

Supplementary Material

Appendix 1 - The behavior of living beings.

o Nothing in Biology Makes Sense Except in the Light of Evolution (Dobzhansky 1973): “Without that light biology becomes a pile of miscellaneous facts, some of them interesting or curious but which do not create a meaningful picture as a whole. This is not to say that we know everything that can and should be known about biology and evolution. Every competent biologist is aware of a multitude of unsolved problems and unanswered questions. After all, biological research shows no sign of nearing completion; exactly the opposite is true.”

o First microorganisms were present on our planet about 3.7 billion years ago (Johnson et al. 2024). The first unicellular organisms capable of photosynthesis appeared 2.4 billion years ago, while the first multicellular animals arrived 800 million years ago. Coniferous and deciduous trees appeared about 350 and 200 million years ago respectively, flowering plants began to populate the planet only 150 million years ago. Progressively, living organisms took control of the planetary environment (Lovelock & Margulis 1974). The most obvious example was the increase in the concentration of oxygen in the air and the decrease in that of CO₂ following the development of plants, with consequent radical modification of the planet's climate (Dahl & Arens 2020).

o Predators in a food web cannot eliminate all their prey because if they did, they would starve. The energy extractable from prey and useful to the predator is worth approximately 1/10 of that ingested by eating the prey (Brown et al. 2004); there is therefore a minimum threshold of prey density below which the predator cannot survive. When the energy contained in the remaining prey is no longer sufficient to support the number of individuals in the predator's population, that number automatically decreases (Lotka 1920, Volterra 1926).

o Each species is linked to the others in an almost mathematical way (Wikipedia The Free Encyclopedia 2024a) and together they co-evolve in ecosystems that cover the planet with a biodiversity that has increased over time, although still poorly understood major crises every 62 (145) million years characterize it (Rohde & Muller 2005).

o A species becomes extinct when it can no longer reproduce in the system that contains it. It is like one of the countless wheels in the gear of a living system. When "the species no longer revolves in harmony with the others", when it prevents the movement of the whole, it is "abandoned to itself", and being isolated, it dies. On average this happens every 5-7 million years (Ceballos et al. 2015). In general, it is replaced by species that are better adapted to the motor gear that evolves with the system in which the species live.

Leaving aside the numerous variations, today two theories are currently competing to explain the evolution of the natural world on our planet:

- competition between species for the use of resources: the individuals of the species that reproduce most successfully in this historical period and in this environment are selected; the individuals that make up the populations of a species are constantly changing and in constant competition in the exploitation of the environment with individuals of many other species (Darwin 1859, Dawkins 1976, Safran & Nosil 2012, Mannion et al. 2014);

- the cooperation of individuals in the use of resources: whatever the species, it is a complex system of individuals adapted to each other in order to grow, a kind of supra-organism contained in other larger systems, making the best possible use of resources and the available energy of an environment that is changing with it (Lovelock & Margulis 1974, Khakhina 1992, Margulis 1998).

Practically the evolving system unit is like a sports team: it wins the race when: 1) it is composed of individuals with peculiar characteristics that are complementary to those of the others; 2) the players "team up", that is, they functionally cooperate with others to win; 3) the individuals and team know how to develop an unpredictable and effective game during the match; 4) the environment in which the game is played must also come out on top, that is, it must have more resources at the end than at the start of the game, in order to continue supporting new races in the long term. This statement was published indirectly with the documented natural history of our planet (Wikipedia The Free Encyclopedia 2024b).

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Appendix 2 - Toumaï and the Anthropocene.

The hominid who lived 6-7 million years ago (these are the oldest hominid fossil remains ever found) was given the name “Toumaï”. The scientific classification of this species is as follows (Brunet et al. 2002): Order Primates L., 1758; Suborder Anthropeidea Mivart, 1864; Superfamily Hominoidea Gray, 1825; Family Hominidae Gray, 1825; Genus Sahelanthropus gen. Nov., Species Sahelanthropus tchadiensis sp. Nov.

Using their innate intelligence to live better in their environment, Toumaï's offspring more or less voluntarily triggered the new geological era of the Anthropocene, not yet officially recognized as of 2022 (Wikipedia The Free Encyclopedia 2024c). Three million years later, the skeleton linked to the upright position of this distant relative was perfected in Lucy (*Australopithecus afarensis*, (Coppens 2012)). The still relatively small brain revealed that the upright position preceded (it was the spark that ignited) the development of the size of the brain, which we find much more voluminous in modern *Homo sapiens*. Standing upright, they could see further, above the grasses of the savannah; erect and stable on two feet, they had their hands free to make new tools for more effective experiences and easier conquests (Coppens 2012).

