The rise of the technobionts: toward a new ontology to understand current planetary crisis

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Abstract

Inhere we expand the concept of Holobiont to incorporate niche construction theory in order to increase our understanding of the current planetary crisis. By this, we propose a new ontology, the Ecobiont, as the basic evolutionary unit of analysis. We make the case of *Homo Sapiens* organized around modern cities (technobionts) as a different Ecobiont from classical *Homo Sapiens* (i.e. Hunter-gatherers *Homo Sapiens*). We consider that Ecobiont ontology helps to make visible the coupling of *Homo Sapiens* with other biological entities under processes of natural and cultural evolution. Not to see this coupling hidden systemic risks and enhance the probability of catastrophic events. So Ecobiont ontology is necessary to understand and respond to the current planetary crisis.

Keywords and phrases: Holobiont; Ontology; Complex systems.

1 Planetary crisis on a nutshell

"One of the key messages that come out very strongly from this special report is that we are already seeing the consequences of 1°C of global warming through more extreme weather, rising sea levels and diminishing Arctic sea ice, among other changes, said Panmao Zhai, Co-Chair of IPCC Working Group I, referring to IPCC report `http://www.ipcc.ch/report/sr15/` release last October 2018.

In the report worked ninety-one authors and review editors from 40 countries, who review more than 6,000 scientific references on the theme. The report states that already "Human activities are estimated to have caused approximately 1.0°C of global warming above pre-industrial levels, with a likely range of 0.8°C to 1.2°C. Global warming is likely to reach 1.5°C between 2030 and 2052 if it continues to increase at the current rate (high confidence)."

The document also highlights that a number of climate change impacts that could be avoided by limiting global warming to 1.5°C compared to 2°C, or more. For instance, by

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2100, global sea level rise would be 10 cm lower with global warming of 1.5C compared with 2°C. Hans-Otto Prtner, Co-Chair of IPCC Working Group II claim that: Every extra bit of warming matters, especially since warming of 1.5°C or higher increases the risk associated with long-lasting or irreversible changes, such as the loss of some ecosystems, meaning we have a reinforce of negative global change processes.

And so, although Climate Change is an urgent issue that must be addressed immediately with clear and massive actions, it is far from being the only source of the current Planetary Crisis. In a 2014 paper on Science, Dirzo and co-workers (11) said that "We live amid a global wave of anthropogenically driven biodiversity loss: species and population extirpations and, critically, declines in local species abundance." According to their study; among terrestrial vertebrates, 322 species have become extinct since 1500, and populations of the remaining species show 25% average decline in abundance. Invertebrate patterns are equally dire: 67% of monitored populations show 45% mean abundance decline.

In-face of this global pattern of defaunation, the authors warn that such animal declines will cascade onto ecosystem functioning and human well-being. They conclude that "...defaunation is both a pervasive component of the planets sixth mass extinction and also a major driver of global ecological change."

In fact, besides Climate Change and Loss of Biodiversity, there are other seven biogeochemical processes recognized as the core of the current Planetary Crisis (see Fig.1), that exhibits clear thresholds that if exceeded will lead to tipping points in the Earth System (31).

To understand this, Kleidon suggests in (18) that we have to rethink Earth as a complex thermodynamic system, that is maintained in a unique state far from thermodynamic equilibrium by maximizing the entropy production. To achieve this Maximum Entropy Production (MEP) dynamics, Earth Systems carry out myriads of processes that transform energy, that results in the mass movement in the atmosphere, in oceans, and on land. But that ultimately all these local processes may cluster under some of the global biogeochemical processes porpoised in (31).

Under steady-state conditions, when a maximum in entropy production is reached, MEP implies that the Earth system reacts to perturbations primarily with negative feedbacks, reinforcing stability. But when external conditions change in such a way that the trade-off between flux and force shifts a perturbation of the flux would be enhanced until the flux reaches the new optimum value at which entropy production is at a maximum (18).

In Prigogine's out of equilibrium Thermodynamic Theory (29), Entropy Production (σ) is given by the product of generalized forces (X) times their conjugates fluxes (J)

$$\frac{dS}{dt} = \sigma = \int \sum_i X_i J_i \tag{1}$$

where it is supposed that forces and fluxes have a linear relation given by

$$X_i = \sum_j L_{ij} J_j \tag{2}$$

in which L_{ij} are the Onsager coefficients.

Now let us consider that before the industrial revolution the Earth System had an entropy profile (EP) as the solid black curve in figure . In that case under some perturbation (black arrow), the system would react with negative feedback (solid blue line)

