UNIVERSITÀ DI PARMA

Prof. Cristina Menta

Corsi: APPLICAZIONI DI BIO-ECOLOGIA DEL SUOLO E DI IDROGEOLOGIA (Mod. A)
MODULO:QUALITA', FUNZIONALITA' ED USO SOSTENIBILE DEI SUOLI

Seminario

Humus per tutti

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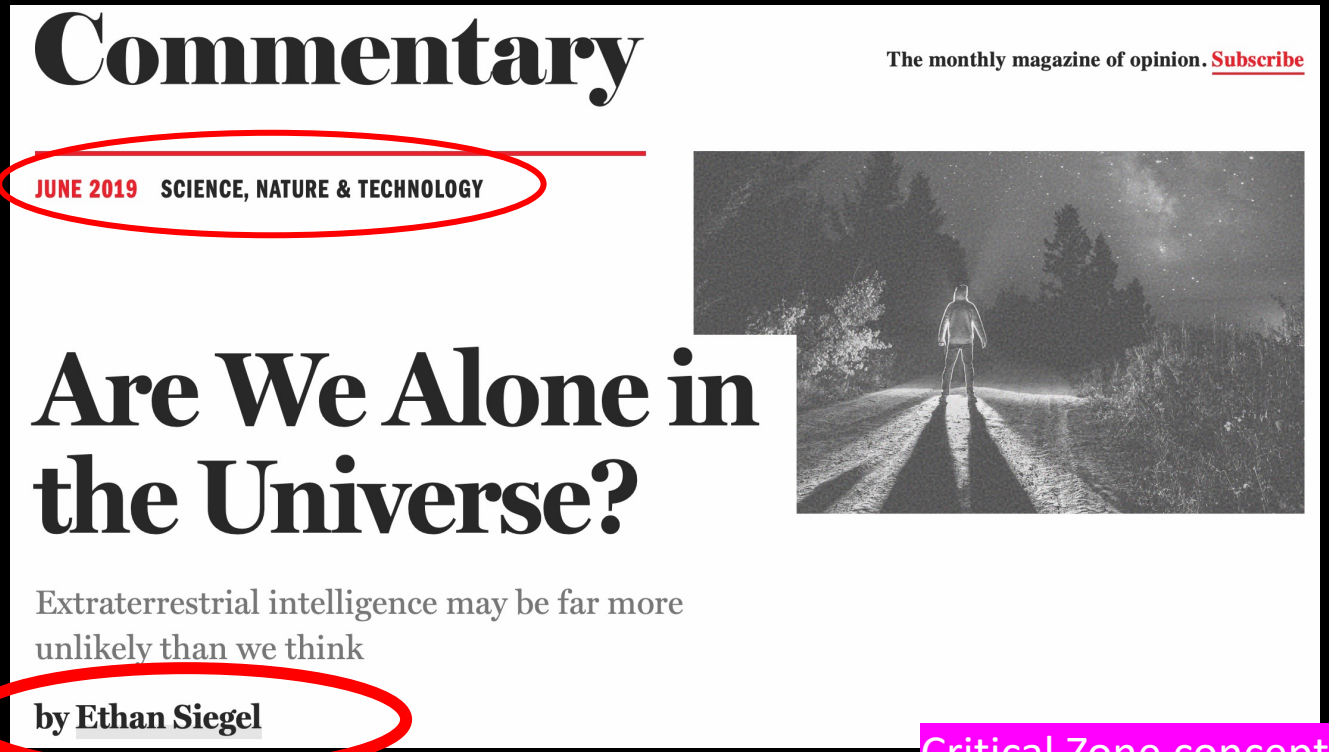


Commentary

The monthly magazine of opinion. Subscribe

JUNE 2019 SCIENCE, NATURE & TECHNOLOGY

Are We Alone in the Universe?

Extraterrestrial intelligence may be far more unlikely than we think

by Ethan Siegel

Critical Zone concept?

All told, we expect there are nearly 10^{22} potentially habitable, Earth-like planets containing the right conditions and ingredients for life.

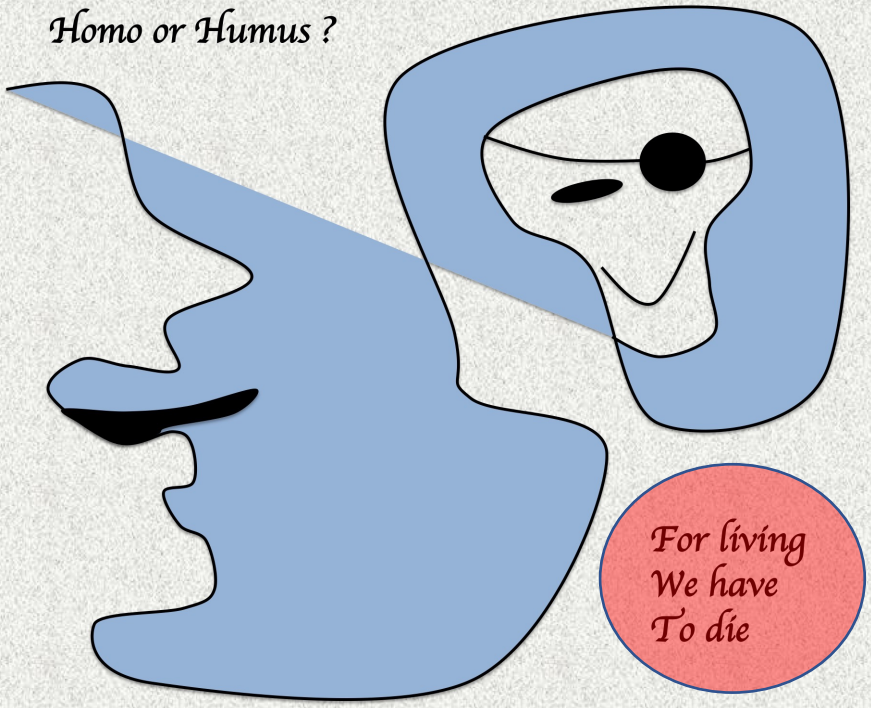
More than a billion such candidate planets exist in our Milky Way alone.

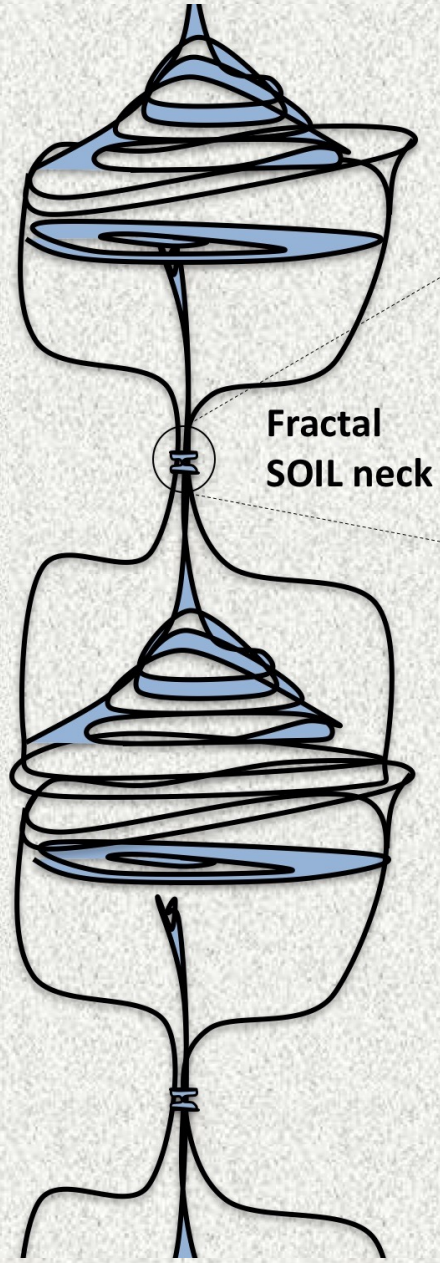
From NASA's Kepler mission:

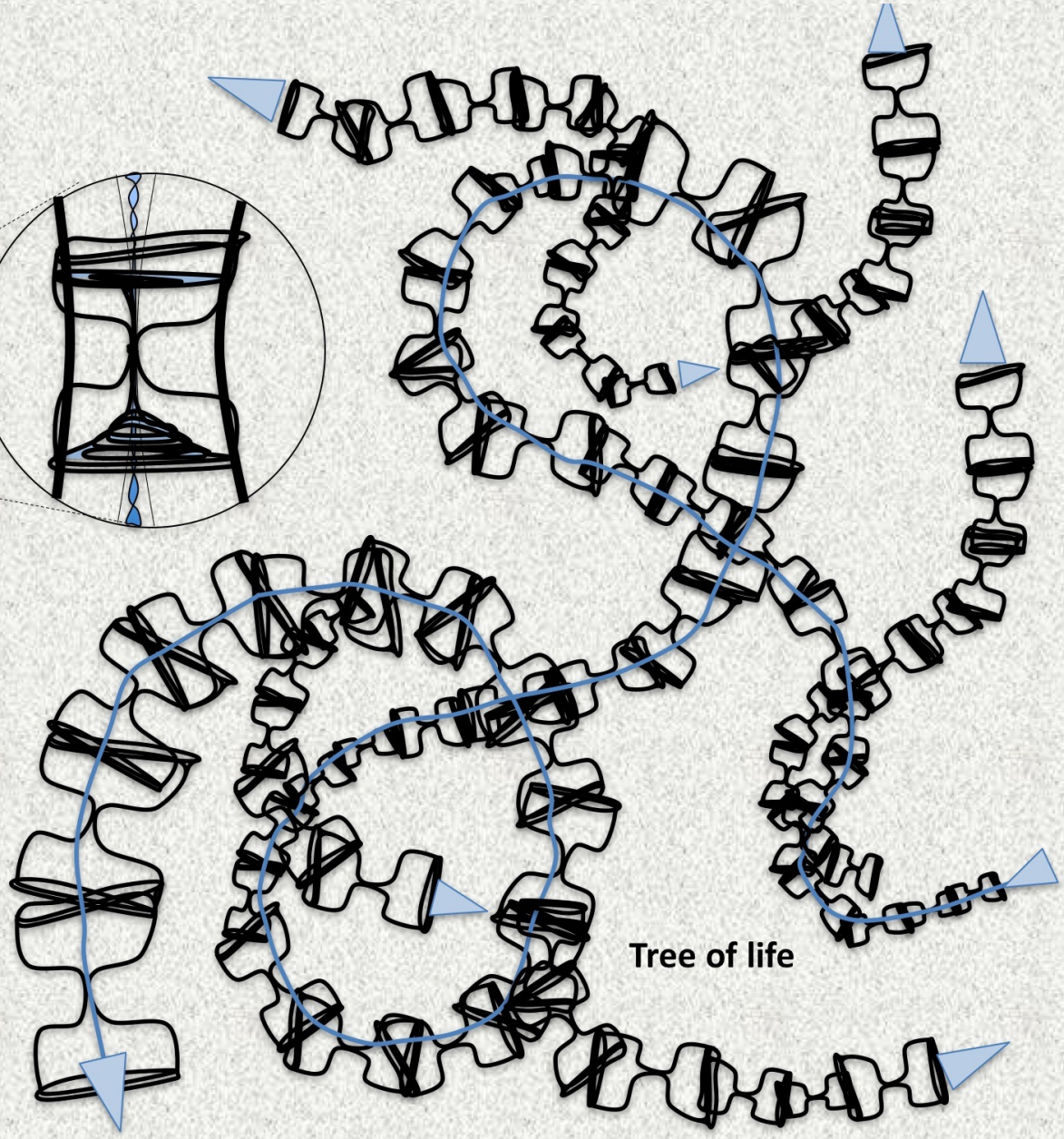
- Approximately 20 percent of all the stars out there are Sun-like, as opposed to red dwarfs (which tidally lock their planets and likely strip their atmospheres away) or the hot, blue stars whose stellar lifetimes are too short.
- At least 80 percent of stars have planets or planetary systems around them, and approximately 10 to 20 percent of those planets are Earth-like in size and mass.
- Well over 90 percent of them have enough of the necessary heavy elements—created in earlier generations of stars—for life to have possibly arisen.
- And finally, approximately 20 to 25 percent of the star systems we know of appear to have at least one planet in their star's so-called habitable zone, which is the right location for an Earth-like planet to possess liquid water on its surface.

