Humus

Subjects: Forestry
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Etymologically the word "**humus**" means ground, dirt; the meaning of "**homo**" or "**human**" is near to *earthling* or *being of the earth*, earth here referring to the ground, or dirt (https://sites.psu.edu/josephvadella/2017/09/08/origins-of-human/). Essentially the words humus and human mean "connected to the earth", earth understood as dust, soil, dirt. The best way to express such a concept comes from an ancient religious Latin sentence: "pulvis est et pulvis reverteris", solemnly pronounced by priests as they deposited a pinch of ash on the believers' heads. Consider that earth has also become the name of the whole planet Earth, and that the Lovelock's Gaia hypothesis assigns the planet the functioning of a quasi-organism (https://en.wikipedia.org/wiki/Gaia_hypothesis). The notion of humus contains and makes explicit the very concept of all existing matter. What is matter (living or not), if always, at a given cyclical moment, matter is forced to disappear by a principle which founds the future of this same matter? Understanding even partially this principle is useful for every single individual and for the whole of the co-evolving society.

Keywords: Humipedon ; Humusica

1. What's Life?

Two opposing processes of degradation and construction of organic molecules (organic = built around a skeleton of carbon atoms) occur in the organic and organo-mineral parts of the soil. Referring to these rather biological processes, soil scientists and biologists prefer to use the more rigorous terms of mineralisation (return to mineral components) and humification (genesis of new organic molecules). The more organic and richer in organisms top part of the soil is called Humipedon. Any dead structure naturally falls to the ground and is here decomposed. It is not that easy to define when a structure is dead. Yellow leaves on a tree, for example, are they still dead? We can probably say that when a leaf reaches the ground it is on the way to become something else. The future of a leaf under degradation is parted in two: mineralisation and humification, both necessary to build new living structures. To stay alive, a living complex must loose part of its components, which must die to produce new input (Figure 1). Or vice versa, as in the question: "Was the chicken or the egg born first?"