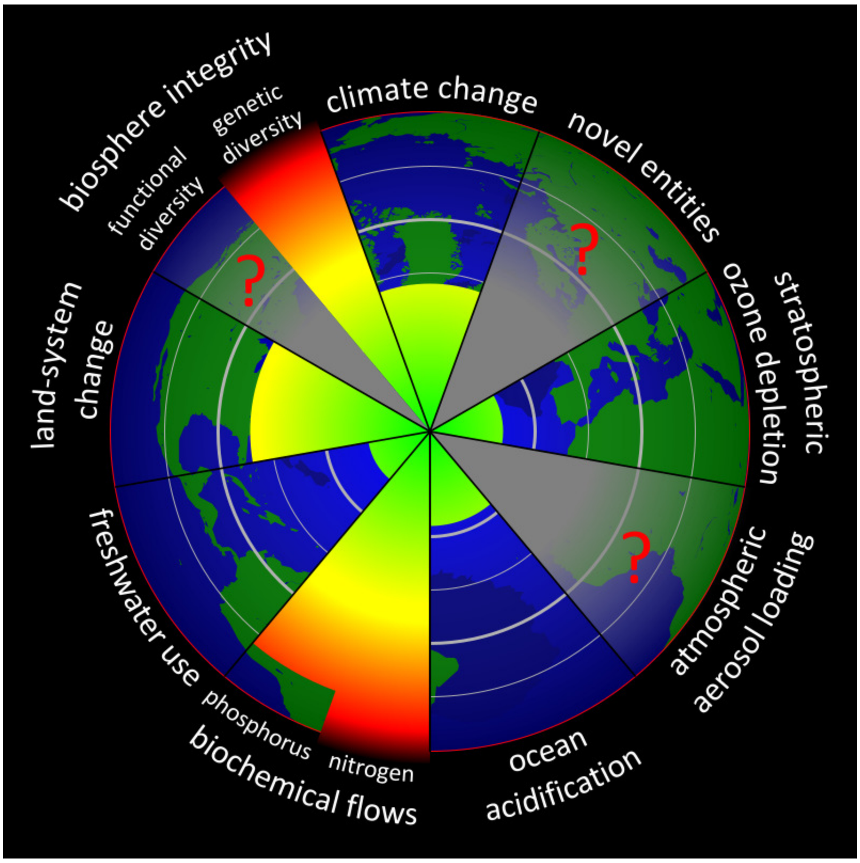

Figure 1: Planetary boundaries. The green areas represent human activities that are within safe margins, the yellow areas represent human activities that may or may not have exceeded safe margins, the red areas represent human activities that have exceeded safe margins, and the gray areas with red question marks represent human activities for which safe margins have not yet been determined. Taken from: https://commons.wikimedia.org/wiki/File:Planetary_Boundaries_2015.svg

as porpoised in (25). But as anthropic activities force more and more Earth System, it could be possible to achieve another maximum entropy profile as the case of the gray dotted line for which the response of the system to perturbations would lead to positive feedback (red solid line).

This kind of tipping point behavior related to Limit Cycles and Planetary Thresholds has been studied recently in (39). In there, the authors explored the risk that self-reinforcing feedbacks could push the Earth System toward a planetary threshold that, if crossed, could prevent stabilization of the climate at intermediate temperature rises and cause continued warming on a Hothouse Earth pathway even as human emissions are reduced.

2 From the Holocene to the Anthropocene

Key state variables of the Earth System (i.e. rain pattern, N2 cycling or ocean's temperature among others) exhibits natural fluctuations as registered for example in the 420,000-year Vostok (Antarctica) ice core record (27). Interestingly enough, as pointed out in Fig. 3, for most of the last 10,000 years Earth has remained within what is

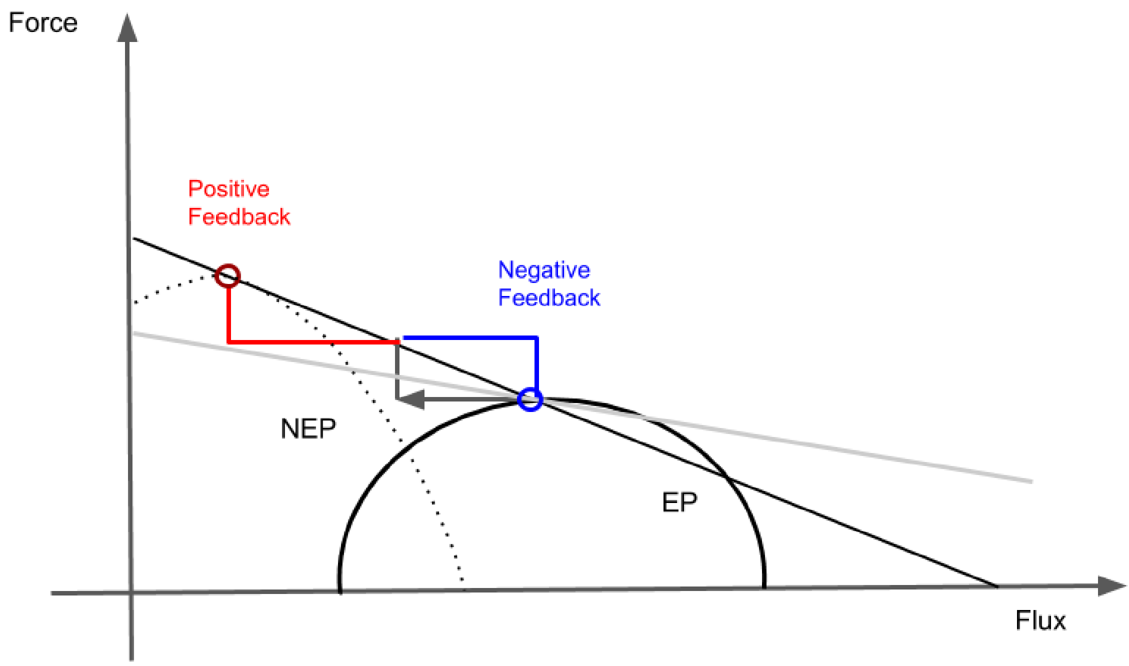

Figure 2: Under some set of perturbation (black arrow) and Entropy Profile (EP) represented by black line-arc the system would react with a negative feedback (solid blue line) as porpoised in (25). But as anthropic activities force more and more Earth System, it could be possible to achieve another New Entropy Profile (NEP) as the case of the gray dotted line, the response of the system to perturbations would lead to positive feedback (red solid line).

called the Holocene Stability Domain (HSD). The MEP mechanism of the planet has kept these key biochemical and atmospheric parameters fluctuating within a relatively narrow range (31). This increase of stability coincides with the emergence of Agriculture and subsequent civilization development.

The current dominant theory about speciation of *Homo Sapiens* out of archaic human varieties derived from *Homo Erectus* is estimated as having taken place over 350,000 years ago (light green area in Fig.3) (36). Since then and for must of our existence as *Homo Sapiens*, we have been organized in small nomadic groups of hunter-gatherers.

