abstract: The objective of this paper is to study the co-evolutionary processes that life has developed over billions of years in the context of "Big History". The main intention is to identify their operational principles and strategies in order to learn how to co-evolve harmonically with nature. The most important observations show us that all forms of life are developing sustainable co-evolutionary strategies in nature since life's first appearance about 3,8 billion years ago. Biomimicry helps to integrate the sociosphere into the biosphere because it creates sustainable designs in economy, architecture, engineering, and so on. As result of discussions, those co-evolutionary operational principles of ecosystem cooperation must be bio-mimetically copied, emulated, and improved to reduce ecological footprint. In conclusion, biomimicry finds in Big History a perfect theoretical model to understand how humanity must co-evolve in harmony with nature.

Секция «Глобальная дипломатия и международные отношения»

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Introduction to the Big History The idea of interconnection between human beings and other life forms leads us to revise the concept of co-evolution through a transdisciplinary study of processes that life has developed on Earth since their appearance some 3.8 billion years ago. For this reason, this article makes a qualitative, exploratory, descriptive, and analytical study that seeks to unify, integrate, and include the history of the universe, the solar system, Earth, and life along the history of mankind. The Big History allow us to identify and recognize the sustainable strategies that work in nature to inspire us bio-mimetically in solving human problems (social, economic, technological, etc.). The continued exploitation of materials and energy resources of the Earth by the models of production and consumption has caused a great ecological footprint that has been disclosed as unsustainable. Nowadays, we must focus our attention on the Sustainable Development Goals (SDGs) lead by the United Nations for the year 2030 to engender a world where "other worlds are possible". This implies a transcultural recognition and

2015. This is a new transdisciplinary organization of knowledge that allows us to include human cultural systems and natural ecosystems within a co-evolutionary historical process. The achievement of the SDGs could find many sustainable and resilient solutions by the imitation of the models, systems, and elements of nature. Biomimicry finds in Big History a perfect theoretical model to understand the humanity sustainability challenge: by raising awareness about the cosmic exception that biodiversity on Earth represent in the whole universe. While Big History contextualize us in nature and the whole cosmos, biomimicry emerges as a new science that considers and values of nature as model, measure, and mentor: looking for the inspiration and imitation of the natural process to be applied into social systems, and thus find innovative solutions to complex problems such the SDGs. The term biomimicry comes from the ancient Greek ´ (bios), life, and ´ (mīmēsis), imitation. In the nineties, the term biomimicry was used in disciplinary fields of material sciences, cosmetic research, and robotics, until the American science writer Janine Benyus popularized it with her book "Biomimicry: Innovation Inspired by Nature". Since then, biomimetic approach is one of the most innovative responses in recent years to protect the environment and improve the quality of life through new sustainable habits of consumption and production. "Biomimicry uses an ecological standard to judge the correctness of our innovations. After 3.8 billion years of evolution, nature has discovered what works, what is appropriate, and what endures," notes Benyus (2012: 13), affirming that biomimetic revolution "begins an era based not on what we can extract from the natural world, but what it can teach us". This scientific line of thought is in harmony with ancient worldview of indigenous and aborigines' peoples, who see in nature its sacred dimension. So, the concept of biomimicry has origin with first human groups that created gods according to various natural phenomena (sun, water, ray...). Biomimicry revives the sacred and our spiritual intelligence (ZOHAR MARSHALL, 2000). That's why science and spirituality converges in the biomimetic philosophy.

A Brief History of Humankind on Earth According with the scientific consensus of Big History, the humanly known universe arose about 13.7 billion years before present (BP), with the explosion of the Big Bang. Earth formation occurred between 5 and 4.5 billion years BP, and the miracle of life appeared around 3.8 and 3.5 billion years BP (MARGULIS, 1998). During the first half of this period, the forms of first-born life on Earth remained at very simple complexity levels (as Archaebacteria or Eubacteria), but the appearance of free oxygen in the atmosphere originated the first complex cells (Eukaryotes), some 2 billion years BP (SPIER, 2011). The Cambrian explosion of metazoans took place about 1,5 billion years later, some 542 million years BP. Since then, the biological variety has increased rapidly, forming a wide range of multicellular organisms that are developing survival strategies with very unique energy flows, such as the food chain. While it seems that life arose in the depths of the oceans, it only managed to reach the mainland about 450 million years BP. Only 250 million years after reaching the Earth´s surface came the first warm-blooded animals, where dinosaurs highlighted during the Jurassic period until they disappeared 66 million years ago by a supposed asteroid impact on Earth. As historian David Christian (2010: 162) noted, this circumstance gave rise to hegemonic period of mammals, from where emerged later the first bipedal hominids around 7 million years BP. Thanks to carbon-14 testing performed on fossil remains found to date, we can know in an approximate way the dating of first Australopithecus, which seem to be about 4 million years. Homo Habilis dates from 2.5 until 1.9 million years, those of Homo erectus are around 1.9 million years, and those of Homo neardenthalis and Homo sapiens point about 200,000 years ago. With the extinction of Homo floresiensis about 13,000 years ago, Homo sapiens is the only survivor of the human species that co-inhabits and coevolves on planet Earth with the rest of the animal biodiversity, plants, insects, bacteria, etc. Co-evolution is a term coined by biologist Paul Ehrlich and botanist-environmentalist Peter Raven in 1964.