What's LIFE?

Hourglass SOIL





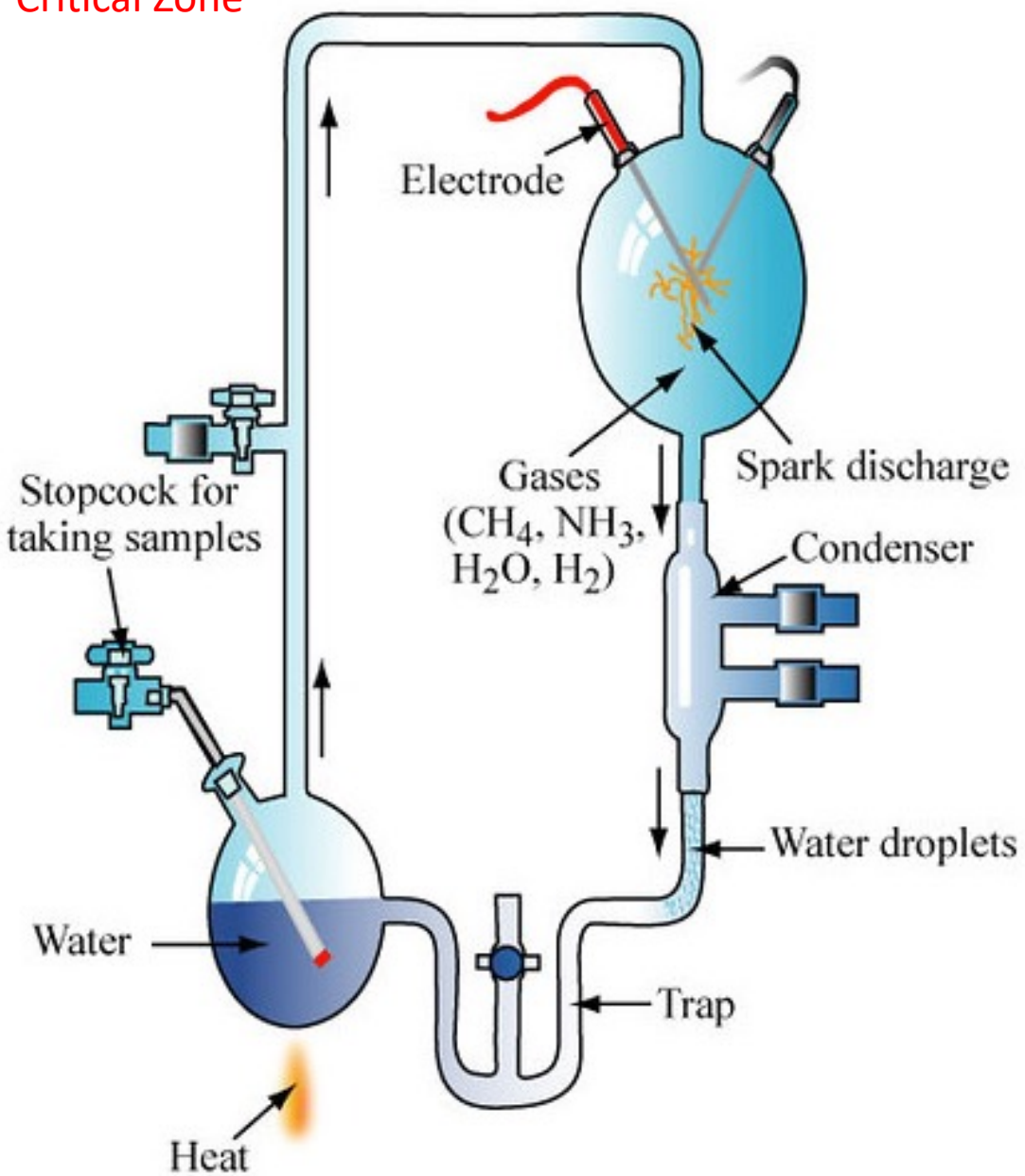


Humusica 1, article 7
Applied Soil Ecology Special Issue 122

Miller-Urey Experiment 1952

Concept of Critical Zone

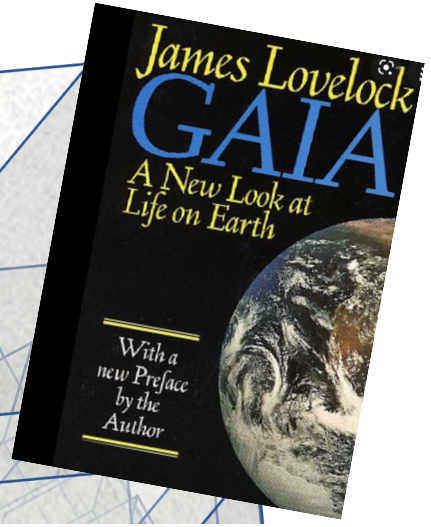
SOIL classification < in the Critical Zone (living system)
or
outside it (= rock)



Amino Acid	Murchison Meteorite	Discharge Experiment
Glycine	●●●●	●●●●
Alanine	●●●●	●●●●
α–Amino-*N*-Butyric Acid	●●●	●●●●
α–Aminoisobutyric Acid	●●●●	●●
Valine	●●●	●●
Norvaline	●●●	●●●
Isovaline	●●	●●
Proline	●●●	●
Pipecolic Acid	●	●
Aspartic Acid	●●●	●●●
Glutamic Acid	●●●	●●
β–Alanine	●●	●●
β–Amino-*N*-Butyric Acid	●	●
β–Aminoisobutyric Acid	●	●
γ–Aminobutyric Acid	●	●●
Sarcosine	●●	●●●
N-Ethylglycine	●●	●●●

On the Origin of Species by Means of Natural Selection, or the Preservation of Favoured Races in the Struggle for Life, 1859

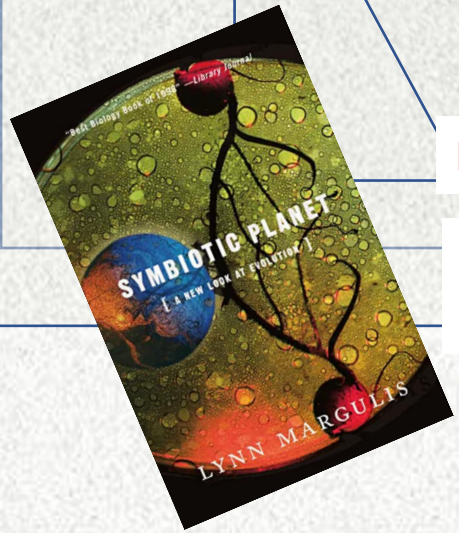
DARWIN



LOVELOCK

Atmospheric homeostasis by and for the biosphere: the Gaia hypothesis, 1973

All organisms have to co-evolve,
as small systems within other larger systems,
and content other smaller systems



MARGULIS

Symbiotic Planet {A new Look at Evolution}, 1998

Paradox: to continue existing, all organisms have to die

The paradox solution is in the soil

- If we want to go into the future, there is a door to pass through: death. As in a relay race, the living passes the **baton** (which is **only partially** the **Richard Dawkins' "Selfish Gene"**) in a mortal trial. It is a mandatory, impressive, crude, natural law: to survive forever, living beings must die.
- Such a dying process happens in some kind of **"PEDON"** => in a **"SOIL like mean".**
- Does the **cytoplasm** of a cell function just like a "**tiny pedon**"?
- In **a natural ecosystem**, the "volume" in which the ecosystem regenerates is scientifically called "**pedon**" (1).

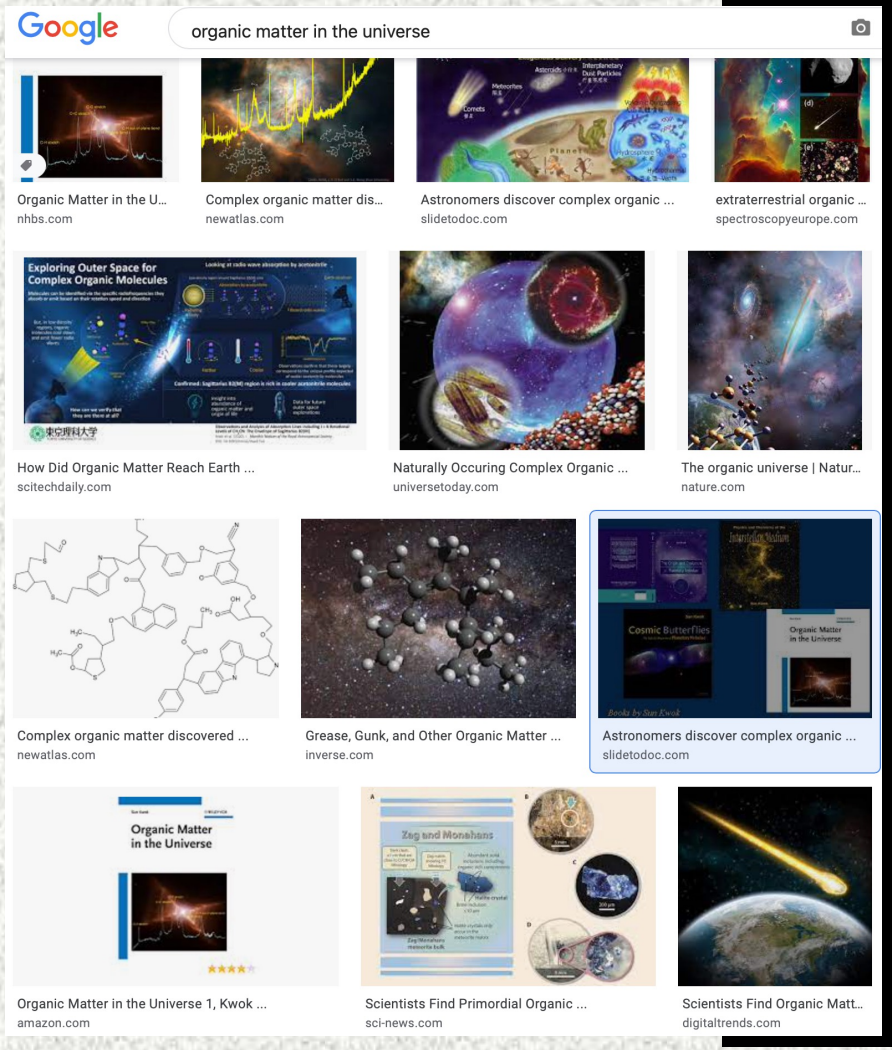
---

(1) More precisely, the process of renewal of a natural ecosystem takes place in the more superficial and organic part of the soil called **"Humipedon"**.

Fig. A.