All animal populations, including *Homo Sapiens*, are sustained by fluxes of matter, energy and information from a finite environment within Physical constraints under evolutionary process. As a result, it is well known the existence of several scaling relations, such as the metabolic rate scaling as the 3/4-power of mass over 27 orders of magnitude, from molecular and intracellular levels up to the largest organisms (see Fig.4) (46; 47).

Contrary to noble savage myths, early humans started to become a source of environmental impact pretty soon as evidence by late Pleistocene extinctions of megafauna, due at least in part to human hunting pressures (16); or by the domestication of several animals converting for example *Canis Lupus* to *Canis Lupus Familiaris* about 100,000 years ago; and in general predating and modification of landscapes, often through the use of fire (30).

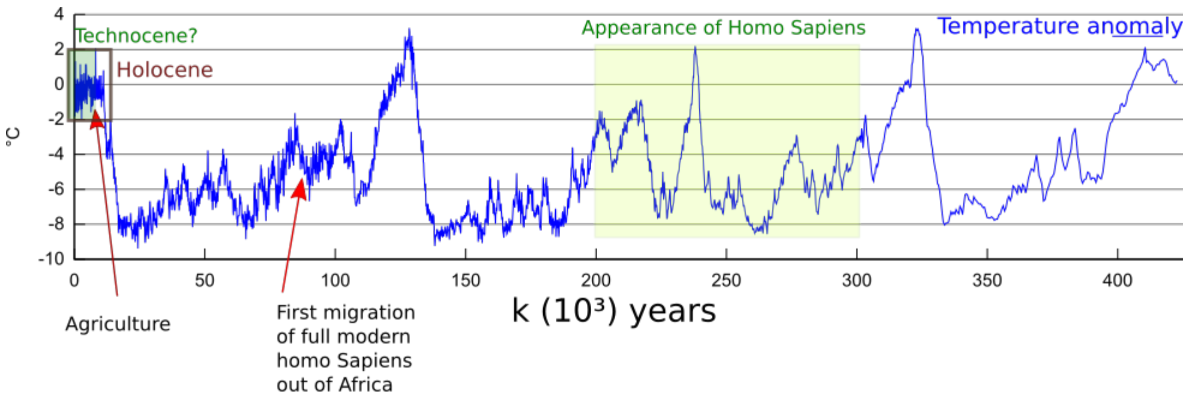

Figure 3: Data of Temperature anomaly (Celcius) from 420,000-year Vostok (Antarctica) ice core record (`https://gcmd.gsfc.nasa.gov`). The reference zero is present year and to the right we have the past in a scale of 10^3 years. Some important events for *Homo Sapiens* are marked in the figure. The appearance of *Homo Sapiens* is in light-green area, whereas Holocene Stability Domain (HSD) correspond to rectangle and inside it in dark-green is the Antropocene or porpoised Technocene

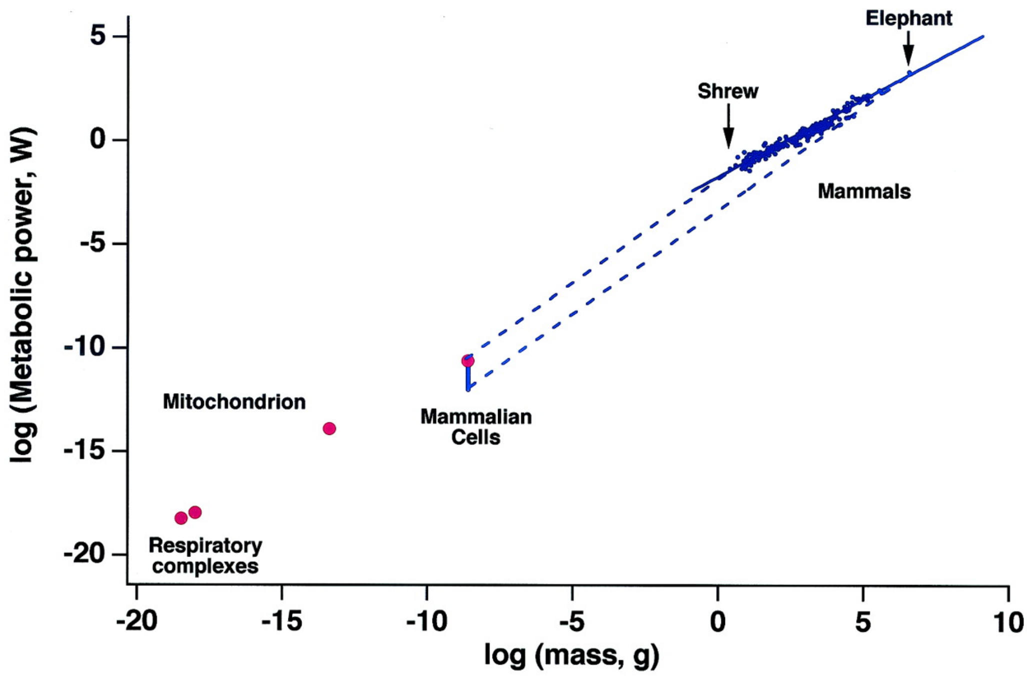

Figure 4: Taken from (47) under CC terms. Basal metabolic rate for mammals as a function of body mass on a logarithmic scale (blue circles). The solid blue line represents the predicted three-quarter power scaling law, covering over six orders of magnitude in mass from a shrew to an elephant. Values for cells in vivo for these same mammals are shown as a vertical blue band at a cellular mass of 3 109 g. These are related to the corresponding whole mammal values by a linear relationship, Eq. 2, as shown by the dashed blue lines. The upper dashed blue line is predicted to intercept the solid blue line at M = , close to the mass of a shrew, and to extrapolate to the value for an isolated cell in vitro (red data point; see Fig. 2). Also shown (red dots) are in vivo values for a mitochondrion, the respiratory complex, and a cytochrome oxidase molecule

Early humans used the considerable power of fire to their advantage, for example keeping dangerous animals at a respectful distance, especially during the night, and helped in hunting protein-rich, more easily digestible food. But as important as it was the real historical shift started with the emergence of agriculture (38).