In their joint work "Butterflies and Plants: A Study in Coevolution", they approached the reciprocal evolutionary influences of plants and insects that feed on them: "an approach to what we would like to call coevolution is the examination of patterns of interaction between two major groups of organisms with a close and evident ecological relationship, such as plants and herbivores" (EHRLICH RAVEN, 1964: 586). While the idea of co-evolution was not new and had already expressed in previous theories, the use made for Ehrlich and Raven allowed thinkers from other fields of application make new interpretations. In 1980, evolutionary ecologist Daniel Janzen was the first to define the concept of coevolution in his paper "When Is It Coevolution?". "«Coevolution» may be usefully defined as an evolutionary change in a trait of the individuals in one population in response to a trait of the individuals of a second population, followed by an evolutionary response by the second population to the change in the first", Janzen (1980: 611) explain adding that "«diffuse coevolution» occurs when either or both populations in the above definition are represented by an array of populations that generate a selective pressure as a group." Thus, ecological interdependence requires three basic principles: 1) specificity, where the evolution of each specie is due to the selective pressures of the other; 2) reciprocity, when both species jointly evolve; 3) simultaneity, both species evolve simultaneously. So, the co-evolutionary process has been used in a relatively restricted sense in the context of biological evolution. But the sense of "coevolution" used in this research goes beyond to discuss about sustainability: including both the degree of mutual phylogenetic partnership as the degree of mutual change in the co-adaptation, but also global processes of macroevolution and specific processes of microevolution. Coevolution is defined, then, as a reciprocal evolutionary change among species and their natural environment that, during the complex development of inter-retro-actions with each other, mutually modify each other constantly. This view is in harmony with the distinction between biological and social evolution introduced by historians Andrey Korotayev, Alexander Markov, and Leonid Grinin (2015). Coevolution is a feedback process very present in nature and has been basis for agricultural and industrial exploitation of human beings in their historical evolution on Earth. As explained by ecological economist Richard Norgaard (1994: 39): "with industrialization, social systems coevolved to facilitate development through the exploitation of coal and petroleum. Social systems no longer coevolved to interact more effectively with environmental systems." With Industrial Revolution, began an era of hydrocarbons that drastically changed co-evolutionary processes of the prior agricultural stage of mankind (LOVELOCK, 1988). When social systems began to exert strong pressure on environmental systems, the stock of energetic and material resources decreased very quickly: starting an evolutionary period of planetary unsustainability. That's why SDGs are so important in Big History. Human race has had a profound impact on the climate and environment of the Earth and the SDGs represent our last opportunity to avoid ecological extinction and points of no return in the new geological era we have entered – the Anthropocene. Hence the systematic degradation of nature makes us accomplices of a global ecocide, since the ecological footprint (WACKERNAGEL REES, 1996) is perpetuated by our active participation in consumerist dynamics and our bioethics passivity before the destruction of life on our planet Earth, which is our sacred common good. "There are few more alarming indicators about the brutal climate imbalance that we have implemented, and the consequences will be terrible (ecocide and genocide, if you want to express in a synthetic formula), argues the philosopher Jorge Riechmann (2014: 333). Our common future is built today and we cannot fail to future generations. That´s why biomimicry emerges as a transdisciplinary science that deals with studying the complexity of inter-retro-actions developed between dynamic systems that make life (humans, animals, plants, etc.), within an environment which houses the ideal conditions for coevolution.

Biomimetic Pathways for Resilient Evolution While it is true that capitalist system has

brought enormous material benefits, its functionalist view subordinates everything to the maximum economic profit and the indiscriminate consumption at the expense of nature. It does not work to debate between communism, anarchism, socialism, capitalism or any other political theory of social organization derived from classical mechanics mental structures (where there is just one level of reality), but to mimic our own nature. Human consumption and production are unsustainable and are also causing serious consequences in the environment: climate change, desertification, destruction of natural resources, pollution of water and air, global warning, etc. The principle of biomimicry acts as a meta-model to be applied in economy, engineer, architecture, design, urbanism, industry, technology, art, politics, education, energy, and so on (COLLADO, 2016b). Nature is the only "business company" that has never failed after 3.8 billion years. To achieve a perdurable sustainable development, it is necessary to understand better the principles and strategies of nature. In this sense, the table 1 shows a comparison between some contemporary thinkers who have proposed to learn from nature to build a more just, democratic, and better integrated with the biosphere society.