If theoretically the Anthropocene began when a previously quadrupedal and arboreal animal "became" bipedal and terrestrial, as long as this new living being remained a hunter-gatherer, the influence on natural evolution was that of a species that respected the laws presented above. In a noticeable way, the replacement of the natural forest by the artificial one began only 10 thousand years ago, with the change of land use imposed by agriculture. We are talking about populations of *Homo sapiens* similar in genetic inheritance to modern ones, with a brain capable of using natural resources to produce abundant food, dwelling houses and monuments of organized societies. The division of tasks in the social fabric left free time for groups of dominant individuals to scientifically conceive the exploitation of other living beings and the environment (Diamond 1998).

It is no longer possible to continue to consider the environment (living and non-living) as something external and not connected to the living structure of human society for the following reasons:

1) Every human organism hosts numerous microorganisms that it needs to live (Grice & Segre 2012). These microorganisms are in equilibrium with those external to us and widespread in the environment. In surface soil these microorganisms number billions of cells per gram of soil; an equivalent number is found in 1 m³ of air we breathe.

2) Every human organism eats to obtain from food the energy it needs to live. What we eat is made of mineral elements that make up the earth's crust (LePan & Venditti 2021). From a nutritional point of view, living organisms are chemical elements (a concentrate of elements useful for the development of living cells and other systems), and energy, which move and are maintained on the surface of the planetary sphere, and which thanks to the process of recycling are available for future generations (Vela et al. 2022).

3) Like all other living things, the human species modifies the environment in which it develops and reproduces. The difference with other species lies in the magnitude of the change that our species is causing. The impact is decidedly greater than that of other species since humans began extracting energy from fossil organic matter to turn engines and produce mechanical and electrical energy. We are practically talking about all modern industry and agriculture, with all means of transportation, lighting, information transmission, construction, education, cultivation, in short the list includes everything that has made human life easier in the last century (Smil 2017). The impact on the environment is so strong that it is dangerously influencing the characteristics of the planet's climate (IPCC 2022).

In the coming decades, the species that are more resistant to the new climate will be selected along with the microorganisms that reproduce better in a warmer environment (Condamine et al. 2019). The phenomenon will be global, even if zonal (different in intensity and consequences depending on the geographical position), but it will also affect the human species, with the microorganisms associated with it. The idea of solving the problem by generalizing the air conditioning of environments in the areas most sensitive to the phenomenon involves nothing less than the risk of the extinction of our species (Lynas 2020).

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Appendix 3 - Can humans live far from Earth?

Some astronauts have lived in space for more than a year. Valeri Polyakov was the most resilient of all, and remained in orbit 437 days and 18 hours (Wikipedia The Free Encyclopedia 2024d). Everyone else returns first, not out of nostalgia, but for health reasons (Wikipedia The Free Encyclopedia 2024e). Our body have adapted to gravity. In space, our blood no longer circulates in our body as it does on Earth. Muscles (even the heart) and bones atrophy. The ear functions poorly, and is linked to orientation in space, with sensations of dizziness and vomiting. Back on Earth, it takes astronauts several months to be able to walk like before. Furthermore, and closer to the subject of this article, on Earth we are surrounded by a cloud of microorganisms, that we breathe and eat all the time. In the air of a spacecraft, the microorganisms are much fewer and not connected to all the others that are prevalent and evolving in the environment on Earth. There are dangers of infection, the ecological balance between groups of microorganisms being broken; it is necessary to filter the air continuously, as and better than a sterile hospital room (Jon 2015). Considering that current techniques allow us to stem the problem but not to solve it completely (Tršan et al. 2019), we still don't know microorganisms well.

The reality is very different from what they show us on television: most of us would die during a space journey that would take us to the moon. And the moon is one light second away from us (if we want to go around another sun, the distances are at least 3 light years minimum). The moon is worse, much worse than the depths of the Sahara in midsummer or the top of Mont Blanc in midwinter: there is no air no water, not even microorganisms live there; if you stick your nose out of the diving suit, it turns to stone in a few seconds and freezes your brain forever. It takes 7 months to go to Mars with the means not yet available today (Bolles 2024); the Moon is a piece of Earth, you can easily come back home; Mars is really another planet, which requires knowledge that we don't yet have. In Ridley Scott's 2015 film "The Martian" (Wikipedia The Free Encyclopedia 2024f), based on the book by Andy Weir (Weir 2011), Matt Damon attempts to produce potatoes on Mars using astronaut's excrements as a source of energy and minerals, after having produced terrestrial air in a greenhouse hermetically sealed from the outside environment. The story makes you dream and ends well, as in all American films. But the reality is closer to that told in another film work entitled "First man", by Damien Chazelle in 2018 (Wikipedia The Free Encyclopedia 2024g), where Rayan Gosling in the role by Neil Armstrong manages to set foot on the moon. The difficulties are impressive, only a young Reinhold Messner, the man who went from one over 8000 to another without oxygen, would perhaps be able to reach Mars if well equipped.

We must resign ourselves: we are obliged to live on our planet, at least until we manage to find a way to migrate with a large part of the planet's biodiversity (which rotates to create artificial gravity by centrifugal force), or until we are able to manufacture and reproduce the planet biodiversity, modifying ourselves accordingly to stay alive.

