Austin Anthropology

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Review Article

The Cloven Humanity - To Italo Calvino with Gratitude

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Received: April 27, 2020; **Accepted:** May 15, 2020; **Published:** May 22, 2020

Abstract

COVID-19 has turned the world upside down. The signs of an ongoing imbalance were there: biological, such as declining biodiversity and the warming climate, and social, with migrations and revolutions due to the growing gap between well-managed and prosperous economies.

It was still necessary to continue finding inspiration in science. Admitting that:

1. Compared to other living beings, humans are young creatures;

2. Soil, the one that houses the plant roots, works as an ecosystems' fulcrum, converting deliverance in germination;

3. Evolution, Darwin's revelation, occurs between species in ecosystems connected to the whole universe;

4. It is not so evident that even conforming people can harm;

5. We can get out of this crisis following a romance and rediscovering the generative power of the soil.

From Soil Ecology lessons, addressed to the students of the Universities of Padua (Italy) and Paris (France), during the COVID-19 period (April 2020).

Keywords: Tumaï, Silent spring; Skeptical ambientalist; IPCC; Cloven viscont; Global warming; Covid-19

Ancestors

Discovered in Chad on July 19, 2001, by a Franco-Chadian paleoanthropological team, Toumaï is not the most distant relative we have; only the Primate among those found so far than highlights characters closer to ours. Starting from the base of the Eukaryotes, all living beings found on the tree of life, genetically connected and leading that leading to Toumaï, are our relatives. Having 98.7% of their genetic material in common, we are close relatives of chimpanzees. We are not even that far from cats and mice (90 and 85 % DNA similarity respectively) and even from bananas (60%), Chris Deziel in *https://sciencing.com/animals-share-human-dna-sequences-8628167.html*. Following the same reasoning, Gabriel Noe estimates the overlapping of human and bacteria DNAs between 1 and 20%, *https://www.quora.com/How-much-DNA-is-shared-by-humans-and-bacteria*.

We know that complex organisms are the fruit of a genetic, functional, historical collaboration. Just as a large company may depend on the cooperation of a multitude of interdependent operators, an organism's body is the result of the partnership of thousand specialized cells. Eventually, species that cooperate in a confined environment form an ecosystem. Lovelock claimed that the entire planet Earth might correspond to a colossal GAIA system [1].

In Figure 1, Toumaï is represented in the guise of a professor. He is telling his students that the crown-shaped virus that is raging at the time imposes significant changes. The oldest student is scratching his head thoughtfully. On the contrary, the one just below and close to him seems in agreement. At their side, we see a hypnotized pupil, also probably convinced. Nearby, a group of quiet adolescents may think that the professor's opinion is not crucial for a living. They seem to be hungry, above all. Below them, there is a skeptical student; he does not believe in what he is listening to, or he feels it coming badly. One among the youngest is exclaiming forcefully: "I am thrilled that everything will change, I am ready to follow you". Instead, the last boy on the right, even younger, cannot care less about all this; he wants to go back home and join his mother.

We know what happened in the following 7 million years.

Figure 1: Seven million years ago, in the Padua forest, much more before the Roman empire's existence, a professor in front of his class, was thinking about a strange disease that raged at that time. He just ruled: "My dear students, such a crown-shaped virus will bring about drastic changes. We will lose some hair and realize that it does not always fan to turn on a planet around a star, into a black space at minus 270 degrees".
On the left: Toumaï Hominid reconstruction - Sahelanthropus Tchadensis. For a quick summary of Toumaï's discovery, see https://fr.wikipedia.org/wiki/Toumaï.

Citation: Zanella A. The Cloven Humanity - To Italo Calvino with Gratitude. Austin Anthropol. 2020; 4(1): 1014.

We came down from jungle trees to walk standing on the prairies, thanks to a providential hold on two legs. This upright posture opened new horizons, allowing us to master all the familiar world. A large part of other living beings was quickly subdued. However, many remained invisible among these creatures, inhabiting the thin air, dark soil, and remote host bodies. Beyond our reach, they managed the gas we breathe, food and water we eat and drink, within a dynamic and influential network that animated all planet Earth.

An even more precise vision of what we humans represent in terms of the evolution of the living world comes from recent studies [2-5]. They assign an equivalent if not preponderant weight to the horizontal genetic transfer (instead of the vertical one, along with the series of generations). As a consequence, even the whole evolution may depend more on microorganisms than on sexual genetic transmission.