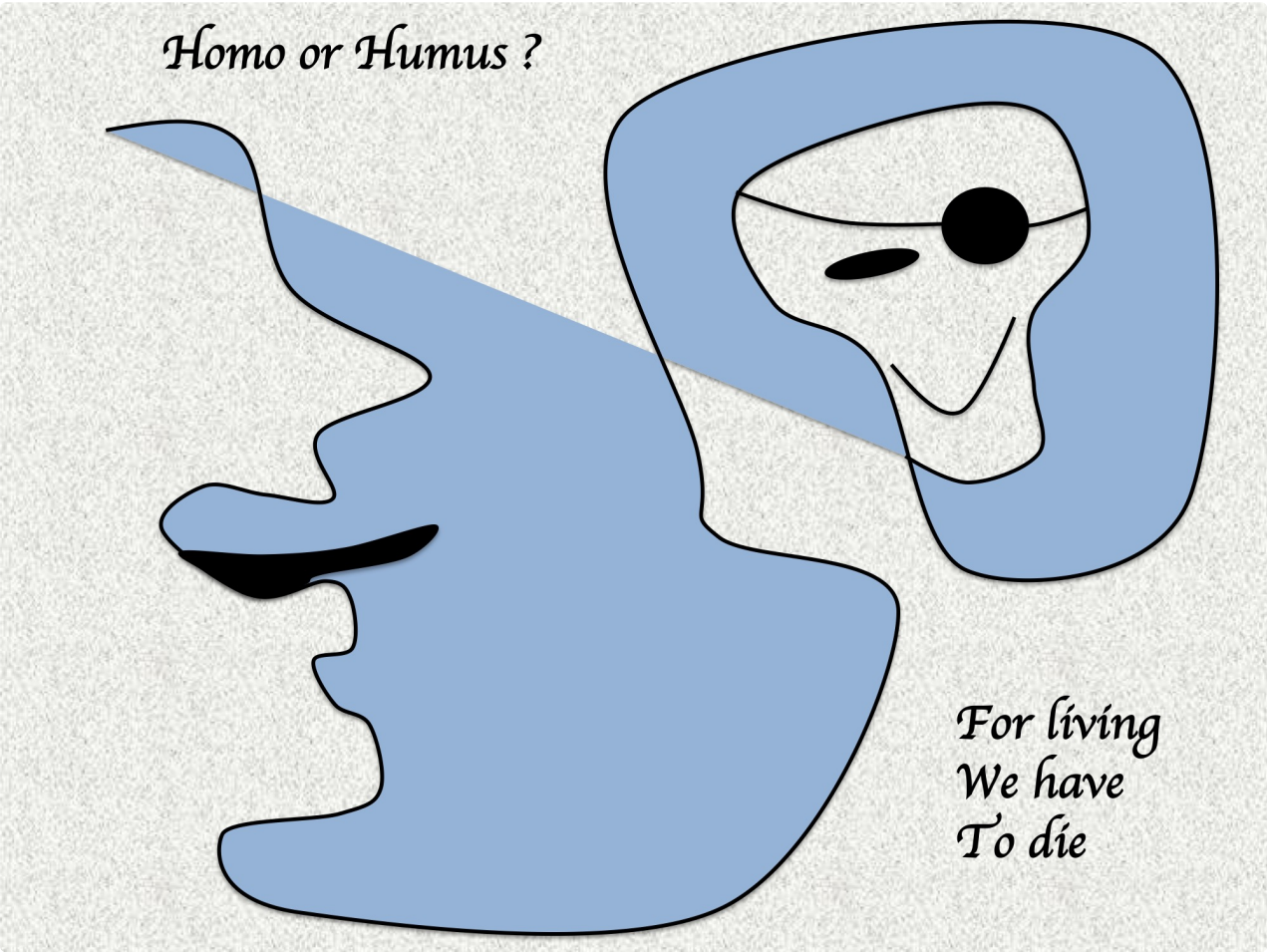

Figure 1. To stay alive, complex structure must partially die[1]. However, something almost miraculous happens: the new generation never starts from the same point of the previous generation; it starts from a re-elaborated base. It is this new base that evolves linearly over time, regardless of the individuals' life. In this long-term process, the humus characterise the period of time that separates dying and nascent generations. For this reason the humus concept is an intriguing matter[2] that attracted even Erwin Schrödinger's spirit[3].

If we consider that life begins with a first "living cell", the early Earth was devoid of life. A name has also been found for this hypothetic primordial "living cell": LUCA (Last universal common ancestor: https://www.imperial.ac.uk/news/120606/who-what-luca/). Problem: a cell is made of complex components that themselves might be considered "alive". On one side, a living structure should be able of auto-reproduction; on the other side, if studied in its elementary components, even a physical atom is so complex and moving, we don't know whether it is composed of micro-creatures. At the larger molecular level, thinking that a DNA molecule might be somewhat "alive" is not considered completely absurd. Although not everyone agrees that viruses are living beings (https://www.scientificamerican.com/article/are-viruses-alive-2004/). There are scientific reasons to think that the molecules that make up the genes of each DNA command natural evolution[4]. Are those selfish genes alive?

We love be thinking that a Miller-Urey soup[5] might correspond to a primordial soil, a very liquid primordial humipedon. Certainly there is organic matter in the black space of the universe[6]. It is very likely that organic molecules from space were also present on the surface of planet Earth when LUCA was generated. Before LUCA there were only Miller-Urey soups, probably at different stages of evolution. Admitting this does not only mean that this is how life was born, but also that it may continue to generate like this at present time; that LUCA was born in an "embryo-soil"; that embryo-soils still exist today and continues to generate new ecosystems. In their soup, Miller-Urey did not found living beings but molecules remaining separate. We know that Miller-Urey soup continued to evolve and to change until the conditions of the soup allowed a functional construction called LUCA to generate. We know the following steps in larger and larger soup-ecosystems. Citing only the crossing stones: Margulis[7] with her symbiotic primordial entities; Darwin's ecological vision of the evolution as a consequence of adaptation of individual characters within changing natural populations of species[8], contained in ecosystems as defined by Tansley[9], explained for the chemical-physical aspects at the planet level by Lovelock[10]. From the point of view of a soil scientist, the process of "genesis and evolution of ecosystems" is still active and should be seek in a sort of "humipedon", even at present day. Mitosis, first, and meiosis, later, might be the result of a controlled evolution of Miller-Urey soup. That all cells are Miller-Urey soups evolving into larger ecosystems. A pure biologist point of view can take a similar way when investigating the boundaries between life and death in cells.

Usually the concept of apoptosis comes into play[11][12], and on the one hand il allows to kill/erase and on the other to create/modify cells, organs or whole organism, in equilibrium at each respective scale and within evolving specific environments. Diseases and cancer can be placed in a context of evolution[13].