Humusica 2, article 13 (2018)

Organic compounds
are **ubiquitous in space**



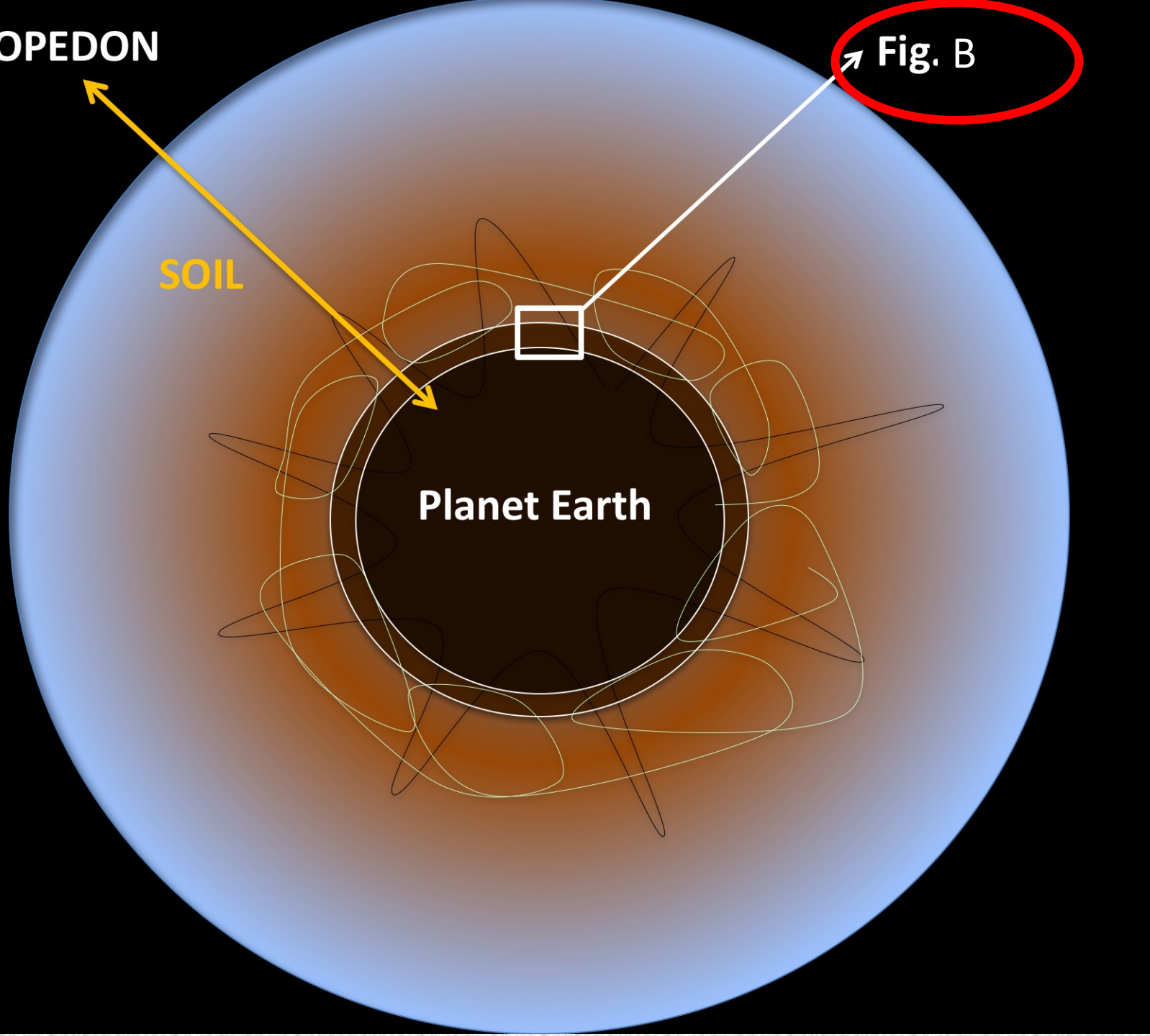
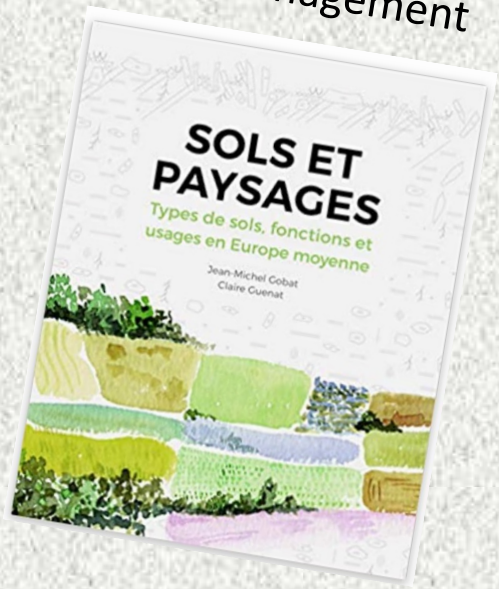


Fig. B.

Humusica 2, article 13 (2018)

Soil management



Generally called SOIL

(COSMOPEDON)

