just being presumptuous in claiming to have access to the full knowledge of Nature and that it is only a matter of time?

Tension of Nature and Humanity

Humans have a tendency to disregard Nature as an isolated entity that does not change. It would do well for us to question such an assumption. Humans have gained much knowledge about the universe, such as atoms and cells that build complex entities like galaxies and societies. But are we anywhere near to really knowing who we are as human beings? After all the discoveries, don't we remain somewhat of a mystery even to ourselves?

When we say that all we need is science to understand everything, we are no longer doing science but are making a philosophical claim. The question of *human agency* is perhaps one of the most challenging problems. The philosopher, Friedrich Schelling (1775–1854), saw this to be an especially difficult issue.[6] We assume that human beings are the only entities capable of agency and imagine that Nature is just there and 'not doing anything.' But aren't we humbled by Nature again and again?

Science is noticeably important to people because it makes our existence more comfortable. Yet it is not and must not be the ultimate end of human imagination. This is why I find Mary Shelly's *Frankenstein* to be such a profound literary achievement. In it, science is used for a noble goal, trying to end death, but complications arise. It is best that we ask ourselves: What sort of monster are we creating from our hubris? We are close to such a scenario today, as AI scientists develop xenobots, robots that can reproduce themselves.[7]

Refusal to listen to Nature will lead to even more suffering. We become our own monsters. Nature is not something we created; we are instead but one part of Nature. We can relate our connection to Nature with the concept of *Goldilocks condition*s, an ideal state of being, or to what Heraclitus poetically described as 'attunement,' as for a lyre, or Aristotle's *Golden Mean*, a point between two extremes.[8] Our challenges of existence in Nature can be constructive: They can be a call to empathy, a call for unity and harmony.

Humanity's Hubris, Filtering Reality, and Science

Hubris is a basis of many of humanity's values. It is good to have self-confidence, but we should be humble. Nature can thrive on its own without us. We need to remember the Lenten message of 'dust unto dust' along with our solar-system's origin in clouds of dust.[9] It all starts with reflection about human finitude and nature's agency, as well as engaging with the best available science, love, and genuine concern for each other.[10]

We might disagree with others in the world, but we are capable of collaboration with them. Whether kings or peasants, rich or poor, Christian, Hindu, Buddhist or Muslim, everyone should respect Nature and practice ecology. As physicist Max Planck said: 'An experiment is a question which science poses to nature and a measurement is the recording of nature's answer.'[11] Humans are rational and naturally capable of learning, but those understandings accumulate through time.

This is all complicated in today's hyper-virtual milieu, where media filters how Nature is seen and valued. It is accentuated by fake news and misguided opinion, which contributes to chaos. A big issue is how new discoveries can significantly change old interpretations and alter our view of reality and nature. We need to rely on the best available science.[12] We need science for its information and knowledge, but other social forms decide its use, from media to elections.

Think to when common people thought the Earth was flat. This is now known to be scientifically wrong, but does it make ancient people less human, less wise or incapable of having been able to live a meaningful life? Of course not. Their social wisdom and collective knowledge were still vibrant and profound. It is simply the way things are when you look at the progress of knowledge.

According to philosopher Martin Heidegger, scientific knowing is not the only kind of knowing, which implies the presence of other avenues of knowledge, such as the wisdom offered by different religions. In ancient times, such holistic concerns about the environment existed, which have resulted in many popular books about the convergence of ancient teachings with modern science.[13]

Ecology is the study of the inter-relationship between organisms and their environments. Therefore, this science approaches the fundamental Buddhist teachings about inter-connectedness and conditionality, which appear in the practice of non-violence (*ahimsa*), loving kindness (*metta*) and compassion (*karuna*) towards all forms of sentient life, including a concern for the environment.[14]

Likewise, Pope Francis' 2015 encyclical, *Laudato Si'* [On Care for our Common Home] promotes loving and mindful care for all living beings, including the planet that we live in. He encourages all of us to have an 'ecological conversion,' such that, if we love God, we should also love one another and the environment; and he emphasizes the need to renew our ties with one another and with Nature – grounded on love, care, and respect.

According to Max Planck: 'Science cannot solve the ultimate mystery of Nature. And that is because, in the last analysis, we ourselves are a part of the mystery that we are trying to solve.'[15] We humans must begin within ourselves, within the small cosmos enfolded within our human consciousness, and it is imperative that we change ourselves; since, the state of one affects the state of the outer world; or, oppositely, the corruption of human acts affect the world and Nature.

For example, Mahayana Buddhism offers a way to make this change concrete through *upaya* [skillful means] applied with wisdom and compassion, which helps to realize enlightenment.[16] Furthermore, the Christian Holy Bible is replete with words regarding ecology, such as in the passage: 'But in the seventh year the land is to have a year of sabbath rest, a sabbath to the lord. Do not sow your fields or prune your vineyards.' This meant that the land must be given rest.[17]

Comparably, the Islamic Holy Book, the *Qur'an*, is likewise filled with verses on ecology. In Chapter 2 (The Heifer) Verse 36, we read: 'The planet Earth is man's temporary home; but a secure and comfortable one; sufficient for human needs.'