We should imagine a sea of bacteria that reproduce at high speed, coexisting with viruses that can make them evolve by horizontal genetic transfer. More complex structures could take place, oriented by changes imposed by the environment. Acting as individuals or organized in colonies of different species, all interconnected, they constructed infinite bodies adapted to each other and to the physical-chemical context in which they evolved over billions of years. Here down, some recent articles that improve historical knowledge about the microbial functional net enveloping our planet:

- Citing a well-known example of nutrient cycle, in an agricultural and forest ecosystems the availability of Nitrogen (78% of the air we breathe) depends on diverse nitrogen-transforming reactions that are carried out by complex networks of microorganisms [6,7];
- Presentation of a vast collection of natural interrelationships between animals, plants, microbes, and the environment in [8-10];
- In ecosystem models, in natural communities, coexisting species are a selected portion of a much larger pool. Even though the number of relationships among species remains very high and impossible to model them [11];
- Physical communications, like sound waves, electromagnetic radiation and electric currents affect and characterize cell-cell microbial interaction [12];
- Tree species richness and phylogenetic diversity had context-dependent (climate, soil abiotic variables) effects on soil microbial respiration, most pronounced at low potential evapotranspiration, low soil C/N, and high tree density. Soil microbial functions increased with the age of the experiment (1-18 years) [13].

Soil

Take a handful of earth, open your hand, and look at it. Soil consists of juxtaposed irregular aggregates that leave reps and holes between them. These void spaces that occupy about 50% of the soil volume content air and water. After a rain, free water runs away by gravity, while the rest ends up in the aggregates, filling tiny cavities and humidifying particles of organic matter. Soil water and transported cations work as chemical bridges between organic and mineral molecules, holding them together and avoiding soil erosion [14,15]. Part of this solution feeds plants and animals. In Figure 2, a camera scans inside one of the soil aggregates. Diagonally, squares correspond to successive enlargements that make up the lumps. Each time new structures appear, first the juxtaposed organic and mineral particles, then small roots or clay sheets aside which cells of bacteria or fungal hyphae cohabit and co-evolve. In the background, a 40 times enlarged arthropod would represent a considerable amount of odd animals that populate in thousands per square meter each ordinary forest soil [16-19].

Figure 2: Soil fractal structure, an example of natural functional complexity. Conceptually, a single cell is not far from a "unit of confined, living soil". Miller and Urey ran the test 61 years ago [22].

A physical phenomenon decided that life should take a fractal structure, maybe because the universe is expanding [20]. In widening, it creates new void space, forcing/aspirating matter to occupy it. Dense matter responds with inertia, while lighter matter (photons), might slip into the new void space generated by expansion, leaving behind collapsing matter. Regulated by physical and chemical laws, such a consequent aggregation creates structures at different scales, small structures contained in larger ones. The process has long been identified and called life [21].

Evolution

Terrestrial biodiversity was born around four billion years ago. We still do not know whether it was a cell of one or of two new groups of microorganisms. They multiplied and recombined, remaining more or less confined in different sites (Figure 3, phase 1). The environment changed with them, as well as the resources they managed to use. They differentiated into groups of living microorganisms, and finally, in so many meso and macro organisms that we have not yet been able to count them all. They are interconnected and act as small systems in larger machinery pieces, like gears of a universal clock [23]. Despite the supposedly selfish inclination of individuals, it is today recognized that the evolution of interacting individuals toward cooperation obeys a principle of Self-Organized Temporal Complexity. SOTC is a bottom-up process explaining why cooperation spontaneously emerges at the biological level [24,25].

Biodiversity increased thanks to the soil [7,26-31]. Even in those days, organisms die and accumulate on the ground. They become a source of energy and many brick-molecules to build a new life. The process accelerates exponentially because the number of bodies grows and dies. The more complex the organisms become, the more the soil

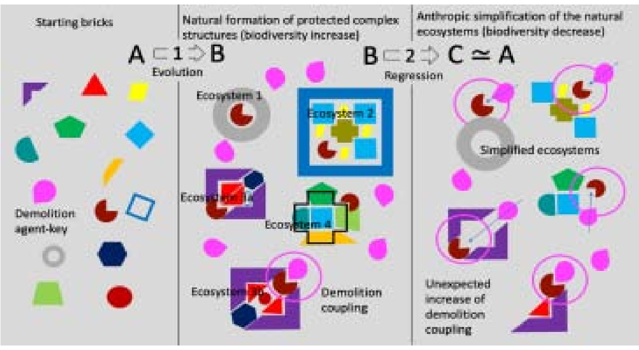

Figure 3: Phase 1, A->B, natural evolution, biodiversity increase, from bricks to complex ecosystems. Phase 2, B->C, regression, biodiversity decrease, from elaborate to simplified ecosystems. Stage C looks like A. A similar process of "regression" occurs in the soil at the expense of dead bodies/organs. It is called decomposition and occurs together with an opposite process of growth and complexification named "humification" [37-39].