At the beginning of the century, Paul Crutzen and Eugene Stoermer proposed that human modification of the global environment had become significant enough to warrant termination of the current Holocene geological epoch and the formal recognition of a new Anthropocene epoch (Crutzen and Stoermer, 2000; Crutzen, 2002).

This proposal of Anthropocene as a new geological epoch is based on the accumulative evidence that human activities have made so profound perturbations on essential planetary processes, that not only we are nearby a planetary tipping point as described in the above section, but they have already driven the Earth out of the HSD in which agriculture, sedentary communities, and eventually, socially and technologically complex human societies flourish (39).

Most interestingly, Burger and co-workers (4) have shown (See Fig.5,6) that even from pre-industrial but mostly modern *Homo Sapiens* living in cities are completely out of energy consumption scaling relation valid for every other animal.

The main idea of the authors is that *Homo Sapiens*, as well as any other species, are subject to fundamental biophysical laws. For example, it is expected that all species in a given environment flux the same amount of energy on average, corresponding to a zero-sum energy game (43; 44).

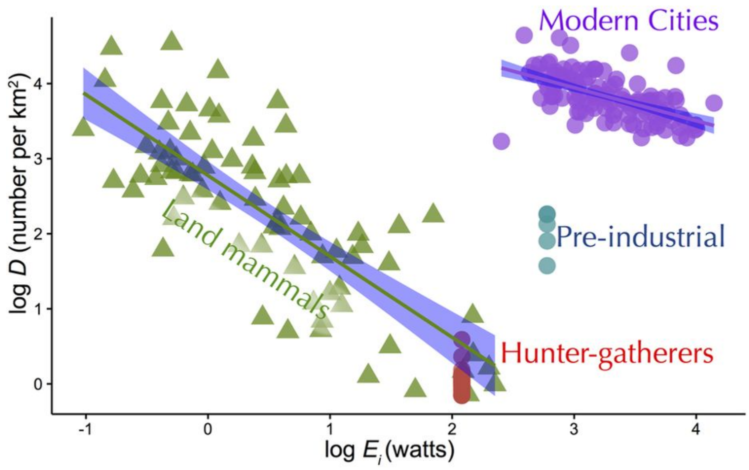

Figure 5: Red circles represent vegetarian hunter-gatherers (n=31), blue circles are pre-industrial societies (n=4), purple circles are modern cities (n=163), and green triangles are other herbivorous land mammal species (n=74). Note that the slope for cities is shallower than herbivorous land mammals, which support theoretical predictions of 1. See supplemental materials for additional details and data sources. Taken from (4) under `http://creativecommons.org/licenses/by/4.0/`

This prediction has been shown (7; 8) using the energetic-equivalence rule (EER) that links individual metabolic requirements to population energy use in space and time in such a way that there should be a power law between Energy use (E_i) and population density (D) as the blue one in Fig.5 that applies well for land mammals including *Homo Sapiens* organized as Hunter-gatherers.

Nevertheless, modern *Homo Sapiens* organized in pre-industrial societies are already far of the above behavior mostly to his capacity to harness extra-metabolic energy in the

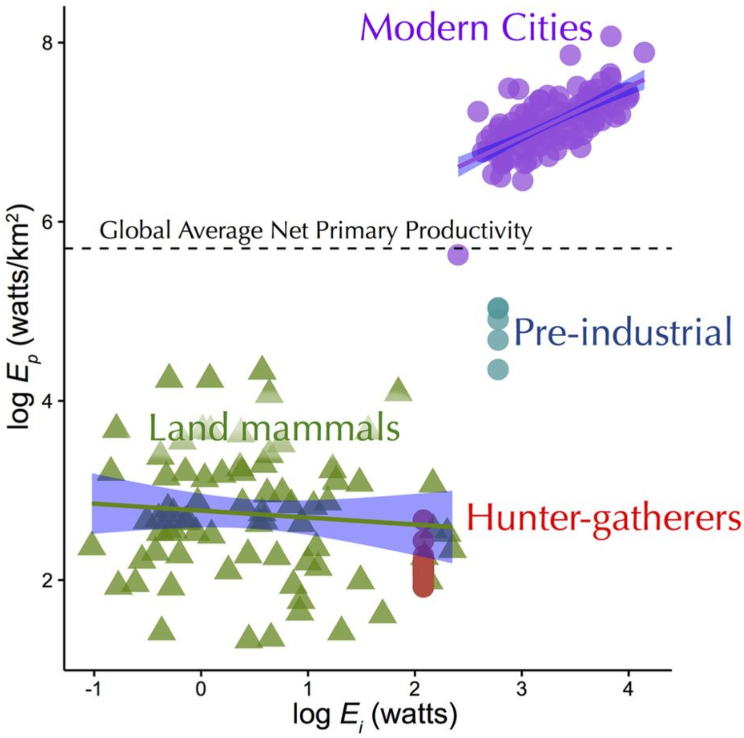

Figure 6: Red circles represent vegetarian hunter-gatherers (n=31), blue circles are pre-industrial societies (n=4), purple circles are modern cities (n=163), and green triangles are other herbivorous land mammal species (n=74). Ep is estimated as the product of density (individuals/km2) and Ei (watts). Note that population energy use for herbivorous land mammals does not vary with individual energy use supporting theoretical expectations (slope=0), whereas urban cities increase (positive slope). The dashed line represents the terrestrial average net primary productivity for the planet from (15). Taken from (4) under `http://creativecommons.org/licenses/by/4.0/`

form of renewable and fossil fuels to power modern agricultural-technological-industrial lifestyles. Even more, *Homo Sapiens* under modern cities organization are quite of chart reaching values of 10,000 watts, compared to 120 watts of biological metabolism in hunter-gatherers organization (two orders of magnitude more). So clearly, not only humans have deviated from other species in their energy use, there are two orders of difference between hunter-gatherers and urban *Homo Sapiens*.