AEROPEDON

SYMBIOPEDON

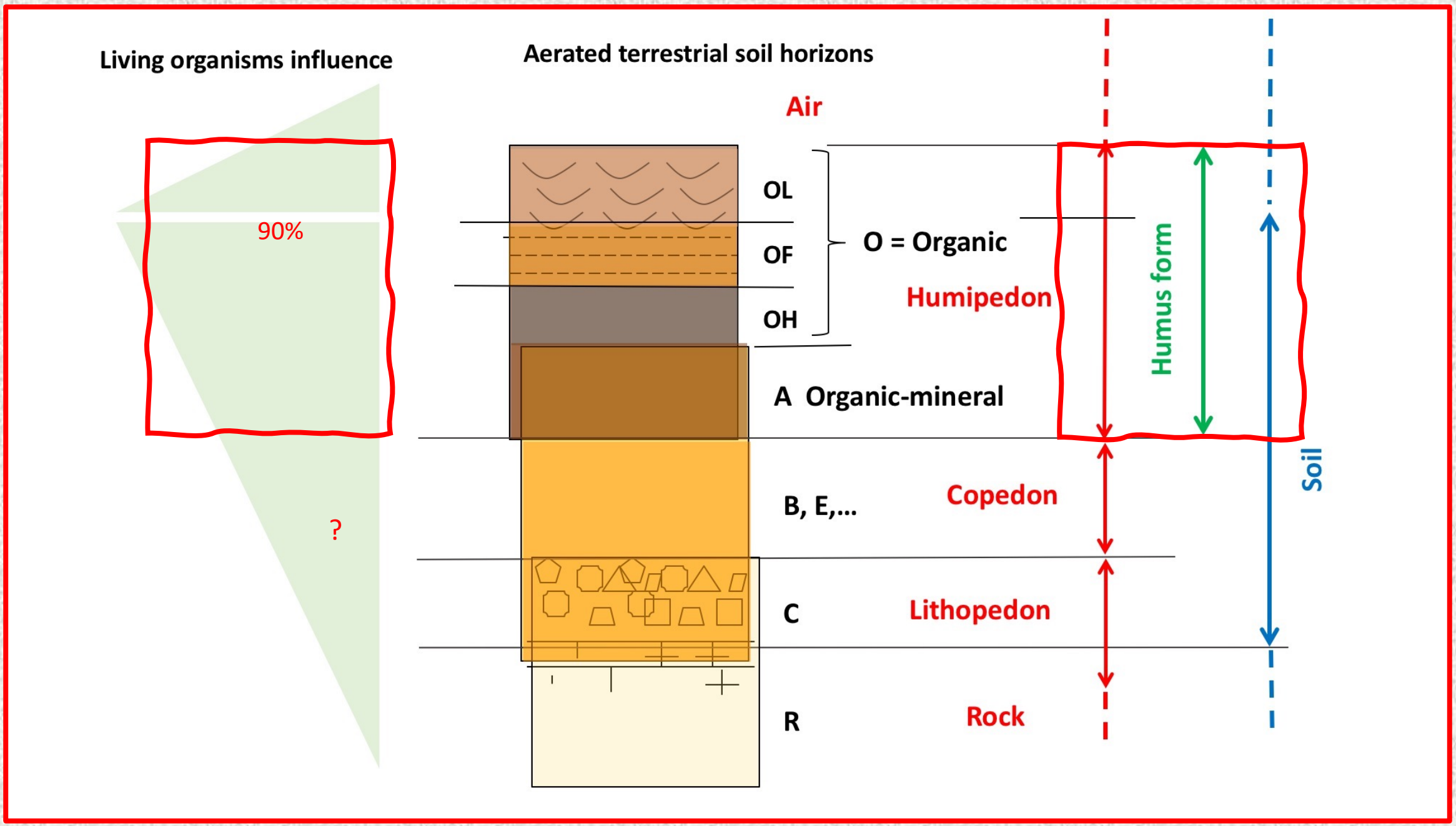
HYDROPEDON

HUMIPEDON

COPEDON

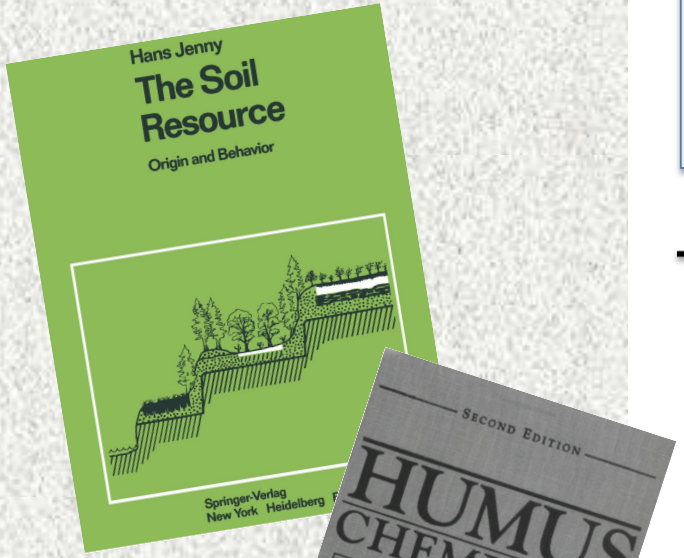
LITHOPEDON

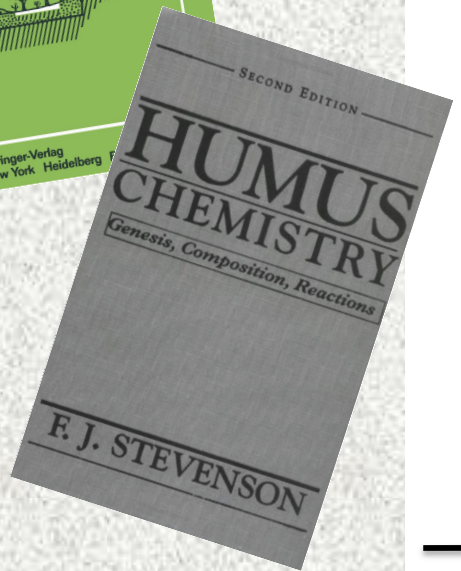
GEOPEDON

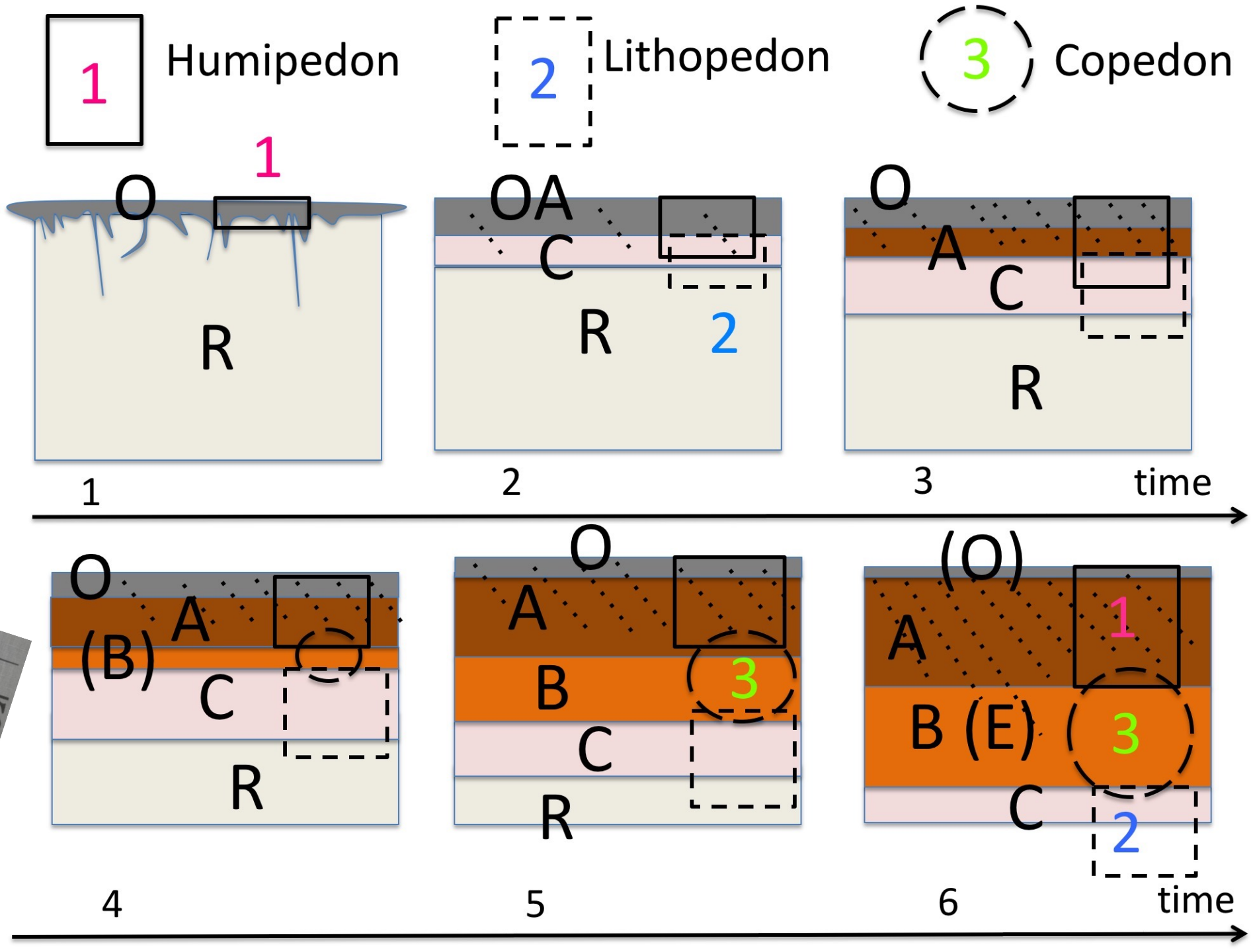

Living organisms influence
90%
?
Aerated terrestrial soil horizons
Air
OL
OF
OH
O = Organic
Humipedon
A Organic-mineral
B, E,...
Copedon
C
Lithopedon
R
Rock
Humus form
Soil

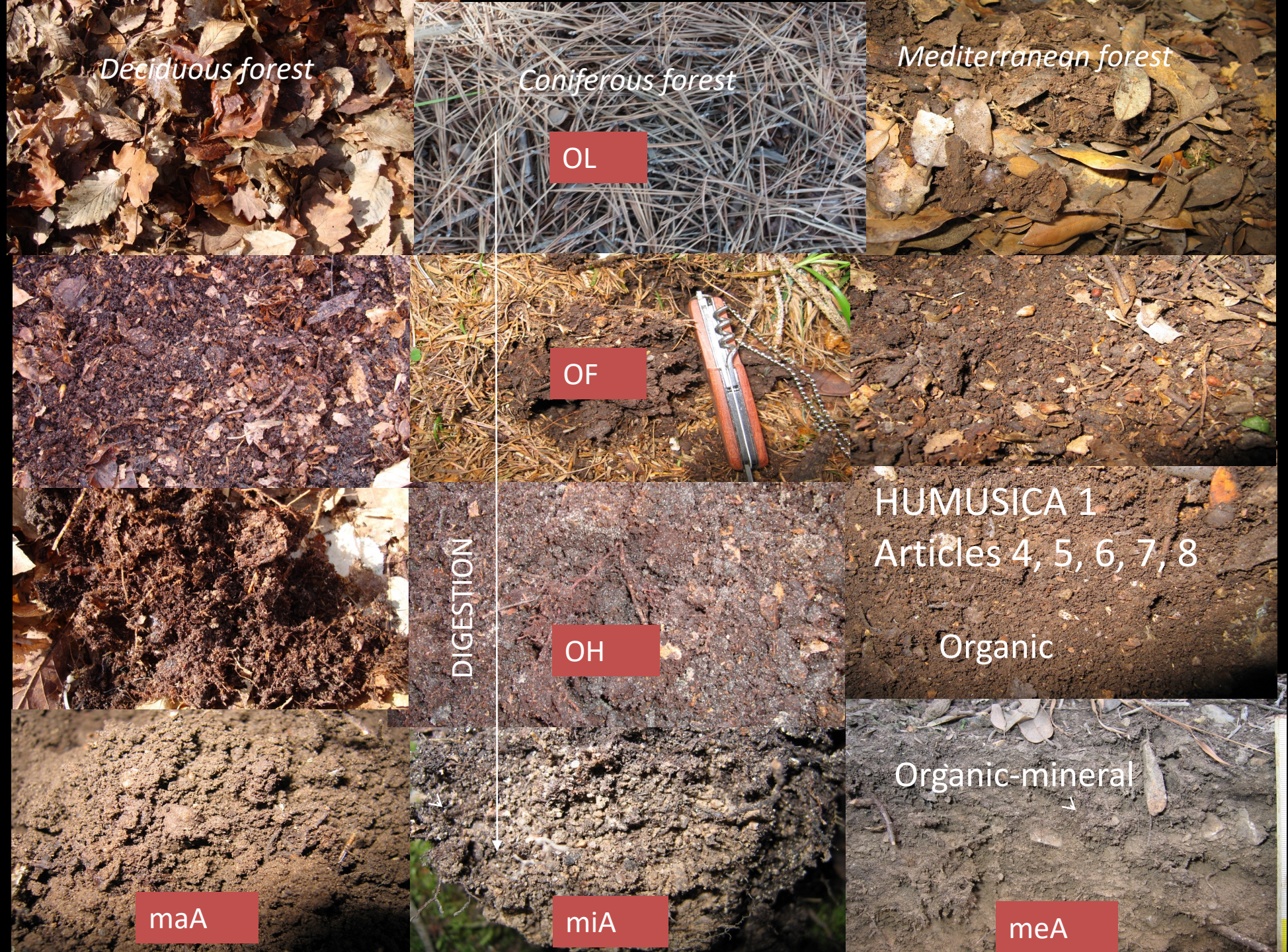
Soil history

Soil horizons
Humus chemistry







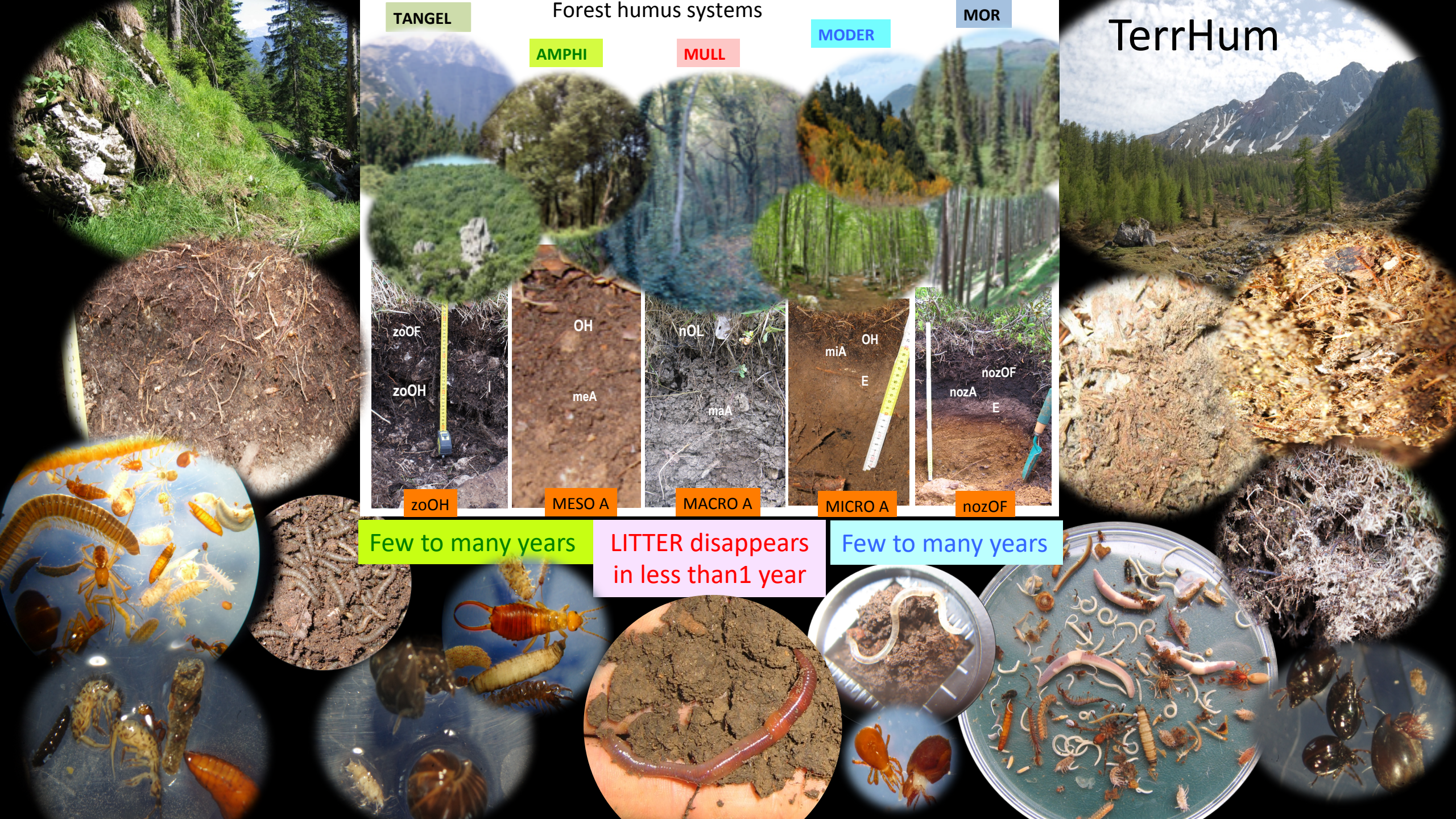

Deciduous forest
Coniferous forest
Mediterranean forest
OL
OF
DIGESTION
OH
HUMUSICA 1
Articles 4, 5, 6, 7, 8
Organic
Organic-mineral
maA
miA
meA