Figure 4: Humanity post-second world war natural history in a picture.
1) Rachel Carson (Silent Spring)[44], a first exemplary environmentalist. With unprecedented research and protest actions, she forced the withdrawal of DDT, an effective broad-spectrum pesticide that killed throughout the food chain to the community all over the world;
2) Bjørn Lomborg (The Skeptical environmentalist), a Danish researcher who published a long list of scientific evidence stating that human and planet healths were not as bad as announced by ecologists. His book opened a concrete and sometimes bitter debate around the world [44-47];
3) Intergovernmental Panel on Climate Change. Composed of more than 300 scientists, IPCC studies the climate trend and environment quality, publishing state of the art with forecasts every two years, since 1988; the cover of the incoming IPCC report sets the background of figure 4.
4) Italo Calvino, an Italian writer who reported the intimate essence of the human spirit and consequent vicissitudes in a short story (The Cloven Viscount).

grows its potential storage. Migration and climate can multiply the proliferation of sites of arising populations. During geological times, decline and regeneration phases were possible. The importance of the soil as a crucial local site of genesis and evolution appeared first. Later, the progressive growth of the whole ecosystem emerged. Finally, it took place the colossal pyramid that comprehends everything and enlarges powered by a rich, available, decomposing world.

Intelligent and adaptable humans took the place of other organisms by simplifying ecosystems and producing food and materials nursing growing societies [32-34]. To eliminate competing organisms, may have negative consequences on the environment equilibrium (Figure 3, phase 2). As in a monospecific culture, it is enough that a parasite pops out to generate significant damages on large surfaces [35,36]. Since the system is simplified, the organisms that inhabit it are also rawer and less specialized as small arthropods, resistant bacteria, archaea, fungi. Large-spectrum agents must be engaged to reduce their damages, which reduces biodiversity and enlarges the habitat of resisting organisms. Instead of being transformed by other living beings into new vital structures, dead bodies end in the air by oxidation, and soil loses its income.

It was not considered harmful to the environment or humans, to create new plants or animal communities by mixing in site organisms of different sources. New microorganisms and viruses were then unintentionally generated. Nevertheless, each ecosystem has its own history, with a balance born from a significant adjustment between the composing livings. Breaking that balance means to lose the hidden historical relationship among them, the one that assures the necessary homeostasis to the whole.

Simplified ecosystems are well suited to organisms with an oversimplified metabolism and even more mobile (transported by water and wind) and more adaptable than we are (living even at a high temperature of, or in acidic substrates). There is a risk of regression, a return to primordial life. Humans cannot be in equilibrium with such a type of life because they were not in the game in that tough primordial time.

The Cloven Viscount

A summary of our post-second world war natural history is depicted in Figure 4. A few critical emblematic figures characterize this period: Rachel Carson [40], Biorn Lomberg [41] and the experts of The Intergovernmental Panel on Climate Change [42]. Italo Calvino [43] was able to tell the events in a hilarious way, and under a pompous title: "Il Visconte Dimezzato" (The Cloven Viscount). From wikipedia *(https://en.wikipedia.org/wiki/The_Cloven_Viscount)*.

The Viscount Medardo of Terralba and his squire Kurt ride across the plague-ravaged plain of Bohemia en route to join the Christian army in the Turkish wars of the seventeenth century. On the first day of fighting, a Turkish swordsman unhorses the inexperienced Viscount. Fearless, he scrambles over the battlefield with sword bared, and is split in two by a cannonball hitting him square in the chest.

As a result of the injury, Viscount Medardo becomes two people:

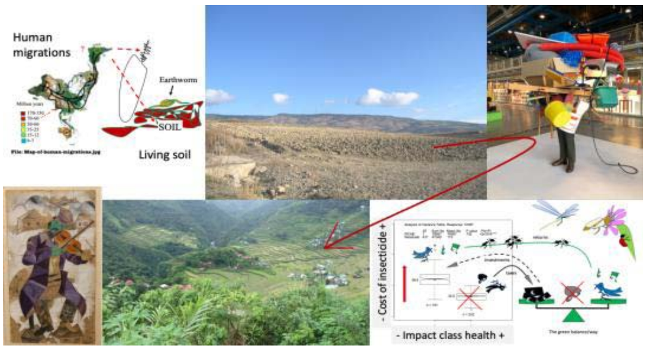

Figure 5: The source of biodiversity lies in the soil [67]. Our well-being (top right: Daniel Firman, 2000: Gathering) depends on biodiversity. To invest in research and use pesticides that are less harmful to humans and the environment [49,68] (downright) should restore biodiversity. Are we able to play with green heads and hands? (Marc Chagall, 1924: Green Violinist).