Since almost all of us live outside of forests, and do well, it seems possible that forests are not essential. We have seen that they occupy about 1/3 of the planet's habitable land surface. The other 2/3 are deserts+rocks+perennial snow (30%), prairies+pastures+scrubland+agricultural land (65%) and cities (1%). Let's assume that forests become agricultural land and/or pastures. What would that change for us? It would change the biodiversity of the planet. In the largest primary forest in the Amazon, there are 427 species of mammals, more than 1300 species 378 species of reptiles, and more than 400 species of amphibians (Brumm et al. 2024). This density of species is also found in other primary forests (1/3 of all forests). For comparison, throughout Italy (not only in its forests) we have about 123 species of mammals, 550 birds, 9150 plant taxa (Loy et al. 2019, Stinca et al. 2021).

In total, the world's forests contain 80% of all terrestrial species of animals, plants and insects (UNEP 2020). If we lose this biodiversity, we will experience inconveniences similar to those encountered by astronauts in space with reduced biodiversity of their shuttle. 80% less biodiversity occurred around the middle of the Cretaceous, around 100 million years ago, when the thousands of genera were 1/5 of the current ones (Fig. S1). Part of the biodiversity will take refuge in the remaining green areas, but that of the forests will disappear. Without this biodiversity we do not know what would happen to our species, since we are still ecologically connected to it.

To get an idea of the climate that could characterize an Earth without forests, and keeping in mind that the activity of living organisms affects the planet's climate, we can hypothesize that the average global temperature and CO₂ concentration could be similar to those of 100 million years ago, when biodiversity was 1/5 of that of today.

Tierney et al. (2020) compared the air temperature and CO₂ concentration forecasts of the IPCC scenarios with those of the period from the present to minus 100 million years ago. The worst IPCC scenario would correspond to the planet's climate in the mid-Cretaceous, with an average air temperature 5°C higher than present and disastrous for humans.

If we consider biodiversity as a macro-system, in which all living are more or less connected to each other, in balance in what we call the biosphere, and which governs the parameters essential to life on the planet (climate, quality of water and air, cycles of the elements, ocean currents and winds, ecological potential, number of living beings and all the vital processes linked to these essential parameters); with the loss of the forests, a large part of this biodiversity would be lost, making the evolution of the planet unpredictable.

There are no models capable of predicting what could happen to humanity if it were confronted with conditions of poor biodiversity. The fact that we are among the species born at the end of 3.7 billion years of evolution raises fears of a profound functional dependence on living things that existed long before us.

Perhaps, the most pressing need is to learn much about the world of microorganisms (Pennanen et al. 2019, Soong et al. 2020, Hartmann & Six 2022, Mo et al. 2022). The soil, main source of microorganisms, is treated accordingly in chapter 3 of the main article.

Science tells us that we cannot live without forests, we must find a way to live with those that remain (Bologna & Aquino 2020). As a precaution, any attempt to reduce the area of forests, now nearly half of the original area, should be avoided. We don't yet have the knowledge to try to manage a forest-free biosphere that includes humans. We do not know what and how much biodiversity is necessary to sustain the human species in the biosphere. From a practical point of view, this means that forests are a common good that must be safeguarded. It is necessary to think about a planetary management of this resource (as well as other related to it, water, air, climate, etc...). Maybe, the administrative division of the planet into independent and uncoordinated states no longer corresponds to the ecological needs of the planet. All citizens of the world should be governed by the same laws of mutual respect and regard for the planet's resources. Without this utopian progress, which still seems impossible, we risk not being able to emerge alive from the selective and adaptive processes underlying natural evolution.