> It is He who produced gardens, with trellises and without, and
> Dates, and tilth with produce of all kinds, and olives and
> Pomegranates, similar and yet different;
> Eat of their fruit in their season,
> but render the dues that are proper
> on the day that the harvest is gathered.
> But waste not by excess (tasrif): for God does not love the wasters.[18]

In the Hadith, the Prophet Muhammad stated: 'Do not waste water even if you were at a running stream.[19] This, in turn, was founded in the *Qur'an* verse: 'We made from water every living thing […].'[20]

Buddhism emphasizes the inter-connectedness of all things, that all our actions have outcomes as influenced by the law of cause and effect. What happens in the environment or surroundings, such as diseases, pollution, garbage and global warming, all directly affects human health and believing that when the Earth is sick, humanity is also sick. And, because of Karma, where humans bear the consequences of their actions; compassion and loving kindness towards nature must be practiced to help ease the suffering of Earth.

All these must begin with the self, before it is realized and practiced in the home, in different institutions, in government, and in the world. In turn, the necessity of starting change with the self is captured in the wisdom offered by many sages, such as saying that all great journey starts with the first step, with regards the answer to the question of how can we change the world? The reply means we begin with our own self that is already a microcosm in itself, before we can affect change outside of our self.

All these serve as an eye-opener to humans that at the spiritual level and consciousness, religions share common ground of universal teachings to preserve Nature and planet Earth.

The Mystical Language of Nature

Something that complicates our understanding of Nature is our use of language. Humans have a tendency to see themselves as the spokesperson for Nature, since Nature seems to be silent. We ask a tree: 'What can you say?' The tree remains silent. So we assign a value to the tree for lumber. We ask a mountain: 'What do you say?' The mountain

remains silent. So we give it value as a golf course. Is this genuine communication between humans and Nature?

Our anthropocentric era began with the Industrial Revolution and, since then, not many humans have listened to Nature. We rely heavily on our intellect and sciences that paved the way for so much technological advancement, so we see ourselves as masters of Earth, as expressed in Descartes' rationalism: 'I think, therefore I am.'[21] That is why, when we confront 'the Other,' such as Nature, we have an 'epiphany' and can be sharply reminded of our finitude. This is a central theme of philosopher Emmanuel Levinas.[22]

Such an effort is not one of abstraction but experience. An extreme answer from Nature can take the form of natural disasters, such as global-warming, rising sea levels, storms, and epidemics. Without a density of plant life and the oxygen it makes, we would perish. Nonetheless, society pursues massive deforestation and destruction of marine life takes.[23] Humans must learn to learn to know Nature in a deeper way.

Genuine communication is not a monologue. The concept of deep ecology, as envisioned by naturalist Aldo Leopold, espouses the idea that Nature and human culture are not opposed – it is just necessary to respect and listen to Nature. Maybe such a dialogue would better be framed as a mystical experience, a reaction that Nature itself often evokes in people.

This was beautifully grasped by philosopher Ludwig Wittgenstein when he stated: 'What we cannot speak about, we must pass over in silence.'[24] The need to listen in contemplative silence to the voice of Nature brings us out of our ivory towers, our institutions, the confines of religions, disciplines, cultures and generations, and lastly, out from our hubris!

Ecological Action

Humans cannot dictate that land should produce crops in a dry season, a condition made worse by severe climate change. It is necessary for humans to listen to Nature before it is too late, because Nature now is acting differently than in the 'predictable' recent past. When Nature speaks in its own voice, as with wildfires, our initial reaction is one of shock, and we ask ourselves: 'What are we supposed to do? – This is my house, who set it on fire?!' If we are to continue to survive as a species on Earth, we need to re-interpret our view of who we are and our relationship with Nature. But how do we begin humanity's sense of responsibility to Nature?

Good intentions are not easily implemented as government action. Even the 1990 Kyoto Protocol on Ecology was not well implemented among all its member nations, which is a reason we have landed ourselves in a severe climate crisis now, with no end in sight. The solution boils down to thoughtful self-action and local engagement. Change can start with individuals, families and neighbours, as in beginning to implement the UN's 17 Sustainable Development Goals (2015), as for clean water and sanitation. Small, realistic steps for individuals and their communities can contribute to resolving the climate crisis and its accompanying issues.

Equally important is for scientists and social and spiritual scholars to have genuine discussion founded on common values to harmonize our practices on environment that will benefit humanity. All humans must see themselves as a part of a greater whole, imperfect, but a grand work in process. Together, through our sciences and religions, all of us need to learn how deeply we need one another to create a healthy life and a peaceful planet.

Educational institutions and religious organizations also can take a lead, by transforming their schools and meeting houses into *Green Sanctuaries*, with an emphasis on environmental stewardship, from recycling, solar energy and waste reduction to composting and promoting energy efficient habits. Notwithstanding the obstacles of regulations and administration at the state, national and international levels, all have the moral duty to overcome obstacles so that individuals are allowed to play a role in environmental protection.

Conclusion

In humanity's attempt to redefine our anthropocentric view of reality; we see a need for a genuine dialogue with nature that must be anchored on concrete experience. The mission of humans is similar to what St. Ignatius of Loyola said: 'Go forth and set the world on fire!' Or as Nietzsche declares: 'I am not human, I am dynamite.' This must start at the individual level, before we may be able to realize it on higher steps, where mutual respect and understanding is promoted by both science and religion.

If an individual does anything helpful, no matter how small, with good intention, they will naturally feel happy. If everyone does the same, treating others and environment in accordance with the noble precepts of truth, goodness, charity and justice, then the Earth can improve. If, in the end, the Earth does not improve, the individual, who

has done so much, will not cry because they have done everything what they can.

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