2. Humus Systems

A humus system is an abstract category in which soil scientists set all humipedons that show a similar aspect and functioning. Imagine a humus lover who studied many humipedons all around the world and who want to inform a friend on this: "in submerged areas I saw thick, organic and dark humipedons; in less humid environments I saw humipedons inhabited by earthworms which incorporate to the soil all fallen litter; in dry zones the humipedons were full of insects, mites, springtails and litter accumulates at the surface of the soil as it was a roof for their home; on mountain rocks exposed to sun wind and rein I found thin crusty microbial humipedons very different from those grey thick and silty forming in at the bottom of rivers and lakes or seas .... "

The humipedons cover all planet Earth surface. They were first classified in humus types[14][15], then in humus forms[16], and finally in humus forms grouped in humus systems[17]. The following have been provisionally described: five systems in not submerged environments, five in submerged areas, two at the sea-side, six in very specific environments (pioneer or primordial ecosystems), and two conditioned or man-made. Classification and distinctive characters in the Morpho-Functional Classification of the Planet's Humipedons.

3. Humus Forms

Humipedons are all different, even within a humus system. The thickness of the litter layer can be very different even within a same Mull system. Why? Leaves may be more or less palatable, earthworms have preferences and do not eat all species of leaves, the number of earthworms is connected to many soil variables (compaction, acidity, humidity ...) and influences the thickness of the litter on which these animals feed, leaves remain a long time on poisoned soils .... In short, it is interesting to be able to individuate some different humus forms in each humus system. Eventually, the planet Earth is covered with humipedons classified into "humus systems", detailed in "humus forms" (Figure 2).

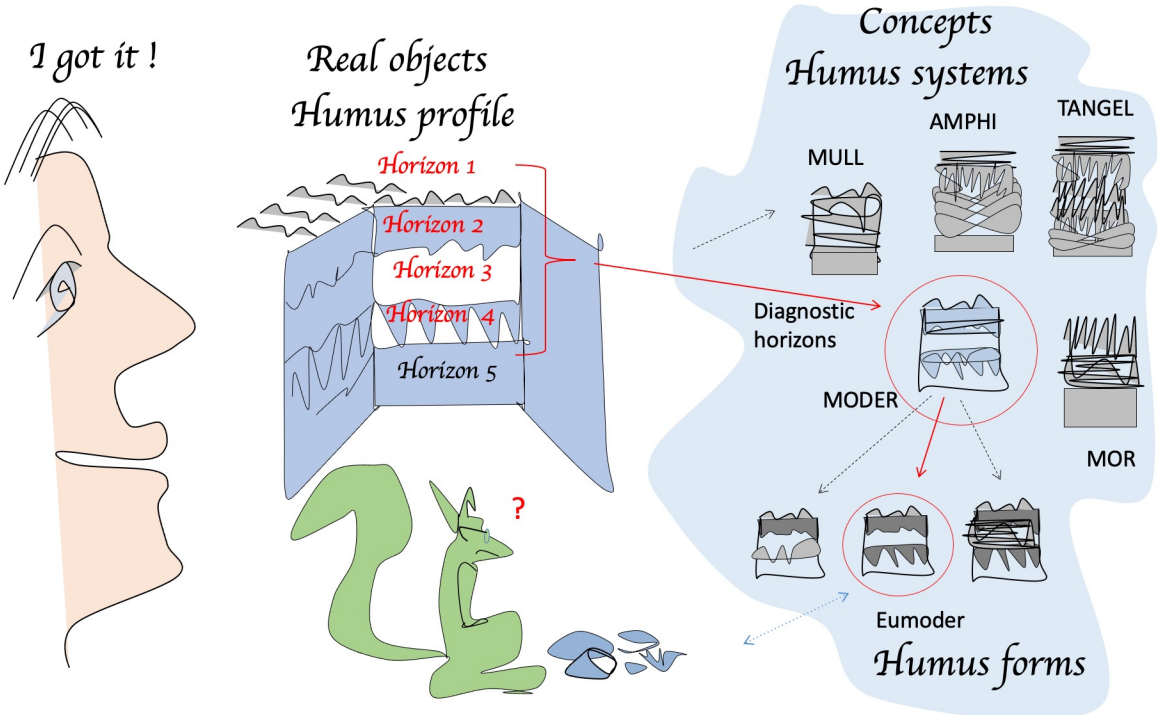

Figure 2. Humus systems and humus forms[1]. The figure shows an open profile divided into horizons. Each humus system is characterized by specific diagnostic horizons. Depending on the thickness of these horizons, humus forms can be identified within each humus system. The subdivision of the Moder system into three forms of humus has been illustrated on the figure. Hemimoder, Eumoder and Dysmoder. Eumoder is the "central" humus forms, corresponding to a typical Moder. To know more: https://www.sciencedirect.com/journal/applied-soil-ecology/vol/122/part/P1 ; https://www.sciencedirect.com/journal/applied-soil-ecology/vol/122/part/P2. An Android and iOS application (TerrHum) is available for free[18]. It helps to recognize diagnostic horizons and humus systems and forms in the field.

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