Author / Principle Barry Commoner Fritjof Capra Janine Benyus Jorge Riechmann 1º Everything is connected to everything else Interdependence Nature runs on natural sunlight Homeostasis in biophysics terms 2º Everything must go somewhere Cyclical nature of ecological processes Nature uses only energy and resources that it needs Living from sun as energy resource 3º Nature knows best Tendency to associate Nature fits form to function Close material cycles 4º There is no such thing as a free lunch Flexibility Nature recycles and finds uses for everything Not carrying too far the materials 5º

Diversity Nature rewards cooperation Avoiding xenobiotics 6º

Nature depends on and develops diversity Respecting diversity 7º

Nature requires expertise and resources

8º

Nature avoids internal excesses

9º

Nature taps into the power of limits

Table 1. Comparison of nature principles proposed by Commoner (1971), Capra (1998), Benyus (2012), and Riechmann (2014).

As different authors have postulated, the principle of biomimicry is already articulated enough to be a tool which guide us towards achieving an enduring sustainable development in co-evolutionary harmony with Gaia. By identifying the operational principles of live at different levels, and more specifically in its ecosystem level, we can design "other possible worlds" where human systems are melodically engaging in the co-evolutionary symphony that takes place in the Big History. In 1971, the biologist and ecologist Barry Commoner formulated the basic "laws" of ecology: 1) Everything is connected to everything else. There is one ecosphere for all living organisms and what affects one, affects all. 2) Everything must go somewhere. There is no "waste"in nature and there is no "away"to which things can be thrown. 3) Nature knows best. Humankind has fashioned technology to improve upon nature, but such change in a natural system is likely to be detrimental to that system. 4) There is no such thing as a free lunch. Exploitation of nature will inevitably involve the conversion of resources from useful to useless forms. In his later book "Making Peace with the Planet", Commoner (1990) notes that techno-sphere prevalent in industrialized societies "is in war" with the biosphere, causing global ecologic crises impossible to be hidden. The notion of "ecoliteracy" or "ecological literacy" developed by physicist Fritjof Capra seeks to understand the organizational principles of ecosystems to build sustainable human communities. According to Capra (1998), there are five main principles: 1) Interdependence. 2) Cyclical nature of ecological processes 3) Tendency to associate, establish links and cooperate as essential characteristics of life. 4) Flexibility.

5) Diversity. In short, Capra (1998: 20) argues that "understanding the life must be seen as the scientific vanguard of the paradigm shift, from a mechanistic world conception through an ecological conception", postulating that human systems should be governed by the key criteria of a living system: a) organizational pattern or configuration of relationships that determinate the essential characteristics of the system; b) structure or physical embodiment of the organizational pattern of the system; c) vital process or involved activity in the continuous physical embodiment of the organizational pattern of the system (CAPRA, 1998: 175). In other words, Capra (1998) believes reconnecting with the web of life means rebuilding and maintaining sustainable communities in which we can satisfy our needs and aspirations without diminishing the chances of future generations. For this task we can learn a lot from ecosystems, true sustainable communities of plants, animals, and microorganisms. To understand them, we must become ecologically literate. "Being ecologically literate, being «ecoliterate», means understanding the organizing principles of ecological communities (ecosystems) and use these principles to build sustainable human communities. We need to revitalize our communities including education, business, and policies (CAPRA, 1998: 307)." In this literacy context, the American science writer Janine M. Benyus popularized the term "biomimicry" in the nineties with her view of Nature as model, measure, and mentor. According to Benyus (2012), Nature as model is viewed as the poetic principle of biomimetics because it tells us how the things are to be "brought forth". Nature as measure is seen as the ethical principle of biomimetics because it tells us how Nature respects its biophysical limits of regeneration and how we may emulate them. And Nature as mentor is watched as the epistemological principle of biomimetics because it tells us Nature is the ultimate source of wisdom and truth (COLLADO, 2016c). The natural world has designed co-evolutionary strategic processes that work and persist over billions, so it represents the best meta-model to imitate, copy, emulate, and perfect to create more resiliente and sustainable civilizational models (COLLADO, 2016a). In this line of thought, Benyus (2012) recognized nine laws, strategies, and operational principles of Life in the Nature that can be used as example of beneficial model for human behavior: 1) Nature runs on natural sunlight. 2) Nature uses only energy and resources that it needs. 3) Nature fits form to function. 4) Nature recycles and finds uses for everything. 5) Nature rewards cooperation. 6) Nature depends on and develops diversity. 7) Nature requires expertise and resources. 8) Nature avoids internal excesses. 9) Nature taps into the power of limits. Those principles invited us to reflect and compare the inherent characteristics of ecosystems with the culture of human production. "It could even be said that capitalism is the metaphorical antithesis of the natural process of life: in it prevails exclusion, squander, deregulation, what we call today as relocations, as well as unaware speculative flows to real production of goods and services" notes the natural philosopher Luciano Espinosa (2007: 66) compared to natural systems of the biosphere where "operate inclusive circuits of all member of the network, which are attached to the ground, tied to the satisfaction of the basic needs and the constant recycling of matter and energy." In short, biomimetics allow us to rebuild human systems in order to fit them in the natural systems, where the whole is co-evolving harmonically. In a similar manner, the economist Jorge Riechmann (2014: 211) suggest six basic principles for the ecological reconstruction of economy: 1) Homeostasis or "steady state" in biophysics terms. 2) Living from sun as energy resource. 3) Close material cycles. 4) Not carrying too far the materials. 5) Avoiding xenobiotics as POPs (Persistent Organic Pollutants), GMO (Genetically Modified Organisms). 6) Respecting diversity. Riechmann defines the concept of economic homeostasis to stop growing economically to focus more on qualitative development. At the same way as there is no living species in nature which grow all time, the economy (as subsystem of Gaia) must steady, only consume necessary natural resources and focus on human capabilities in a broaden form. This means stop using the GDP and GNP as a compass to guide progress, because they do not take into account the