In Fig.6 it is shown that unique to urban humans is the positive relationship between population energy flux and per capita energy requirements whereas other land mammals show a slope indistinguishable from 0 as the theory predicts. Interestingly to note that no other land mammal on earth has ever organized itself in such a way that its energy flux is higher than Global Average Net Primary Productivity.

These two results are so different for *Homo Sapiens* organized in modern cities that leads to the question if those are the same kind of organism that Hunter-gatherers in terms of Earth System functioning.

In this work, we porpoise that in order to understand and respond adequately to current Planetary Crisis we need to introduce a new ontology that captures this clear departure of modern urban *Homo Sapiens* from Hunter-gatherer *Homo Sapiens*. We call this ontology the Ecobiont and the particular kind of Ecobiont corresponding to modern urban *Homo Sapiens* the Technobiont.

3 The new Ecobionts ontology

According to Bunges Dictionary, ontology is the branch of philosophy that studies the most pervasive features of reality [...] Ontology does not study constructs, i.e. ideas in themselves(3). This means that ontology is, in a broad aspect, the more general class of theories about the world.

We are going to use the ontology concept from the point of view of the philosopher W. V. O. Quine(49) who argue that the scientists are committed to accepting the existence of those entities that are truth-makers of the theory.

The philosopher says in his text On what there is:

> Our ontology is determined once we have fixed upon the over-all conceptual scheme which is to accommodate science in the broadest sense; and the considerations which determine a reasonable construction of any part of that conceptual scheme, for example, the biological or the physical part is not different in kind from the considerations which determine a reasonable construction of the whole.[1]

With this, the notion of ontology is in the sense of a simplest conceptual scheme where the pieces of the entities puzzle can be ordered in a reasonable theoretical construction.

And following the ideas on how to model ecological and evolutionary processes as in (6; 22) let us consider a multidimensional Abstract Resources Space (ARS) in which a resource could be biotic (b_i^α), such as genome, microbiome and so on; abiotic (a_j^α) such as nutrients or solar energy for example; or social resources (s_k^α) including culture, economy and technology.

Then we define the Ecobiont (α) represented as the vector EB^α in this ARS

$$EB^\alpha = (a_1^\alpha, \dots, a_n^\alpha, \dots, b_1^\alpha, \dots, b_m^\alpha, \dots, s_1^\alpha, \dots, s_l^\alpha). \quad (3)$$

We claim that this definition of Ecobiont takes the idea of the Tangled Nature Model(6), which has been considered as a valid idealization of the quasi-species model in a frequency-dependent fitness landscape(10), a two-step forward.

But also, the ontology of Ecobiont would be a physical object (21), meaning: that the object should be subjective-invariant. (It means that the object should be invariant on respect to any subject, where the subject may be a researcher or a scientific community with its instruments of measurement and observation. Besides, it should have its theoretical framework.) And it should be be susceptible of contrast. (This means that the object should be susceptible to be contrasted between theoretical predictions and its experimental behavior).

The first step is based on the idea of Holobionts as units of selection and as a model of their population dynamics and evolution as porpoised in (32). Where the authors define Holobionts as "..., consisting of a host and diverse microbial symbionts, function as distinct biological entities anatomically, metabolically, immunologically, and developmentally. Symbionts can be transmitted from parent to offspring by a variety of vertical and horizontal methods. Holobionts can be considered levels of selection in evolution because they are well-defined interactors, replicators/reproducers, and manifestors of adaptation"

The importance of microbiome in evolutionary process has attracted a lot of attention recently. For example in (33) the authors say that evolutionary theories need to be

[1]Quine, W.V. (1948). *On what there is. Review of Metaphysics. P. 9.*

recast in the light of microbiome discoveries to fully understand and incorporate the role of microbes in our evolution. Fundamental evolutionary concepts such as diversity, heredity, selection, speciation, etc., which constitute the modern synthesis, are now being challenged, or at least expanded, by the emerging notion of the holobiont. In a subsequent paper, the authors claim that they have constructed the first model in which symbiotic interactions, diversity, specialization and dysbiosis in an ecosystem emerge as a result of coevolution (17) .

The second step is to incorporate the environment of the Holobiont as an integral part of its evolutionary process. For example to define *Puma concord* in this Ecobiont ontology it is not enough to think in *Puma concord* as in the Entangled Nature Model because it does not evolve in an isolated manner, for the contrary, it is co-evolving, for example with its biotic network of prays. Even more, all organism regularly modify local resource distributions, influencing both their ecosystems and the evolution of traits whose fitness depends on such alterable sources of natural selection in environments (19).

The clearest example of this is the co-evolution of life as a whole and the atmosphere chemical constitution. The coupled evolution of land plants, CO2, and climate over the last half billion years has maintained atmospheric CO2 concentrations within finite limits, indicating the involvement of a complex network of geophysiological feedbacks (1). It has been even suggested that from a thermodynamic perspective, life is a dynamic, out of equilibrium process, stabilizing and coevolving in concert with its abiotic environment. Then Life could be seen as a catalyst for entropy production through the water cycle, and ocean and wind currents, linking biotic processes to abiotic processes with the universal goal of increasing Earths global entropy production and thus provides a framework within which coevolution of the biotic with the abiotic can be studied (23). Other authors consider that from a geological point of view, life is an integrated part of the exogenic cycle, and one may regard the biosphere as a laminar, highly activated global envelope, energized by solar radiation, modeling the terrestrial physiognomy, and catalyzing major geochemical reactions. In other words, Life is a Geological force (48).