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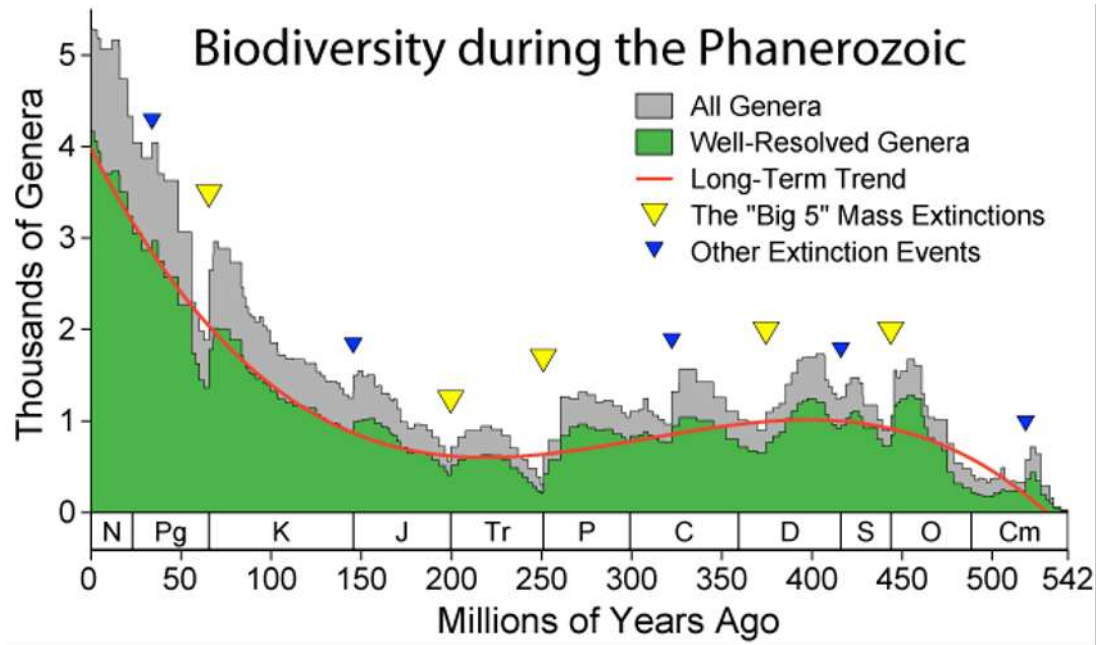
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Fig. S1 - Biodiversity during the Phanerozoic (Common Wikimedia 2008). The growth of biodiversity is noted in the long term, with moments of crisis every 62 million years in Mannion et al. (2014), with data from Jenkins et al. (2013) and Willig et al. (2003). Not on the figure: the ancestral relative *Toumaï* appeared only 7 million years before the present, in a phase of high biodiversity.



Appendix 4 - What if “forest ecosystem services” didn't exist? Let's ask Artificial Intelligence too.

The word “services” is not appropriate. That the action of a forest existence and survival can also have beneficial consequences for humankind is acceptable and certainly true (Jose 2009, Holland et al. 2015, Barrios et al. 2018, Eldridge et al. 2023). But that the forest should provide "services" to humans is an anthropocentric way of thinking that must be abandoned. The forest does not exist to provide services to humans, although it cannot do without them. The forest and humanity are called to coexist. It should not happen that the forest continues to decline so that humanity can grow. This is what has happened in the past. We can make a conscious decision (weighing the economic consequences) that the remaining forest can continue to live as a forest and independently of the ecosystem services that it provides for humans. The forest is an autopoietic living system that is called by design to exist, to increase its complexity/biodiversity, to increase its efficiency in the use of resources, to contribute to the balance of the systems around it, to ensure sustainability to the Earth system which includes them all, in the conceptual scheme of Lovelock-Margulis and Gaia. In doing so, it responds to laws that Darwin (1859) had interpreted as competition between living things and that Khakhina also brought back to the path of symbiosis (Khakhina 1992, Sapp 1994, Margulis 1998). Lovelock & Margulis (1974) published an article in which they reported scientific evidence that once started, life acquired control of the planetary environment and produced the homeostasis by and for the biosphere that persists ever since.

Let's see how Chat GPT answer the question: Does ecosystem services really exist or are they a human-centric concept?

Ecosystem services are indeed a human-centric concept, but they are based on real and tangible benefits that ecosystems provide. Here's a deeper look into the idea:

What Are Ecosystem Services?

Ecosystem services are the benefits that humans derive from natural ecosystems. These benefits can be categorized into four main types:

1. **Provisioning Services:** These include tangible products obtained from ecosystems, such as food, water, timber, and fiber.
2. **Regulating Services:** These are benefits obtained from the regulation of ecosystem processes, including climate regulation, flood control, disease regulation, and water purification.
3. **Cultural Services:** These encompass non-material benefits people obtain from ecosystems through recreation, aesthetic experiences, and spiritual enrichment.
4. **Supporting Services:** These are necessary for the production of all other ecosystem services, including soil formation, photosynthesis, and nutrient cycling.

Human-Centric Nature

The concept of ecosystem services is inherently human-centric because it frames the value of ecosystems in terms of their usefulness to humans. This anthropocentric view is useful for several reasons:

- **Communication:** It helps in communicating the importance of ecosystems to policymakers, stakeholders, and the general public in terms that are directly relevant to human welfare.
- **Economic Valuation:** It provides a framework for economic valuation, making it easier to include ecosystem considerations in economic decision-making and policy development.
- **Conservation:** By highlighting the direct and indirect benefits humans gain from ecosystems, it can incentivize conservation and sustainable use of natural resources.

Existence of Ecosystem Services

While the concept is human-centric, the underlying processes and functions that provide these services are real and integral to the functioning of ecosystems. For example:

- **Pollination by bees:** Essential for the production of many fruits and vegetables, a clear provisioning service.
- **Wetlands filtering water:** Natural filtration systems that improve water quality, a regulating service.
- **Forests sequestering carbon:** Helping to regulate the global climate, another regulating service.