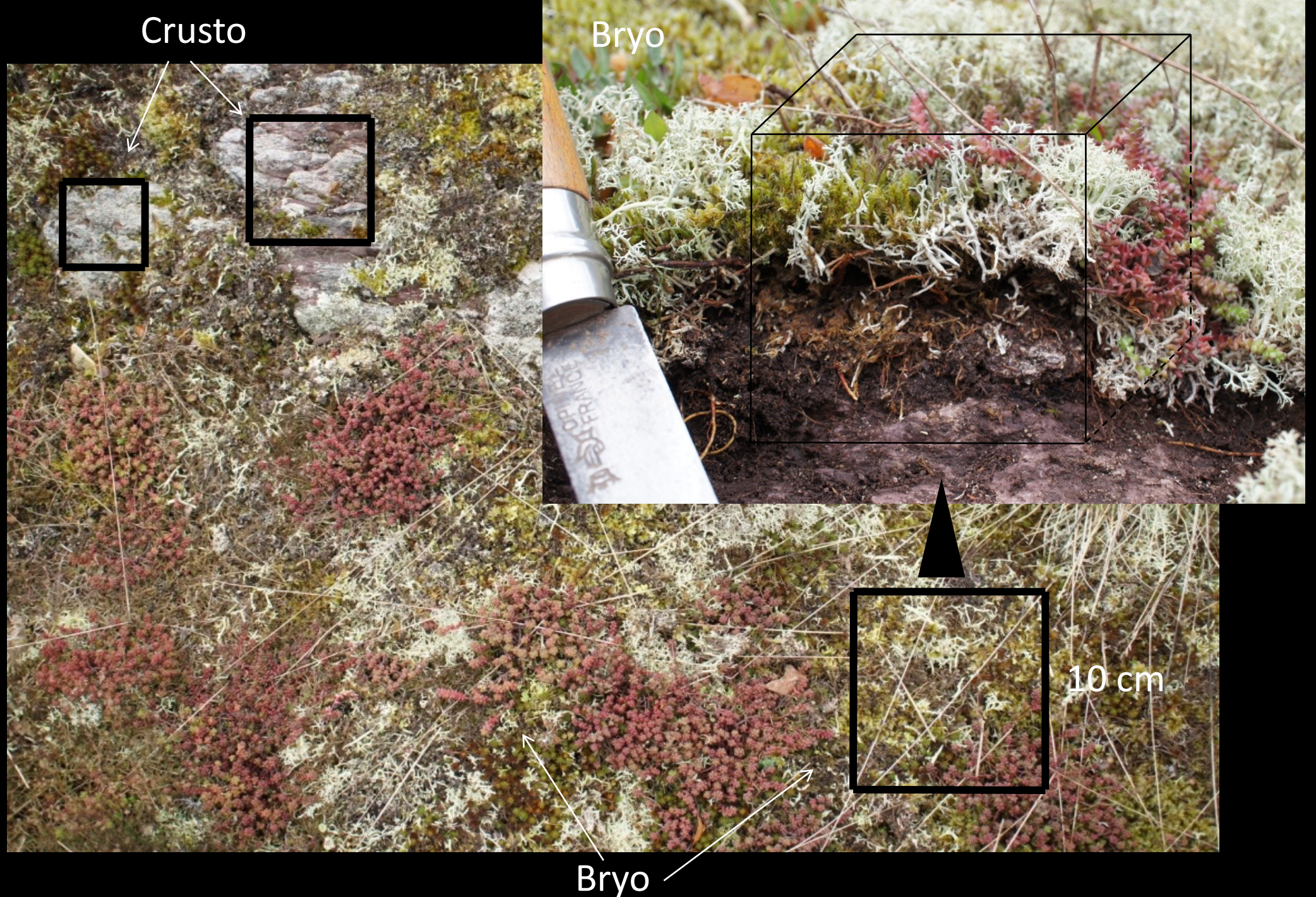
HYDRO as prefix when presence of gOH or gA

wmO = wild mammal Organic horizons (organic material > 50%):

wmOL = A aggregates < ¼ (< 20%) in O
wmOF = ½ (20-35%) A aggregates in O
wmOH = > 1/3 (35-50%) A aggregates in O

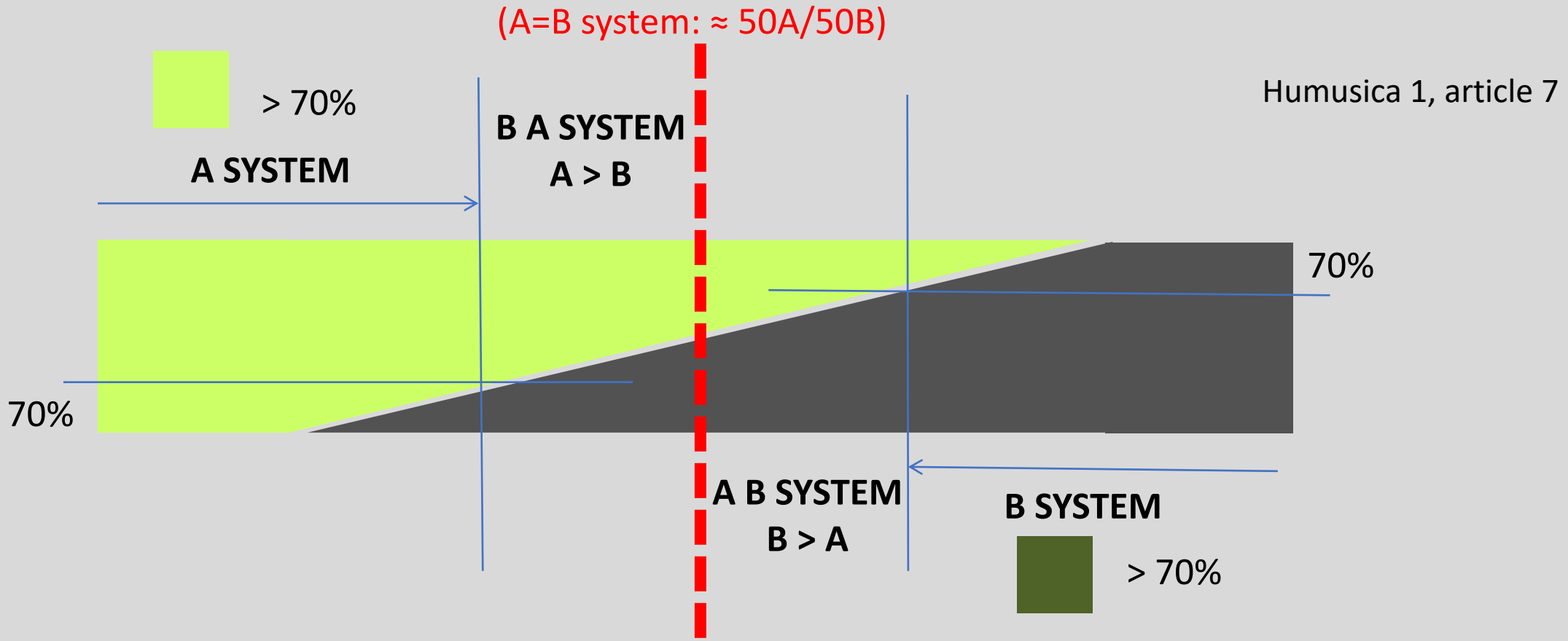
wmA = wild mammal A horizons (organic material ≤ 50%):
wmmaA, wmmeA, wmmiA


TerrHum
Forest humus systems
TANGEL
AMPHI
MULL
MODER
MOR
zoOF
zoOH
OH
meA
nOL
maA
OH
miA
E
nozOF
nozA
E
zoOH
MESO A
MACRO A
MICRO A
nozOF
Few to many years
LITTER disappears in less than1 year
Few to many years


Crusto
Bryo
10 cm
Bryo

A HUMUS diagnostic horizons (estimated volume in the humipedon)

B HUMUS diagnostic horizons (estimated volume in the humipedon)



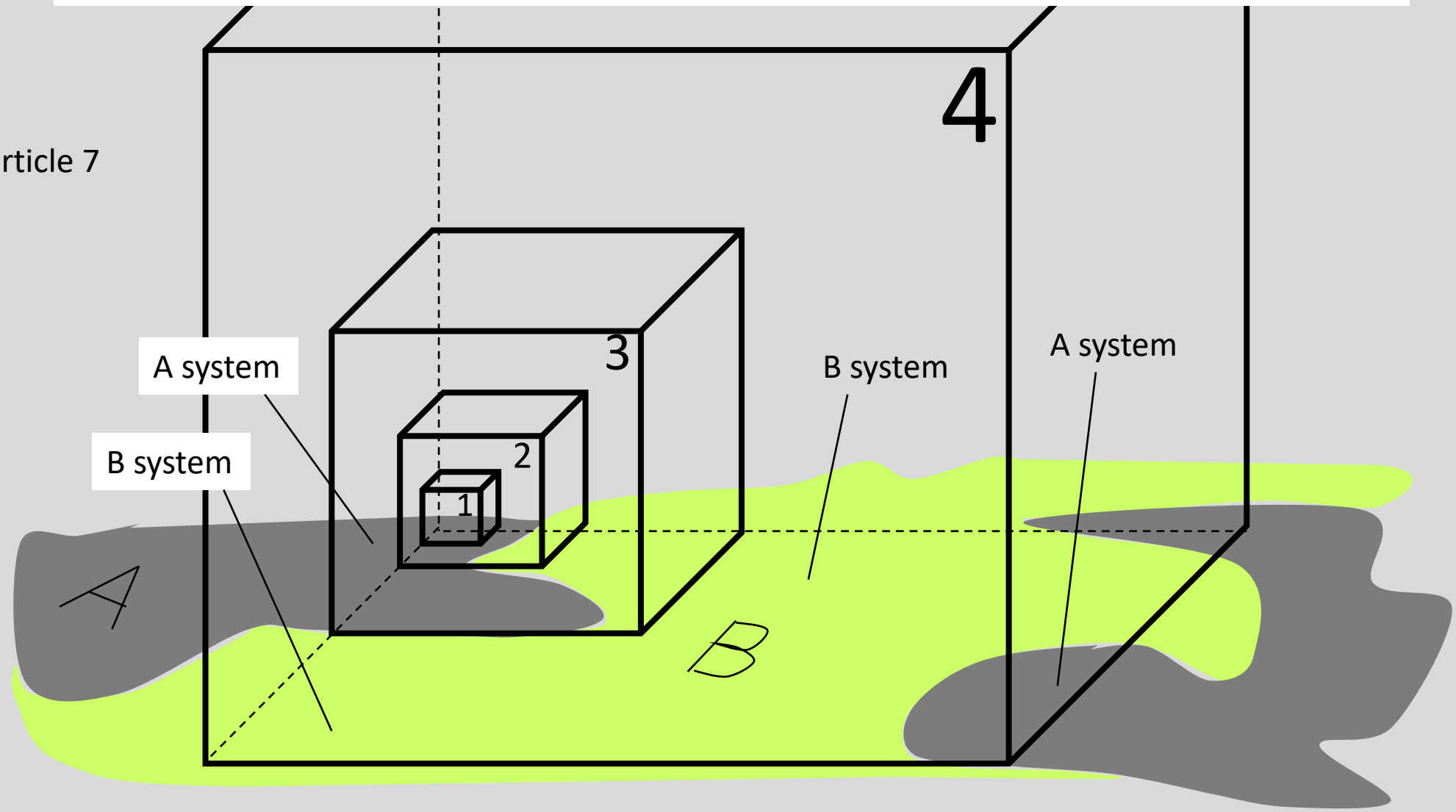
NAME of complex system (overlapping systems)

Humus systems: A = Bryo; B = Moder

A B system: Bryo Moder (humus system) or Bryo Eumoder, Bryo Dysmoder…(humus form); or Bryo on Moder, or Bryo/Moder to precise that a Bryo system overlaps a Moder one