number of hours that parents devoted to their children, or insecurity in the streets, or the quality of education, quality health systems, etc (COLLADO, 2017a). Unlike the Industrial Revolution, the Biomimetic Revolution involves the appearance of a new epistemological paradigm that focuses on what we can learn from nature, rather than focusing on what we can exploit it to obtain raw materials to be manufactured in the industry. Biomimicry seeks to involve and innovate various socio-ecological areas for the achievement of the SDGs (i.e. biotechnology, biotextil, bioengineering, bioarchitecture, biomedicine, bioeconomy, etc.). All these ecological principles mentioned above do not tell us what Nature is, they just tell us about certain key aspects of the human relationship with Nature. This is the main reason we must learn to co-evolve between the constant processes of material and energetic restructuration of nature.

Conclusions: Learning to Co-evolve with Nature Biomimicry could be defined as the transversal study of self-eco-organization of biological systems in their environment, in order to discover the principles of sustainability and co-evolutionary strategies that occur in Gaia to take them as a meta-model to imitate in human sub-models (COLLADO, 2017b). To achieve global sustainability that goes beyond of SDGs by 2030, we need to create transdisciplinary bridges between natural sciences and social sciences, as made in Big History. Transdisciplinary and biomimetic thinking is required to achieve the SDGs. Biomimicry is a meta-model that seeks to transform paradigmatic crossroads at which we are now through imitation of the creative processes that have been inherent in the wisdom of nature. It is an epistemic tool that facilitates the civilizational change course to restore biodiversity and the achievement of the SDGs. Biomimicry shows us that continued material growth is unsustainable and invites us to conceive the universe with a holistic, relational, contextual, and participatory thinking. According to Benyus (2012: 16), "living things have done everything we want to do, without guzzling fossil fuel, polluting the planet, or mortgaging their future. What better models could there be?" In this direction, we must learn from ecosystem processes that are co-evolving in the Big History to copy them, imitate them, and perfect them with the main goal to achieve the SDGs. Consequently, biomimicry also represents a (r)evolution of human knowledge because it leaves behind centuries of efforts to dominate and control nature. An idea that has always been present in the ancestral worldviews of indigenous and aboriginal peoples, who defended Mother Earth as a living organic system, and not as a dead entity that only provides us with raw materials for manufactures. Hence the adjacent transdisciplinary character in biomimicry, whose ecology of knowledge -scientific and not- creates an epistemic meta-model that opens the doors for a sustainable development on a planetary scale. For this reason, many scientist are returning to study all those epistemologies that advocate to rescue and defend all living and non-living organism of nature above economic gain imposed by the dominant globalization. It is obvious that biomimicry is not a new idea, since humans have always looked to nature for answers to solve complex and simple problems of our existence on Earth. Biomimicry represents a theoretical-pragmatic symbiosis between citizens from the North and the South, and also a fundamental tool to face the SDGs. Let´s ask to Big History how learning to co-evolve harmonically with Nature. Are you ready? I invite all readers to explore and discuss more ideas concerning the topics of this paper.

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