Criticisms and Challenges

Despite its utility, the concept of ecosystem services is not without criticisms:

- **Reductionist View:** It can be seen as reducing nature to its utility to humans, potentially overlooking intrinsic values and ethical considerations regarding non-human life.
- **Measurement and Valuation:** Quantifying ecosystem services can be challenging and may lead to oversimplification or misrepresentation of the complexities of ecosystems.
- **Equity Issues:** Focusing on services to humans might prioritize benefits to certain groups over others, leading to issues of environmental justice.

Conclusion

Ecosystem services are a human-centric concept that highlights the essential benefits ecosystems provide to human society. While this framing is useful for communication, economic valuation, and conservation efforts, it is important to recognize the intrinsic value of ecosystems and address the challenges and criticisms associated with this approach. The concept is based on real, measurable processes and functions in nature, making it a valuable tool for fostering a deeper understanding and appreciation of the natural world.

For fun, we also used the artificial intelligence (AI) available online (Microsoft Bing 2024) to create some images, using as “prompt” the words written under the four generated figures (Fig. S2). Remember that the AI develops information that is already accessible on the internet and that is continuously updated; by searching with the keywords indicated, the proposed figures change over time. Everyone can generate this type of figures without effort, no one is the author (actually...who is the author?), with the purpose to answer such a type of answers: what can an AI program catch in the sea of Internet to construct images using keywords like “soil”, “Homo sapiens”, “forest” and “biodiversity”? What will AI show us if we ask “what the forest and the forest soil are”?

That the forest might “want” something seems like a decidedly unscientific point of view. Perhaps it is easier to understand this concept if we consider our body as a living being: our body also "wants" something that is beyond our control, our body also wants to grow and age; we cannot stop growing; since the fertilization of the egg cell in the mother's womb, we all continue to grow, and there is no way to stop this intrinsic movement. Even death is nothing but a different growth with the transformation of matter in harmony with the universal movement: we will become mineral dust that will later be integrated into other growing bodies. Our body "wants something", it wants to grow and "complexify", increase its "harmonious and functional diversity", it wants to reproduce and perpetuate life. We cannot stop this universal and intrinsic movement of the living (Maturana & Varela 1980, Michaelian 2011). A forest carries out a similar process on the scale of a larger system composed of numerous co-evolving living beings. A forest does not live to provide ecosystem services, but grows and reproduces, changes and evolves.

Humans belong to the world of the living and not vice versa. It was the forest system that generated humans who then began to live outside of it, until they succeeded in changing the evolution of the planet. However, what recently happened with Covid-19 should incite prudence and humility in the face of a universe that is still too large and unknown for us. The limits of what lives in the infinitely small (viruses and microorganisms) touch us closely, and correspond in the infinitely large to what our space telescopes discover in the distance (primordial galaxies and giant black holes).

The forest (functional set of living things) needs what all living things (including humans) need. Therefore, it is mandatory that humans share space, air, water, biodiversity, nature's products and the future on the same planet with the forest. These “elements” (space...future, planet) belong to an evolving whole, not just humans. Outside of this living whole that surrounds them, humans may not be able to exist. Many foresters/humans are thinking: “we are already trying to coexist with the forest; silviculture was born with the intention of perennializing forestry production” (Susmel 1954, Motta et al. 2018, Cagliero et al. 2020, Sabatini et al. 2020, Motta 2020, Aszalós et al. 2022, Motta & Larsen 2022). A question then arises spontaneously: “Is it true that we think that our future depends on that of other living beings and on the forest?”