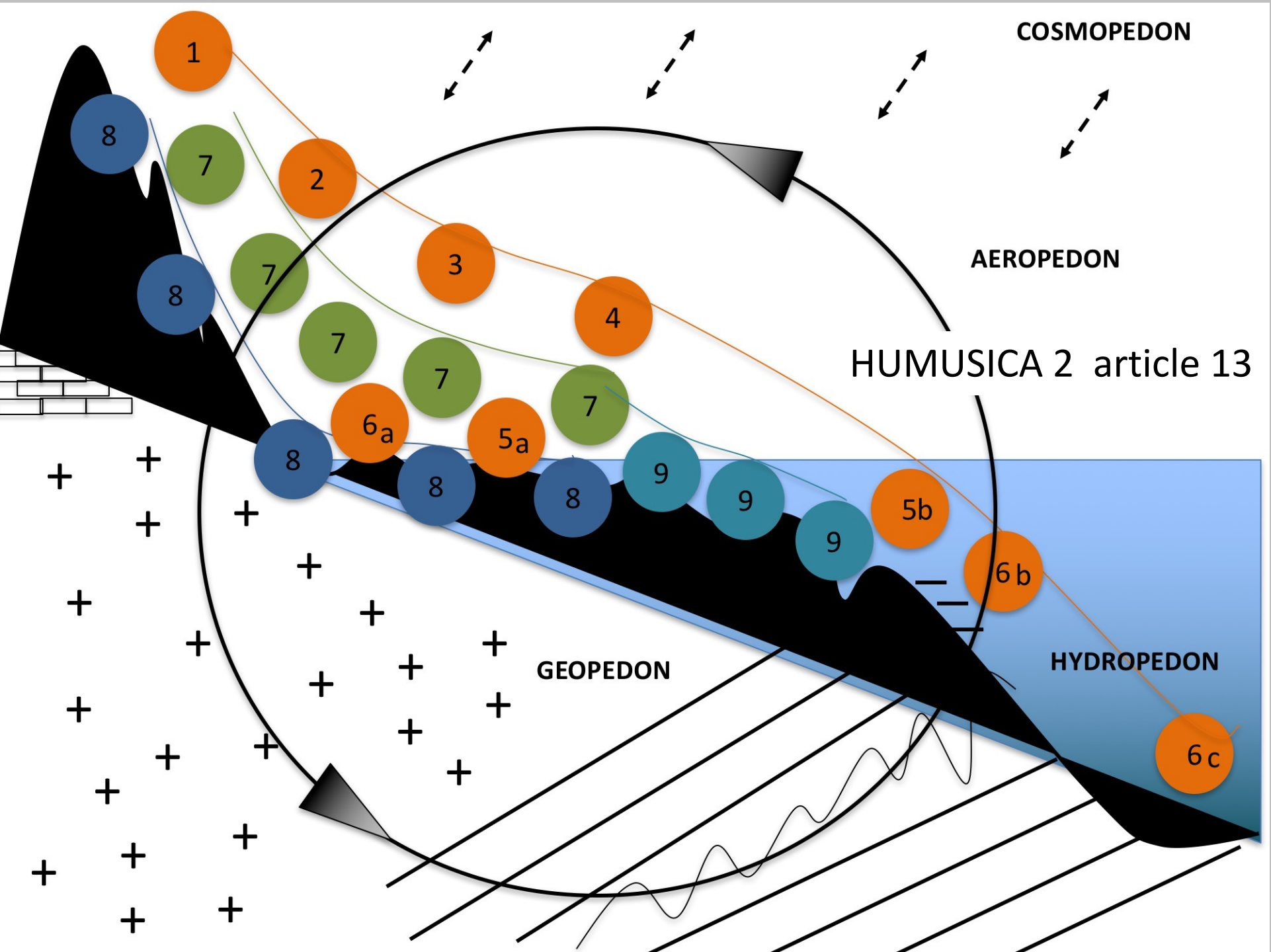
Systems arranged in mosaic. Example: A = Bryo; B = Moder
In box 1, A covers > 70% of the surface, name: Bryo
In box 2, A covers more than B, but 70% or less of the surface, name: Moder- Bryo
In box 3, B covers more than A, but 70% or less of the surface, name: Bryo-Moder
In box 4, B covers > 70% of the surface, name: Moder

Humusica 1, article 7



Tutto quello che vorreste sapere sulle forme di Humus:

Publications (PDF): 4F0B2301492C572697673D57A6C996CA.pdf



1. Crusto (bacteria, fungi and lichens, cyanobacteria and algae on mineral particles in aerated environments);
2. Bryo (arbuscular lichens, bryophytes and small plants on mineral and/or organic and/or organic-mineral soil horizons);
3. Rhizo (fern, grass, ericaceous roots and rhizomes on soil horizons);
4. Ligno (wood-destroying animals and fungi on woody remains);
5. Anaero (anaerobic microorganisms, in always submerged environments: 5a, river bottoms, lake; 5b, sea, ocean floors);
6. Archaeo (archaea living in very harsh environments, 6a out of water, 6b in photic submerged zone, with photosynthetic organisms, 6c in aphotic zone, in deep seas).
7. Main terrestrial humus systems (all on evolved soil horizons; Mull = dicots, in temperate climates; Mor = conifers, in cold rainy climates; Moder = mixed forests, in half mountain, half continental climates; Amphi = sclerophyllous vegetation, in contrasted climates (mountain, mediterranean); Tangel = conifers, in contrasted dry climates);
8. Main histic humus systems (all in semi-terrestrial more or less anoxic environments; Fibrimoor = base-poor soils, in brook valley systems and bogs; Mesimoor = moderately base-poor soils, in brook valley systems and bogs; Amphimoor = moderately moist base-rich soils, in brook valley systems or in half-drained fens; Saprimoor = base-rich soils, in brook valley systems or fens; Anmoor = base-rich soils or soils enriched by base-rich groundwater, in brook valley
systems and floodplains, never in dynamic floods with fast currents);
9. Aqueous = tidalic ecosystems (Oxitidal = Fe_2O_3 dominant; Reductitidal = Fe_2O_2 dominant; Eusubtidal = only Fe_2O_2).

1. Humus system strongly influenced by hygrophytes or peat mosses forming more or less submerged peat deposits (bogs, fens), or seaside and tidal zones. Presence of H or/and anA /anaA diagnostic horizons → **HISTIC** or **AQUEOUS** systems → Humusica 2, articles 9, 10, 11 and 12

2. Humus systems strongly influenced by fungi, algae, lichens, mosses, roots and/or rhizomes, wood burrowing animals, anaerobic bacteria and archaea. Dominant presence of specific O and OA diagnostic horizons (cruO, cruOA, bryOL, bryOF, rhiA, ligOL, ligOF, anaOA, arcOA) → **PARA** systems → Humusica 2, article 13, (Applied Soil Ecology, Special Issue 122b)

2020

3. June, 2021

TERRESTRIAL systems,

aerobic conditions, no water saturation, absence of H or anA horizons

Humusica 1, articles 1 to 8 (Applied Soil Ecology, Special Issue 122a)

Modified in June 2021, without A horizon pH

Mull central morpho-functional characters:
1. **Absence of an OH horizon**, and
2. presence of a zoogenic **organic-mineral A horizon containing earthworm casts** in temperate climate, or/and
3. **large** (> 1 mm) **arthropod droppings** in dry tropical, subtropical and Mediterranean climates

Amphi central morpho-functional characters:
1. Presence **of both zoogenic OH and OF horizons**, and
2. high amount of **large (> 1 mm) aggregates** in the **zoogenic A horizon**, and
3. **A horizon at least twice the thickness of OH**;
4. in general, on **basic parent material**

Tangel central morpho-functional characters::
1. Presence of **both zoogenic OH and OF horizons**, and
2. **possible A horizon at the bottom of the profile at the bedrock contact**, and
3. **OH horizon more than twice the thickness of A**;
4. in general, **on basic parent material**

Moder central morpho-functional characters:
1. Presence **of both zoogenic OH and OF horizons**, and
2. presence of **biomicro (≤ 1 mm) aggregates** in the A horizon (absence of other zoogenic aggregates), **or**
3. presence of a **non-zoogenic single grain or massive A** horizon, and
4. presence of a **gradual (> 5 mm) transition** between OH and A horizons;
5. in general, **on acid parent material**

Mor central morpho-functional characters:
1. Presence of a **non-zoogenic or slightly zoogenic** (no or rare droppings) **OH, or/and nozOF** organic horizons, and
2. if an organo-mineral **AE** or a mineral **E** horizon is present, it is **devoid of faunal droppings,** and
3. presence of **a very sharp transition (< 3 mm)** between organic and organic-mineral or mineral horizons;
4. in general, **on acid parent material**

[ ] = possible, or discontinuous, or in pockets

- [nOL]/maA → **EUMULL**
- nOL/[vOL]/maA → **MESOMULL**
- nOL/vOL/[zoOF]/maA or meA → **OLIGOMULL**
- nOL/vOL/zoOF/maA or meA → **DYSMULL**

Sharp O/A transition < 5 mm, maA
- OL/zoOF/[zoOH]/maA, OH < 1 cm → **LEPTOAMPHI**
- OL/zoOF/zoOH/maA, OH ≥ 1 cm → **EUMACROAMPHI**

Gradual, diffuse O/A transition ≥ 5 mm, meA or (meA + miA)
- OL/zoOF/zoOH/meA or meA + miA, OH < 3 cm → **EUMESOAMPHI**
- OH ≥ 3 cm → **PACHYAMPHI**

OL/zoOF/zoOH or szoOH/ [A], never maA
- OF +OH < 15 cm → **LEPTOTANGEL**
- OF + OH = 15-50 cm → **EUTANGEL**
- OF +OH > 50 cm → **PACHYTANGEL**

[ ] = possible, or discontinuous, or in pockets

gradual (> 5 mm) transition
- OL/ zoOF/[zoOH]/meA, miA, [OH] → **HEMIMODER**
- OL/ zoOF/zoOH/miA or sgA or msA, OH < 1 cm → **EUMODER**
- OL/ zoOF/zoOH/[szoOH]/miA or sgA or msA or AE or EA, OH ≥ 1 cm → **DYSMODER**

very sharp transition (< 3 mm)
- OL/[nozOF]/zoOF/[zoOH]/A absent or sgA or msA or AE or EA → **HEMIMOR**
- OL/ nozOF/[zoOH]/szoOH/A absent or sgA or msA or AE or EA → **HUMIMOR**
- OL/ nozOF/[szoOH]/A absent or sgA or msA or AE or EA → **EUMOR**

Zanella A., Ponge J.-F. , Le Bayon R.-C., Tatti D., Stanchi S.