Gramo (the Bad) and Buono (the Good). The army field doctors save Gramo through a stitching miracle; the Viscount is "alive and cloven". With one eye and a dilated single nostril, he returns to Terralba, twisting the half mouth of his half face into a scissors-like half smile. Meanwhile, a group of hermits finds Buono in the midst of a pile of dead bodies. They tend to him and he recovers. After a long pilgrimage, Buono returns home.

There are now two Viscounts in Terralba. Gramo lives in the castle, Buono lives in the forest. Gramo causes damage and pain, Buono does good deeds. Pietrochiodo, the carpenter, is more adept at building guillotines for Gramo than the machines requested by Buono. Eventually, the villagers dislike both viscounts, as Gramo's malevolence provokes hostility and Buono's altruism provokes uneasiness.

Pamela, the peasant, prefers Buono to Gramo, but her parents want her to marry Gramo. She is ordered to consent to Gramo's marriage proposal. On the day of the wedding, Pamela marries Buono, because Gramo arrives late. Gramo challenges Buono to a duel to decide who shall be Pamela's husband. As a result, they are both severely wounded.

Dr. Trelawney takes the two bodies and sews the two sides together. Medardo finally is whole. He and his wife Pamela (now the Viscountess) live happily together until the end of their days.

In the end, inexperienced readers undergo an atrocious existential truth: even conforming people can harm. Good and just people do not guarantee a peaceful coexistence of imperfect beings. People can be "too good".

Coexistence

We recognized that something went wrong on the side of biodiversity [48-52]. Climate is warming [42,53-55]. Preparing a COVID-19 vaccine is not easy, and it is not a definitive solution against an RNA virus [56-58]. The world economy is stagnant. We are at a historic turning point.

We must cohabit with "as many as possible" other living beings. If one day, we have to migrate (could be the sun dying), we should be able to leave with the network of organisms that keeps us alive. As humans separate from the rest of the living, we are not yet able to manufacture all food and water that keep us alive. Although it is still not 100% scientifically accepted that organic food is healthier than the one produced by intensive agriculture [59-63], how long can we resist without our planet subsidence resources?

For now, there are two more pressing problems to face: COVID-19 and climate warming. Both imply economic diseases. In many societies, the most prosperous ten percent of the population controls more than half of the total wealth: *https://en.wikipedia.org/wiki/Distribution_of_wealth*. After the two previous disastrous world wars, it was asked the wealthy human families for funds, which allowed the restoration of an excellent and fruitful social, economic, and ecological equilibrium.

From an ecological point of view, natural ecosystems can produce a surplus by using soil as a dynamic warehouse (Figure 5). Soil stores information and additional energy allowing the system to evolve. Soil functions like a belly. Can we survive without a belly? A process of biodiversity reconstruction passes through soil protection and activation [64.] Soil is a living matrix that humans should use to restore a planet-home that lost part of its constitutional biodiversity [65,66].

Converting large-scale intensive agriculture into organic farming, or in any case towards farming that respects biodiversity, should be a big step. It certainly will mitigate the climate. Taking care of sea, lakes, and rivers, which also function like diluted soil, will help a lot. The Rampant Baron [70] also informed us that attempting to reason humans from the height of trees is not enough. So there is still a lot to do. We are like this, half right and half wrong. Only by accepting this truth will we keep ourselves in continuous evolution, thanks to democratic debate, as seems to be the rule for existing in nature. Ciaoooo Italo!.

E-lectures held in April 2020 during the confinement period implemented in Italy and France to stop the diffusion of Covid-19 and addressed to 137 students of the University of Padua (Italy), Department of Land, Environment, Agriculture and Forestry (Environmental and Forestry Sciences Degree), and 124 students of the Universities of Paris (France), Sorbonne Paris Nord (Degree in Life Science), Paris-Saclay and Sorbonne Paris (Biodiversity, Ecology and Evolution Master).

Thank you to doctors and nurses, university staff, students, and all humans who worked every day so that everyone could eat, drink and feel good despite the COVID-19. Our planet must recover biodiversity and balance. Success seems to depend less on our desires than on interacting with all other living beings.

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