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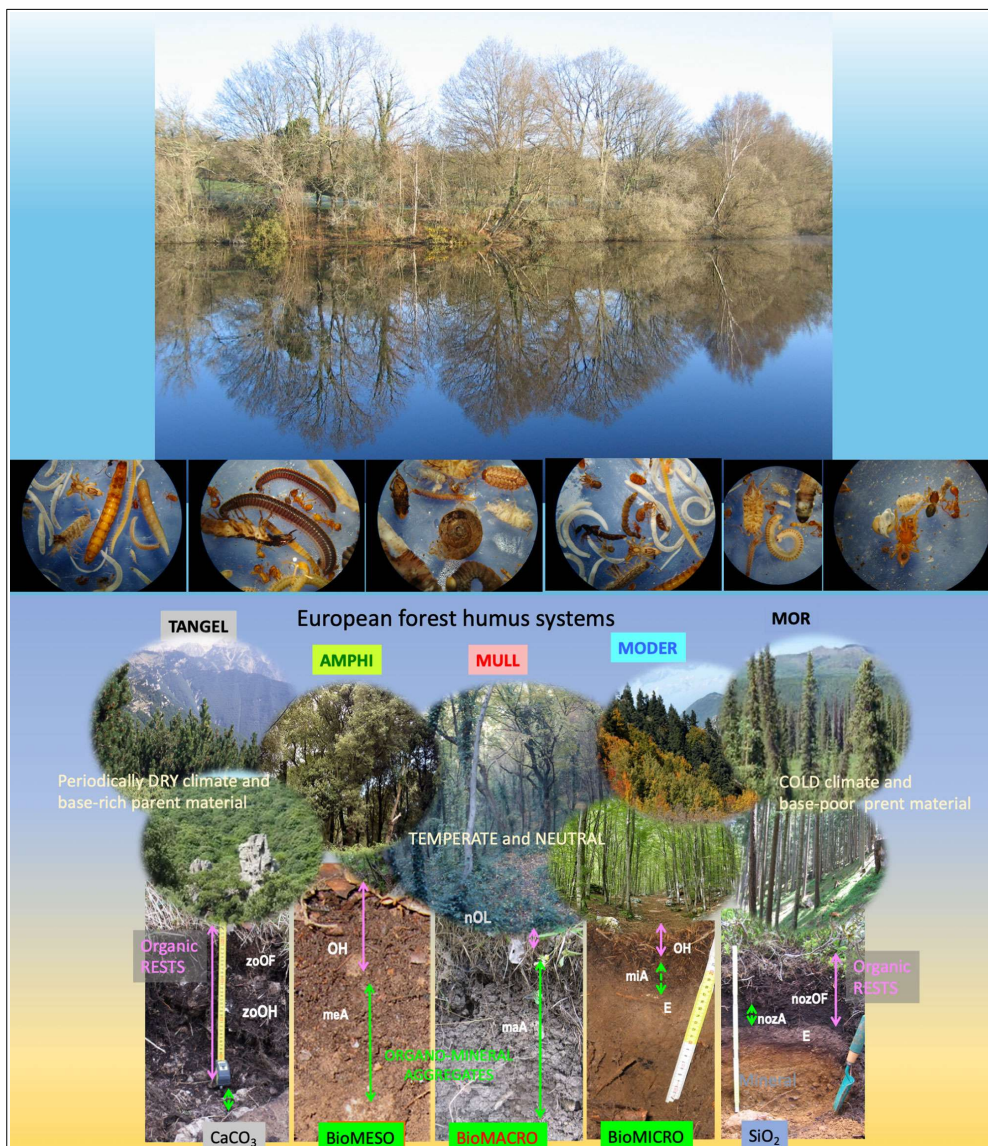
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Appendix 5 – Mirrors. The soil in the mirror.

Fig. S3 - Mirrors. Above: The flat, still mirror of a pond's water and the dawning light of day can produce an unexpected effect: that the upside-down image of trees reflected in the water is sharper than that of their shape in the air. In the very brief moment of hesitation when the person wonders which of the two images corresponds to the real world, the brain of this same person also tries to evaluate the possibility that the two figures could correspond better, together, to the reality of the 'object carefully observed. And if this person has already opened a hole in the forest, she/he can create in her/his brain, a complete forest, with soil. In the soil of a European forest one can easily count one million of individuals of soil animals per m², as the ones collected by students in a Fago-Quercetum of Fontainebleau Forest (France) and reported on a band in the middle of the figure. Below: European forests and their typical humipedons, from the left: high mountain forests in periodically dry climate and base-rich parent material with Tangel humus system; mountain, submountain forest with Amphi; low mountain, temperate plain forest on neutral substrate and Mull; mountain forest on acidic substrate and Moder, high mountain in cold climate, base-poor parent material and Mor.



Appendix 6 - To feed the plants, feed the soil organisms.

Soil is considered a self-regulating superorganism (Lovelock 1993, Bockheim & Gennadiyev 2000, Phillips 2009), an ecosystem that connects plants with the mineral world, a sort of biological intermediary. This concept is well represented on Fig. S4, taken from a PhD thesis which aimed to compare soil functioning and the complexity of the interactions between soil components in different types of agriculture (Fusaro 2015). The link between the properties of the soil and cultivated plants (20 groups of indicators) would not be direct, as a simplistic agronomic view would suggest, but could be manifested through the 157 biotic and functional indicators considered in this research, describing, in a holistic manner, the complex relationships that occur in the soil. By extracting from the set of relationships (a black line that corresponds to a statistically significant correlation on Fig. S4) the soil properties on the one hand and the crop properties on the other, we see that these two sets are not so directly and strictly connected. They "talk" to each other through the soil which is made of tiny living organisms immersed in a world of mineral and organic resources.