ESSENTIAL FIELD morpho-functional features associated with each humus system (without pH)

Mull

Absence of an OH horizon, and
presence of a zoogenic organic-mineral A horizon containing earthworm casts in temperate climate, or/and
large (> 1 mm) arthropod droppings in dry tropical, subtropical and Mediterranean climates

Moder

Presence of both zoogenic OH and OF horizons, and
presence of biomicro (≤ 1 mm) aggregates in the A horizon (absence of other zoogenic aggregates), or
presence of a non-zoogenic single grain or massive A horizon, and
presence of a gradual (> 5 mm) transition between OH and A horizons;
in general, on acid parent material

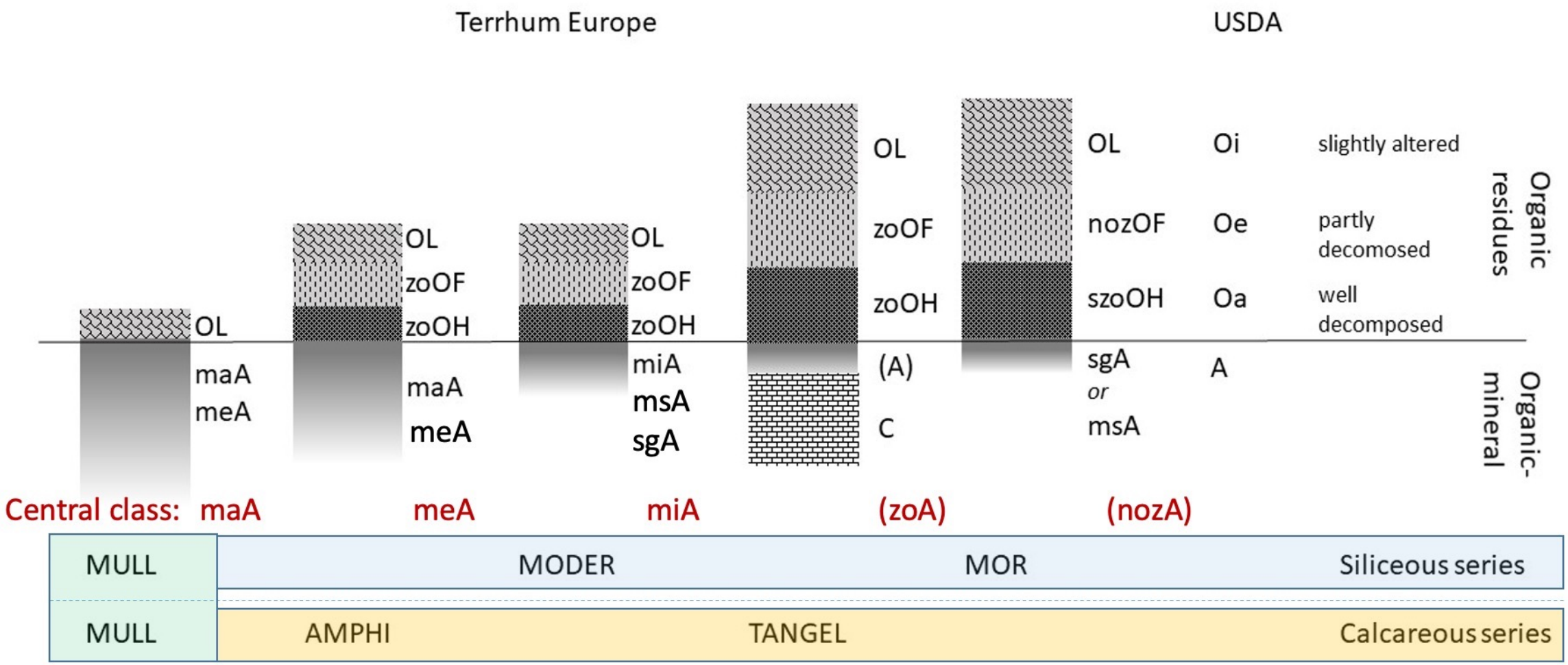
Mor

Presence of a non-zoogenic or slightly zoogenic (no or rare droppings) OH, or/and nozOF organic horizons, and
if an organo-mineral AE or a mineral E horizon is present, it is devoid of faunal droppings, and
presence of a very sharp transition (< 3 mm) between organic and organic-mineral or mineral horizons;
in general, on acid parent material

Amphi
Presence of both zoogenic OH and OF horizons, and
high amount of large (> 1 mm) aggregates in the zoogenic A horizon, and
A horizon at least twice the thickness of OH;
in general, on basic parent material

Tangel
Presence of both zoogenic OH and OF horizons, and
possible A horizon at the bottom of the profile at the bedrock contact, and
OH horizon more than twice the thickness of A;
in general, on basic parent material

Names of humus systems or forms of humus can be written in both upper or lower cases.
Examples: a **Mull** system in a Cambisol, or a Cambisol with a **mull**; a **Dysmull** or a **dysmull** influencing a Luvisol; a thick Humimor or humimor or mor characterizing a Podzol.



OF or OH: zo...zoogenic, noz...non zoogenic, szo...slightly zoogenic

A: zoogenic: ma...biomacrostructured, me...biomesostructured, mi...biomicrostructured
non-zoogenic: sg...single grain, ms...massive

HUMUSICA – Humus Group

MUSE
Università degli Studi di Padova
TESAF Dipartimento Territorio e Sistemi Agro-Forestali Università di Padova
BOKU Universität für Bodenkultur Wien
unine Université de Neuchâtel
AgroParisTech
WAGENINGEN UNIVERSITY & RESEARCH
UGA Université Grenoble Alpes
OHGA
TUM Technische Universität München
UNIVERSITEIT GENT
SAPIENZA Università di Roma
UNIVERSITÉ DE ROUEN NORMANDIE
UNIVERSIDADE DE VIGO
UNIVERSITÉ DE LORRAINE
IFAB
Eesti Maaülikool Estonian University of Life Sciences
LUXEMBOURG INSTITUTE OF SCIENCE AND TECHNOLOGY LIST
IUFRO Interconnecting Forests, Science and People
arpav Agenzia Regionale per la Prevenzione e Protezione Ambientale del Veneto
Bundesamt für Wald
PROVINCIA AUTONOMA DI TRENTO
Office National des Forêts
International Union of Soil Sciences

TerrHum

Horizons
Examples

O/A Transitions
Examples

Systems and Forms
Examples

Help
Pedofauna, tables

About TerrHum
Humus Group - Humusica

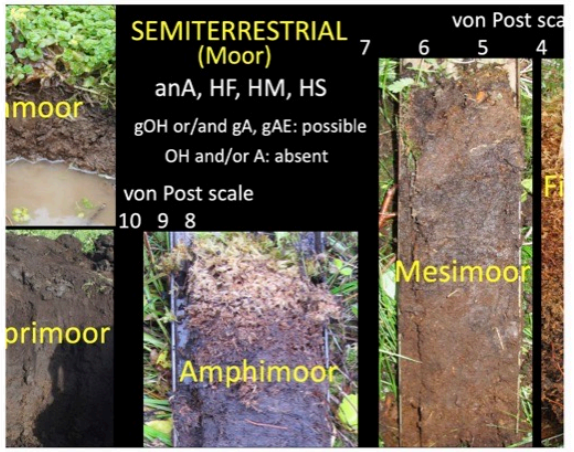
Classification key

NEW

11:54

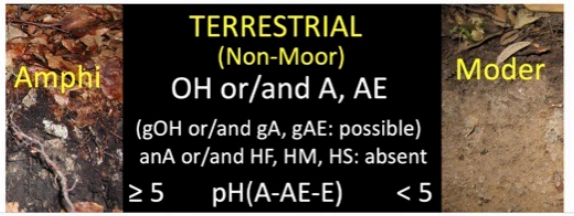
Choose (touch a figure)

SEMITERRESTRIAL (Moor) systems



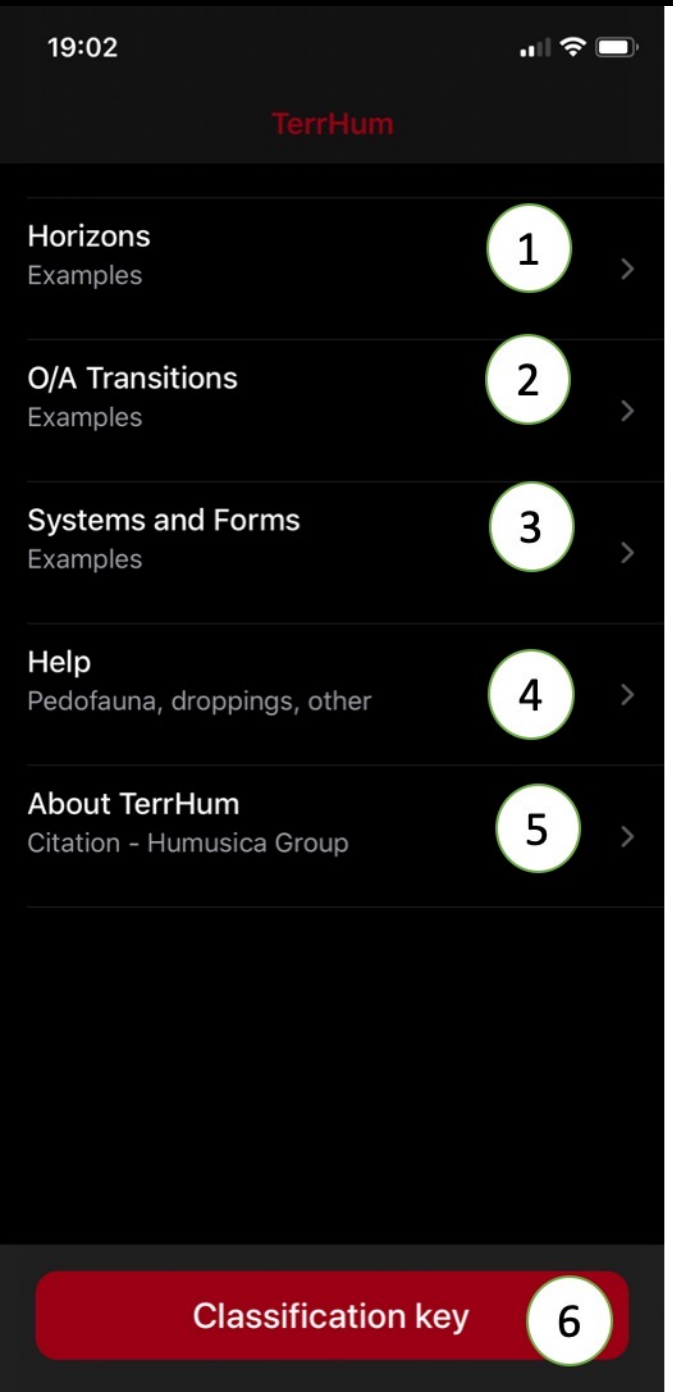
Presence of dominant anA or HS or HM or HF horizon (examples in HOR) within the first 40 cm below the surface