Finally when we think in the environment we are not only considering the physical one but also the social environment as well. Lalland and co-workers in (20) propose a conceptual model that maps the causal pathways relating biological evolution to cultural change. A process usually integrated with the concept of Niche Construction and which refers to the activities, choices, and metabolic processes of organisms, through which they define, choose, modify, and partly create their own niches. Niche-constructing organisms may also substantially modify the environment of their offspring, and even more distant descendants. Thus, generations of organisms inherit not only genes from their ancestors but also a legacy of natural selection pressures that have been modified by ancestral niche construction. This legacy of modified selection pressures has previously been labeled an ecological inheritance but the authors expand the concept of cultural inheritance. But in addition to being the Ecobiont a physical object, it can be examined by the scientific community to corroborate the theoretical scope proposed here and take it in contrast with the evidence.

In this theoretical model, we consider that although the hologenome already provides an evolutionary functional unit, the social context modulates these processes generating a kind of effective evolution. In this way we should recognize effects of modulation in the anatomy of the holobionts, in their metabolism, immune system, or in their development, all of them modifying their fitness or their niche and therefore intervening in the selection processes.

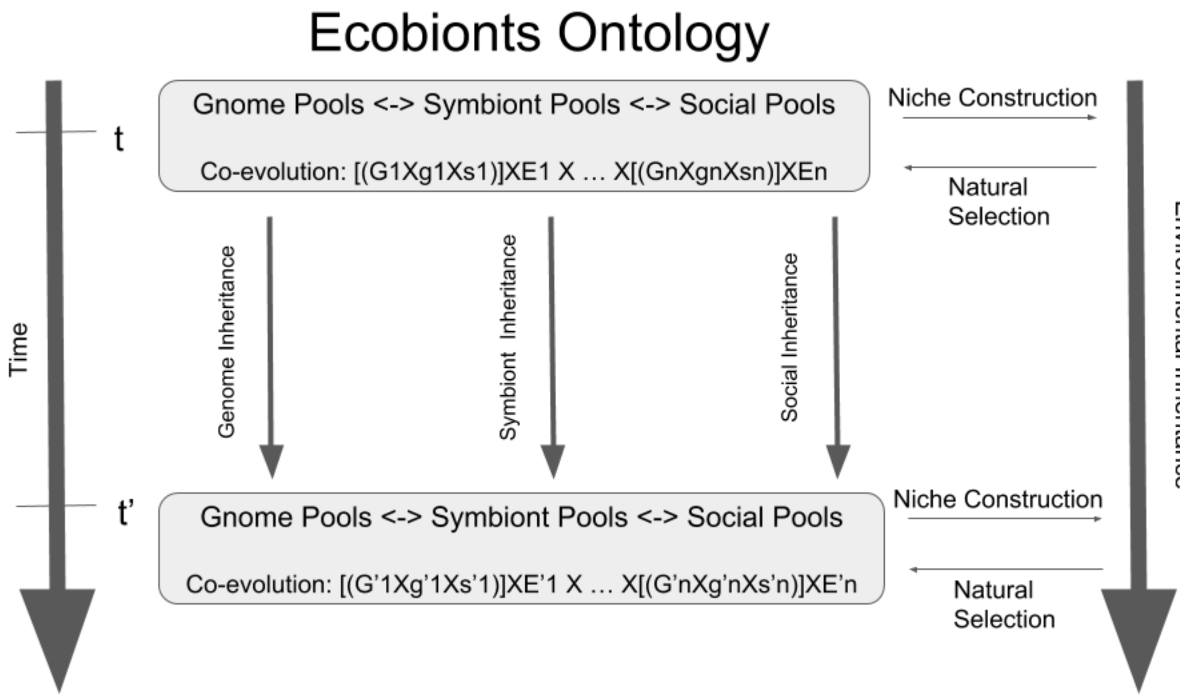

Figure 7: Theoretical model for the Ecobiont Ontology. We consider a set of interacting pools (genes, microbiome and social) that co-evolve from some arbitrary time t to t', by means of natural selection and niche construction. In the co-evolutionary multidimensional process G_i is the genotype of the population i that is coupled with its symbionts (g_i) and together as an holobiont co-evolve with local environment E_i forming one coherent evolutionary unit; which in turn co-evolve in parallel with many other of this units or Ecobionts.

As an example, there is a current trend of wearable robotics which is a promising way of integration between humans and robots. Typically wearable robot is intended to be a way to substitute missing parts of the human body, by means of a prosthesis or to enhance human body force and precision capabilities, by means, for example, of exoskeletons (2; 5; 51; 52). Recent developments (28) go beyond this in what may be call Enhance Human Technology (EHT), building prosthesis not to replace but to add functionality to the human body, in the form for example of a second thumb.

Even more, a recent in-depth article in Science (37) the authors discuss how we are entering into a new era in bioelectronics, developing devices that can be integrated seamlessly into nervous tissue. As good as it sounds in terms of innovative treatments in humans for everything from blindness and paralysis to brain diseases such as Parkinson's and Alzheimer's, this new technology can carry inputs as well as outputs, the day when bioelectronics will not just monitor animal behavior, but also control it, is then not far off. So the authors claim that these advances are beginning to dissolve the boundary between living organisms and the outside world.

If this anatomical modulation through a socio-cultural process (technology only one of many possible) carry with them fitness modulation in terms for example of sexual selection (as with Padaung woman in Thailand) or economic benefits that if maintained could have evolutionary effects. On this issue, Laland and co-workers have porpoise that if the cultural inheritance of an environment-modifying human activity persists for enough generations to achieve a stable selection pressure, it will be able to codirect human genetic evolution (20).