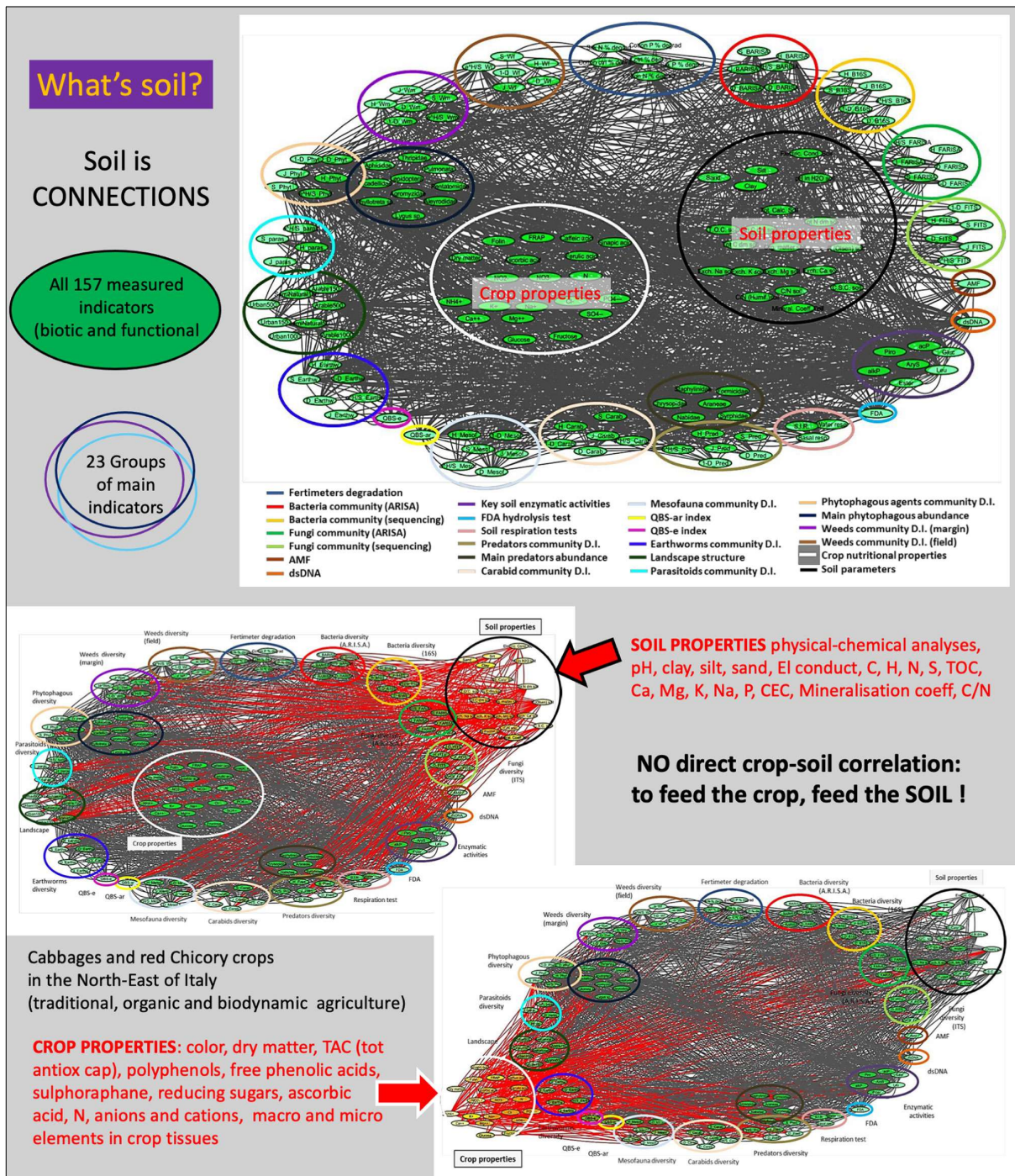
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The soil-conscious forestry and the forbidden apple

iForest – Biogeosciences and Forestry – doi: [10.3832/ifor4584-017](https://doi.org/10.3832/ifor4584-017)

Fig. S4 - Soil as living cloud of interconnections, from (Fusaro 2015). Above: What's soil. Crop and soil properties immersed in the network of correlations between 157 indicators of soil functionality. Black strokes represent statistically significant correlations. Below: Soil and crop properties. Crop and soil biotic and functional soil properties are extracted from the set of correlations. The correlations indicated in red are those that go towards Soil and Crop groups of properties. The largest number of them do not go directly from one group to another and use the mediation of other surrounding variables linked to soil biology.



Appendix 7 – Autopoiesis.

Trying to summarize the concept of Autopoïesis by Maturana & Varela (1980), an autopoïetic entity is capable of preparing the building blocks needed for its construction and that manages to re-produce itself over time, adapting to the environment in which the vital process occurs. When the living beings that inhabit a forest die, they are recycled in the soil, to reuse part of their remains in the form of ions or more or less complex molecules reused at the level of living organisms in and out of the soil (Zanella 2024).

A forest that turns and grows, like a wheel that recycles more and more of the material it is made of, to reinvest them in a new and more complex forest. Growth is partially reinvested in the soil, which acts as bank-storage for the forest system: the funds set aside in the soil can be called upon at will and reinvested in productive mass at the right time. A system organized like this is destined to grow.

When the topsoil is young, forest vegetation takes nutrients from the soil, when it is old, forest releases the nutrients to the soil and prepares it for a new cycle (Fig.s 3 to 6 in the main article). The forester should give the forest time to return nutrients to the soil.