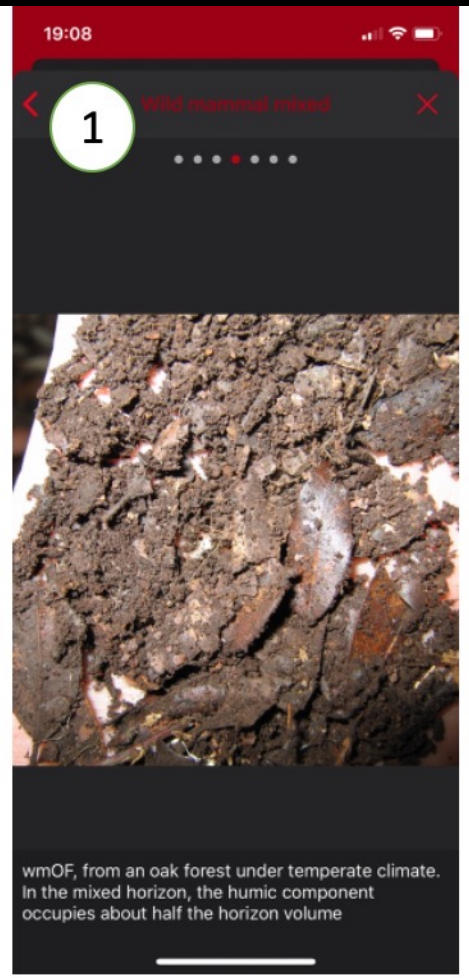
TERRESTRIAL (Non-Moor) systems

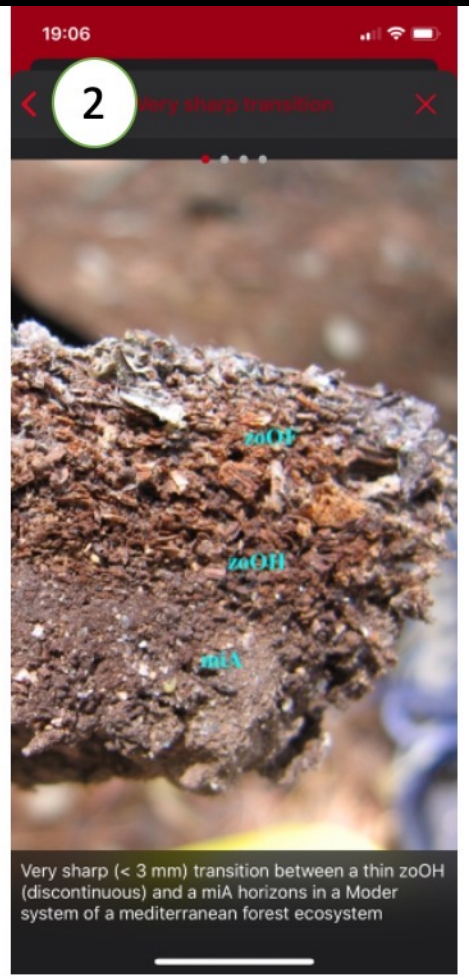


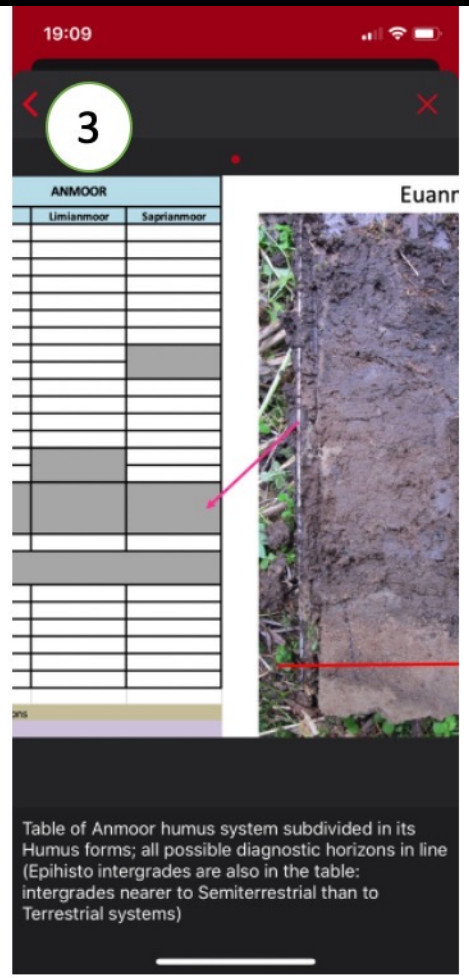
Next

HOR O/AT SYFO HELP









5

https://www.academia.edu/44800243/TerrHum_iOS_or_Android_App

11:20

Horizons

- nOL
- vOL
- zoOF
- nozOF
- zoOH
- szoOH
- maA
- meA
- miA
- nozA (sgA, msA, AE)
- Wild Mammals Mixed

12:01

zoOH

zoOH from an Alpine beech forest, under temperate climate. In this ecosystem, enchytraeids (little white transparent microannelid worms) play a dominant role in litter biodegradation. The passage between OH and A is very gradual and it is often difficult in the field to mark the limit between these horizons of a Eumesoamphi humus form

11:21

Transitions

- Gradual transition
- Sharp transition
- Very sharp transition

11:21

Very sharp transition

Very sharp (< 3 mm) transition between a thin OH (discontinuous) and a miA horizons in a Moder system of a mediterranean forest ecosystem.

11:36

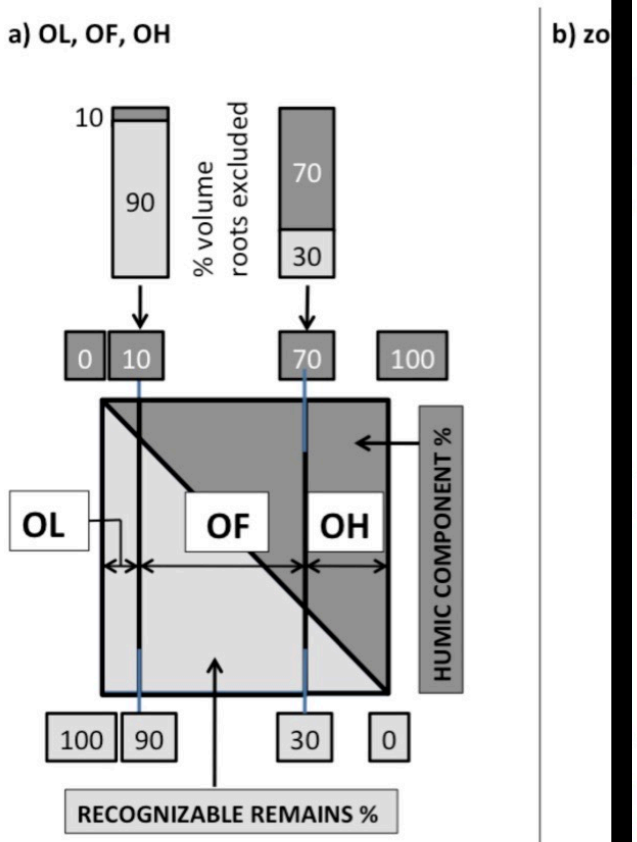
Help

- Pedofauna and dropping
- General
- Horizon quality
- Systems

11:23

Pedofauna collected by Universidad Pierre y Marie Curie (UPMC) students (Paris, France) from a Moder in a mixed beech-oak forest in Fontainebleau forest (France)

11:36



Humus horizon codes and percent in volume roots excluded of Recognizable remains, Humic component, Zoogenically transformed and Non-Zoogenically transformed materials

11:35

DIAGNOSTIC HORIZONS Trans: O-A		TA	
HYDRO	(typical)	Leptotangel	Eu
gOL, gOF posble not sufficient, gOH sufficient for Hydro prefix	nOL	possible and	
	vOL		
	nozOF		
	zoOF	OF+OH < 15 cm OH > 2A	OF+O O
	szoOH		
	zoOH		
Transition O-A (mm)		not di	
gAE, gnozA, gzoA (gmaA, gmeA, gmiA) sufficient for Hydro prefix	AE, EA		
	nozA	possible	
	miA		
	meA	OR possib	
	maA		

(*) Mandatory in Tangel: pHwater of nozA = msA ≥ 4.5

Possible hydromorphic (g) terrestrial diagnostic horizons

Terrestrial diagnostic horizons

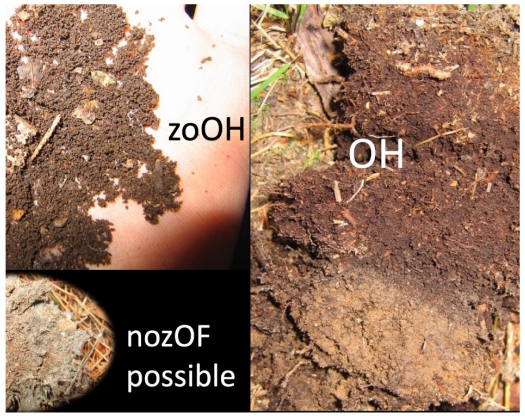
Table of Tangel humus system subdivided in its Humus forms; all diagnostic horizons in line, superposed as in natural topsoils

08:20 4G

Back

Check on profile and touch the screen: zoOH or szoOH or nozOF PRESENT

YES = NON-MULL systems



zoOH or/and szoOH or/and nozOF: present; Hydro gOH, gA: possible

NO = MULL humus system

Next

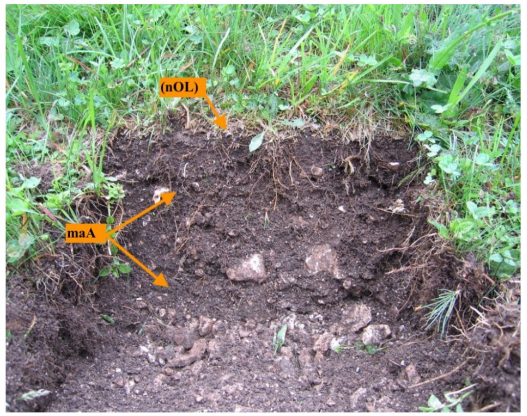
HOR O/AT SYFO HELP

08:20 4G

Back

MULL central diagnostic characters: 1. absence of an OH horizon and;2. presence of a zoogenic organic-mineral A horizon containing: a. earthworm casts in temperate climate, or/and b. large (> 1 mm) droppings of various animal origins according to regions; possible Hydro intergrades Choose a humus form (if none, Back):

Eumull



nOL : possible continuous, discontinuous or in pockets ; maA : present

Next

HOR O/AT SYFO HELP

08:21 4G

Back **Dysmull**

Description

nOL and vOL - zoOF continuous - maA or meA< 3mm

Horizons

- nOL : continuous
- vOL : continuous
- zoOF : continuous
- Transition O/A : Sharp transition
- maA or meA : present

08:20 4G

Back

nOL, vOL : present ; maA : present

Dysmull

nOL : continuous ; vOL : often present ; zoOF : continuous ; meA or maA: present

Hydro MULL

Next

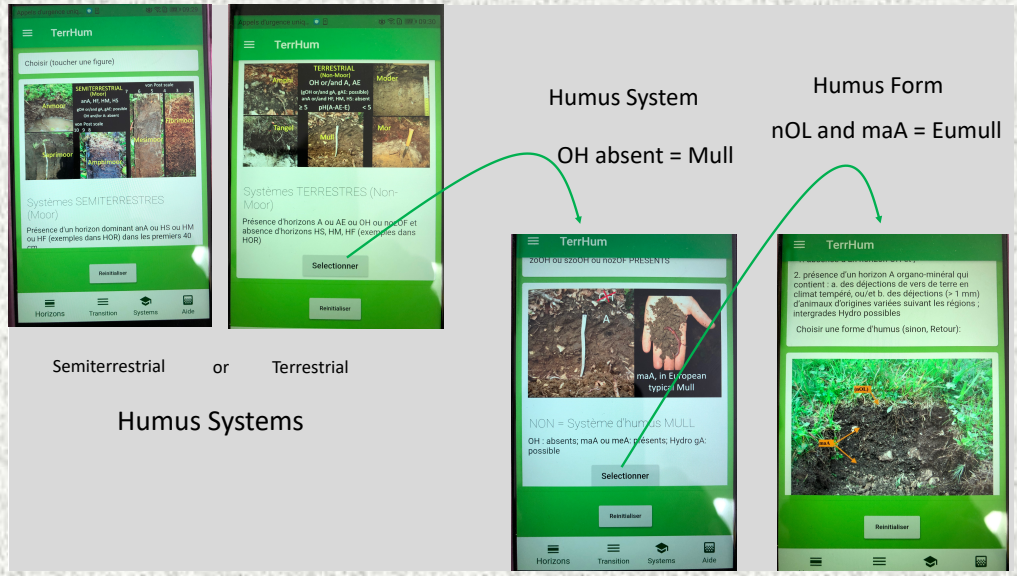
HOR O/AT SYFO HELP

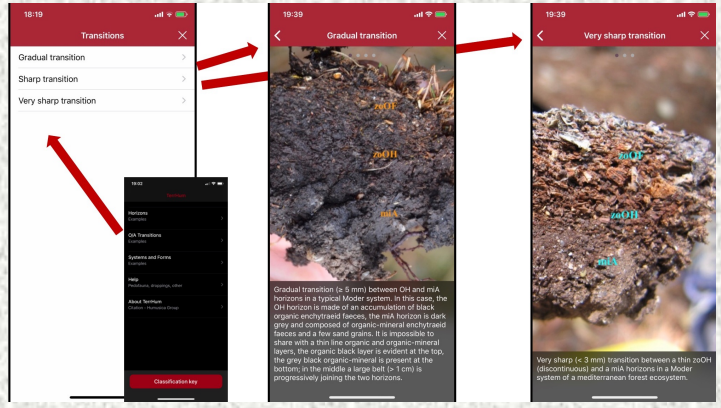
There is an app for cell-phones and tablets that helps to classify the main Terrestrial, Histic and Para humipedons of the world in a standardized way.

TerrHum

free Android or iOS application

Languages: English, French and Italian





Thank you for your attention

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Applied Soil Ecology