Take the classic example of Kwa-speaking yam cultivators in West Africa. These people increased the frequency of a gene for sickle-cell anemia in their own population as a result of the indirect effects of a socio-cultural process: the yam cultivation. By making clearings in the rainforest for the yam cultivation, they created more standing water and increasing the breeding grounds for malaria-carrying mosquitoes. This, in turn, intensifies selection for the sickle-cell allele because of the protection offered by this allele against malaria in the heterozygotic condition (12).

In another type of examples, recently the significance of the relationship between gut microbiota and its mammalian host in the pathogenesis of obesity and the metabolic syndrome has been demonstrated and emerging data has linked intestinal dysbiosis to several gastrointestinal diseases (including inflammatory bowel disease, irritable bowel syndrome, nonalcoholic fatty liver disease, and gastrointestinal malignancy) (26). There are clear socio-cultural processes that affect microbiome. Ingestion of a Western Diet (WD) that is high in saturated fat and added sugars negatively impacts microbiome and cognitive functions (24); extensive and even excessive antibiotic use (or overuse) has severe consequences linked to obesity, allergies and microbiome dysbiosis (9). Most interesting, a recent work (34) has shown that maternal high-fat diet (HFD) affects third-generation female body mass via the paternal lineage. We showed here that the offspring born to HFD ancestors displayed addictive-like behaviors as well as obesity and insulin resistance up to the third generation in the absence of any further exposure to HFD. In this way, not only this microbiome adverse socio-cultural processes are inherited (20), but their effect is also past to following generations.

Most interesting is that under this ontology we may be in place to start to formalize it under the scope of out of equilibrium thermodynamics. Following (22) we may understand Ecobionts co-evolutionary process in the multidimensional ARS as an atomic cluster in which for example temperature, kinetic energy in atomic clusters, corresponds to mutations, abiotic resource or socio-cultural fluctuations. In the same way collective movement that in the atomic cluster give place to isomerization, in the Ecobiont model results in an evolutionary episode.

Under this theoretical framework one may define the different types of interactions, the ones between Ecobionts and environment (E_1), interEcobiontical (E_2) such as competition, parasitism, or symbiosis; and the intraEcobiontical (E_3) between members of the same type of Ecobiont due to competition arising from the limited carrying capacity of the local environment.

Let p^α be the population of EB^α Ecobiont, k^α a constant and r^α the root mean square value of ARS gradient. Then the interaction of Ecobionts and the ARS is proportional to resource gradient.

$$E_1 = k^\alpha r^\alpha \tag{4}$$

Taking the typical functional forms types for interactions in physics, the E_2 component of the interactions should be a function of the distance between them in resource space. Because of competition for resources between Ecobionts located close together in resource space, the interaction should be repulsive (increasing the free energy) at short distance and banish when distance tends to infinity. For intermediate distance Ecobionts interaction could be attractive when physical association exists in form of symbiotic or parasitic interdependence; repulsive when resource competition dominate. In this way

$$E_2 = r^{\alpha} r^{\beta} \left\{ L_{\alpha\beta} \exp\left[-u\left(r_{\alpha\beta} - 1\right)\right]\right\} - M_{\alpha\beta} \exp\left[-v\left(r_{\alpha\beta} - 1\right)\right], \tag{5}$$

where the $L_{\alpha\beta}$ coefficient is positive defined representing repulsion due to competition for resources in the ARS. The constants u, v most by such that $u >> v$ in order to capture only two Ecobionts interaction in a specific hypervolume of the ARS. The sign of the coeffcient $C_{\alpha\beta}$ is defined as

$$\begin{cases} C_{\alpha\beta}, C_{\beta\alpha} & < 0 \quad \text{for competition interaction} \\ C_{\alpha\beta} C_{\beta\alpha} & < 0 \quad \text{for parasitism interaction} \\ C_{\alpha\beta} C_{\beta\alpha} & > 0 \quad \text{for symbiotic interaction} \\ C_{\alpha\beta}, C_{\beta\alpha} & = 0 \quad \text{for null interaction} \end{cases} \tag{6}$$

The product $r_\alpha r_\beta$ represents the increasing interaction strength between Ecobionts α and β as either any of them increases its resource gradient requirement. And $r_{\alpha\beta}$ the distance $r_{\alpha\beta} = \|r_\alpha - r_\beta\|$ between Ecobionts α and β.

Finally the E_3 component is defined by

$$E_3 = \begin{cases} B_{\alpha\alpha} r_\alpha^2; & 0 < r_\alpha < k \\ \to \infty; & r_\alpha \leq 0, r_\alpha \geq k \end{cases} \tag{7}$$

with $B_{\alpha\alpha}$ a positive defined intersction coefficient, and k a resource boundary related with carrying capacity of the ARS.

In this way we can define the internal energy of the system as

$$U = \sum_{\alpha} \left[p_\alpha E_1\left(r_\alpha\right) + \sum_{\alpha \neq \beta} p_\alpha p_\beta E_2(r_\alpha r_\beta) + \frac{p_\alpha^2}{2} E_3\left(r_\alpha\right) \right] \tag{8}$$

If appropriate vibrational and translational entropies are calculated then as shown by Michaelian in (22) one may write the entire Helmholtz energy $F = U - TS$, with U as define above and T being the temperature as discuss early. Then the destiny of the Ecobionts cluster will be defined by minimizing F that may be accomplished by means of a genetic algorithm as occur in nature.

4 The rise of the Technobionts

Modern urban *Homo Sapiens* has become a Planetary force with mostly negative impact among others Climate Change and loss of Biodiversity which seems to be accelerated or magnified by socio-cultural process especially technology and economy.