A fundamental point: in addition to taking, trees give to the soil. There are two processes, the long-term one, from rock to forest (thousands of years, forest ontogeny), and the short-term one, from young to old forest (hundreds of years, silvogenesis). In the first, the vegetation gives more to the ground than it takes from it, for this reason the system becomes increasingly larger and more complex; in the second, the balance is attenuated by the fact that the young forestry takes more than it gives to the ground, and then gives it all back in the end, when it dies. This general and cyclical movement is expressed on Fig. S5.

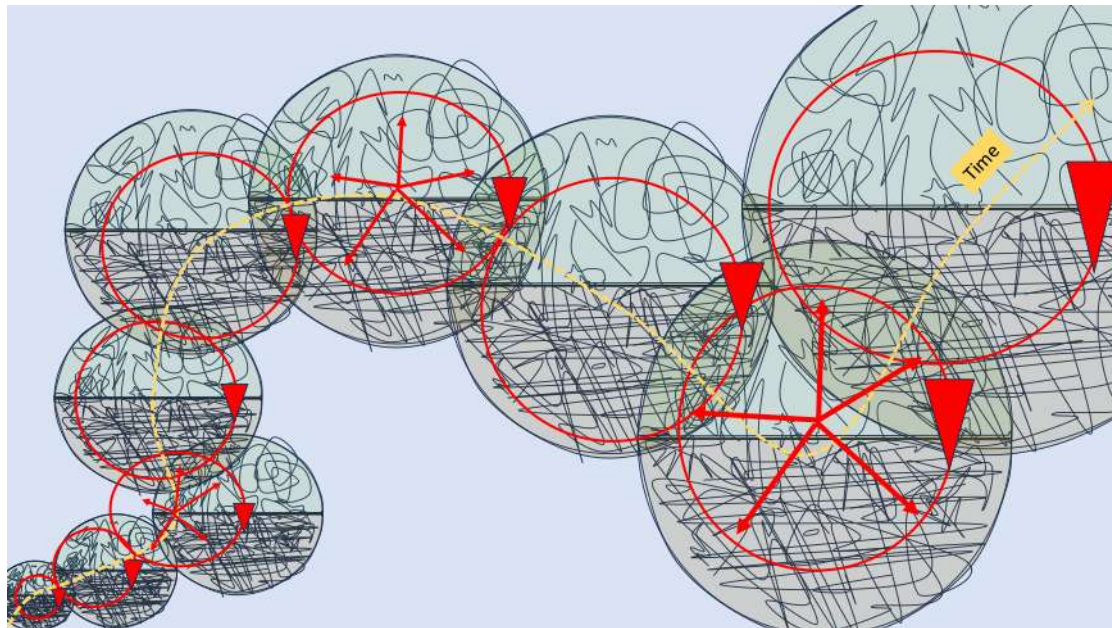
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Fig. S5 - A forest that turns and grows, like a snowball that rotates along a slope, the forest captures the sunlight and recycles all the materials that compose it. These remains are biodegraded and transformed into the soil to be absorbed at a root level and reinvested in "new forest". The forest thus becomes more and more complex, while continuing to live normally: it is in its being to change and grow. It is no coincidence that the spherical figure recalls our planet: left to itself, the forest would cover it entirely, even managing to modify the climate on the planet.



Appendix 8 - Forest SOC and climate change.

- Today's forest does not start from zero SOC values. Why do we observe such a high growth rate in storage?

Jonard Mathieu, contacted via email: As you noticed (Jonard M. et al. 2017), the C sequestration was higher in the young forest stands but these stands often correspond to coniferous plantations installed on former agricultural lands. The stand age effect could therefore be partially confounded with a species effect and depend on the time since afforestation. There is no guarantee that, if these plantations are replaced by broadleaved plantations when reaching maturity, the carbon sequestration will follow the same age trajectory. The time since afforestation will be much longer and a species effect could occur. The high C sequestration rate observed in young forests might be due to particular circumstances that may not recur in the future.

- Can climate change explain the registered C sequestration? In fact, the "less artificialized" uneven-aged forest sets aside more than the even-aged one, why?

JM: Climate change could also partly explain the C sequestration due to a higher litter and deadwood production (increase in productivity, mortality) and a lower litter quality (decrease in nutrient concentrations). Such effect could be more pronounced on young stands.

In the uneven-aged system, there is no clear felling and tillage (to prepare the future plantation) which are known to reduce the carbon storage in the upper soil layers (Landmann et al. 2023).

- Could the storage rate you measured increase after 200 years?

JM: I have no evidence that makes me think that this could happen unless the proportion of dead wood increases.

- How do you explain it being so high at the beginning of the cycle? How do you go from low at the end of the cycle to high at the beginning at the same point in just a few years?

JM: We don't think the mortality of young trees can explain the phenomenon.

In an even-aged system, I expect that the C storage decreases after the clear felling during the first years of the new stand; then it recovers with the increase of the stand productivity to reach a maximum from which it progressively decreases. This temporal pattern can be modified when the environmental conditions change.

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