According to Young and co-workers in (50), mayor environmental impacts may be started as early as 10,000 years ago with the emergence of the agriculture which was a major turning point in the development of the human enterprise, with significantly more extensive modifications of the environment at larger scales. The two most important in terms of biophysical impacts were the clearing of forests and the tilling of grasslands for agricultural crops and the irrigation of rice. In some cases, these practices dramatically altered landscapes at a regional level. However, the rate and geographical scale of the spread of agriculture were still modest enough to produce no significant impacts on the dynamics of the Earth System. There is no strong evidence from global environmental records of human impacts associated with early agriculture. Social-ecological systems operated at the local and regional scales.

In that sense, it has been suggested that meanwhile, the negative environmental impacts remain local ecosystems tends to avoid catastrophic tipping points (35).

So for us, the point is not if *Homo Sapiens* generate negative impacts or not, but when do this impacts propagates beyond the local scale. This is very interesting because information propagation (impacts for example) propagating through multiple scales happens at high levels of complexity reaching the maximum percolation at criticality. We have probed in a paper under review, that time series complexity of magnetization and energy from 2D Ising model is reached a critical temperature.

As shown in Fig.6 *Homo Sapiens* has strongly departed from natural scaling relation at least from pre-industrial time and clearly in the modern urban organization. Interestingly enough this period from pre-industrialisation to modernity is also a major period of complexation.

We coin the term Technobiont to refer to *Homo Sapiens* under modern urban organization far away from natural scaling. In this way, we consider that we are more than in a Technocene instead of Anthropocene because for several tens of thousands of years, *Homo Sapiens* remains under the natural restrictions in terms of scaling for example or extension of its impacts.

Our current technology trends point to a more profound irruption in the dimensions that define Ecobiont's ontology. There could be two *Homo Sapiens* Ecobionts type living together: Classical *Homo Sapiens* (CHS)considered as *Homo Sapiens* not living in modern urban organization with energy scaling between *Homo Sapiens* hunter-gatherer and pre-industrial *Homo Sapiens*; and on the other hand we have Technobiont understood as *Homo Sapiens* living under modern urban organization far away from CHS energy scaling.

As resource gradient required by Technobionts is much higher that CHS, and most likely to be a zero-sum interaction. Then by E_2 a very intensive competitive interaction is excepted and there for concerns about the possibility of co-existence arise not only between Technobionts and CHS but with all the rest of Ecobionts as well.

Recently Elon Musk (Tesla's CEO) said "people must become cyborgs to stay relevant" and has raised at least $27 million for Neuralink Corp., a startup developing brain-computer interfaces (see `https://www.youtube.com/watch?v=ycPr5-27vSI`). Digiwell a biohacking startup estimate there are about 100,000 cyborgs worldwide. Humanity cant wait millions of years for evolution to improve their brains and bodies, Kramer (DigiWell CEO) says. Thats why were doing it ourselves.

In spite of the well documented planetary crisis described in first section, as a result of the rise of the Technobionts, West in (45) somehow suggest that Technobions (not in that term, he refers to cities) are at the same time the source of the problem and the only possible source for its solution. He points out that because creativity and innovation scale super-linearly with population, then cities provided us with a unique demographic bonus. From this, one narrative could go by telling that as we have perturbed earth system so much (maybe beyond tipping point) the only way to avoid annihilation as species is accelerating our technological coupling, just as one has to push the accelerator in order to not crash on high-speed curve taking. In a first stage if we inject great quantities of resources to Technobionts an increment in environmental impacts should be excepted but then a Kuznets curve effect in function of technology coupling could be reached and impacts could drastically be reduced.

Nevertheless, this argumentation is based on the ontology of individuals of biological species. In that respect, we think it is undoubted that we are in a revolution of our understanding of what basic biological study unit is. Animals can no longer be considered individuals in any sense of classical biology: anatomical, developmental, physiological, immunological, genetic, or evolutionary. Thus, the holobiont, with its integrated community of species, becomes a unit of natural selection whose evolutionary mechanisms suggest complexity hitherto largely unexplored (13)

There is a clear need to unveil the links between the units, the systems and the processes of cultural and biological evolution. Knowledge of them could provide us with important not to say vital clues on how to change social institutions and technologies in accordance with, not only more ecologically driven ethics but the long-term interest of our Ecobiont. (14).

5 Conclusions

Under the Ecobiont ontology, we clearly see that accelerating the technological coupling could very easily lead two the extinction of CHS. The first avenue of extinction is by means of competitions and assimilation, meaning that technological shift became so ubiquitous that CHS will disappear by cultural processes. The second venue is that environmental impact related to the rise of the technobionts make earth system incompatible with CHS way of living, of course, Technobionts can always move to Mars, for example, buy not CHS. Bottom line we as society have to decide if we want to survive current planetary crisis only as species or as Ecobiont, which implies co-maintain not only our classic biological identity but also the other dimensions of what we may consider makes us human.

Of course, it could be the case of win-win events in which Tecnobiont rise leads to West kind of scenario in a way compatible with CHS. Nevertheless as there is a catastrophic scenario at least for CHS (and no doubt for a lot of other Ecobionts, we are in a mass extinction event already) we should include a Precautionary Principle analysis as used in (42) from which most likely the technological coupling acceleration strategy should be avoided or restricted by incorporating, for example, Taleb's *Skin in the Game* principle (41). Skin in the game is a "global and morally mandatory heuristic that anyone involved in an action which can possibly generate harm for others, even probabilistically, should be required to be exposed to some damage, regardless of context. While perhaps not sufficient, the heuristic is certainly necessary hence mandatory. It is supposed to counter voluntary and involuntary risk hiding and risk transfer in the tails" (40).

We consider that Ecobiont ontology helps to make visible the coupling of *Homo Sapiens* with other biological entities under processes of natural and cultural evolution. Not to see this coupling hidden systemic risks and enhance the probability of catastrophic events. So Ecobiont ontology is necessary to understand and respond to the current planetary crisis.

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