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TOWARD A EUROPEAN HUMUS FORMS REFERENCE BASE

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1. Historical path

A network of European researchers working on humus forms was created in Trento (Italy) in 2003. In July 2004, the commission "Classification of (European) Humus Forms" met in Vienna (Austria) and drafted a taxonomic key to the main terrestrial humus forms based on response to environmental conditions and specific biological activities (Ponge, 2003; Graefe and Beylich, 2003). This draft was presented in Freiburg (Germany) at the EUROSOIL 2004 congress (Jabiol et al., 2004).

From this event onwards, other results have been achieved:

- the definitive admission of the *Amphi* forms at the first level of the classification during the meeting in San Vito (University of Padua, Italy, 2005). The name means "*twin* forms", differentiating from Moder because of the strong earthworm activity in the A horizon and from Mull, on the other side, because of the important accumulation of organic matter at the soil surface. The same solution has been adopted in the last version of the French Référentiel Pédologique (AFES, 2009);
- a draft of a European key of classification has been presented in the form of a poster (Fig. 1) at the 18th Congress of Soil Science, USA, Philadelphia (Zanella et al. 2006);
- the first level of the proposed classification key has been implemented and integrated into the manual of the UN-ECE–ICP Forests programme available on internet (http://www.icp-forests.org/Manual.htm);
- an agreement has been reached for characterizing the structure of the A horizon within the European humus forms classification. The soil structure defined in the USDA Soil Survey Manual (1993), also used in the World Reference Base for Soil Resources (IUSS Working Group WRB, 2006) and the FAO Guidelines 2006, has been adopted in the new characterization of the five diagnostic A horizons;
- a workshop was made to improve and extend the *Amphi* classification draft in order to include some typical Mediterranean humus forms (meeting at the University of Cagliari, Italy, 2007);

- the most recent version of the key, re-elaborated thanks to a workshop organized during the EUROSOIL 2008 congress (Vienna, Austria), includes the *Tangel* humus form, which has a relatively broad distribution in the calcareous Alpine ecosystems;

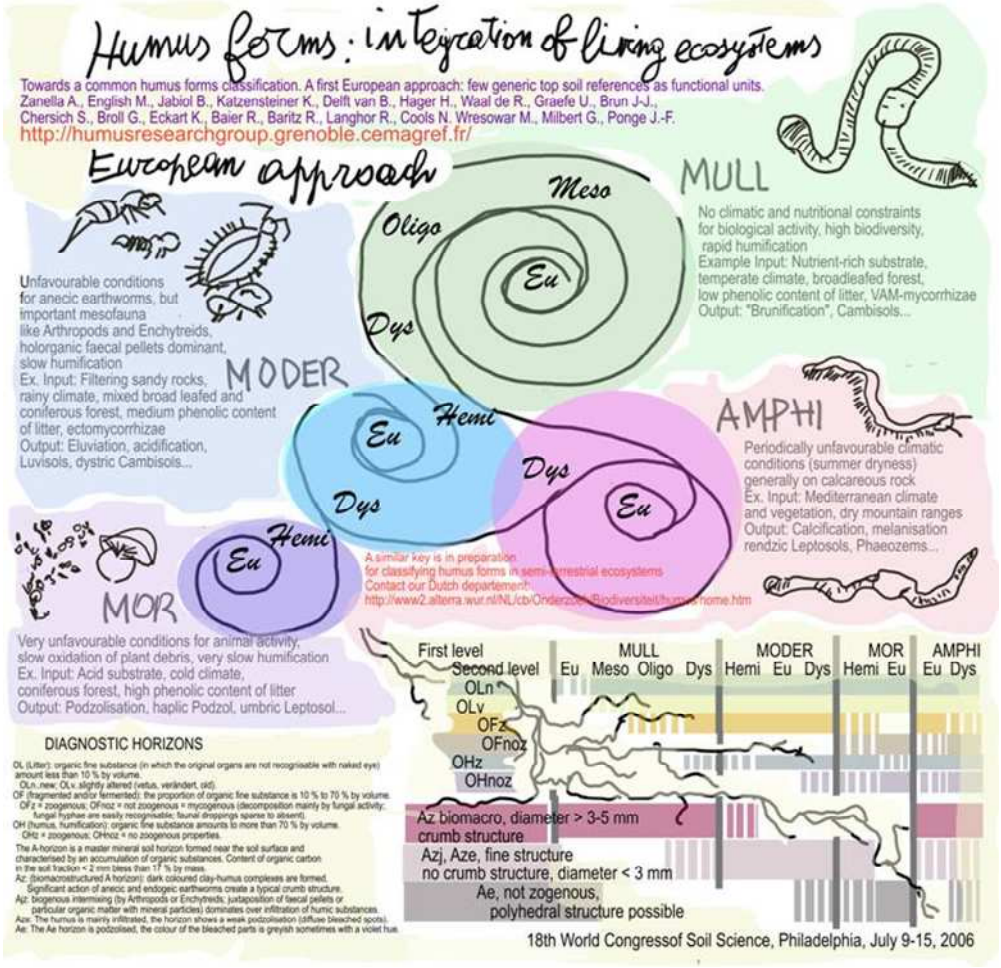

Figure 1. A poster at the World Congress of Soil Science in Philadelphia (2006), for disseminating the humus forms concept. It resumes the work about the humus forms two years after the foundation of the European Humus Group: 4 main humus forms, 11 second-level categories and a mild attempt to organize some ecological attractors around them.

- starting from a first attempt presented by the Dutch members of the humus group (Alterra) during a meeting in San Vito (Italy, 2005), the *semi-terrestrial* humus forms have been considered and included in the classification. A final agreement was found only after the Eurosoil 2008 meeting (Fig. 2). Diagnostic horizons for the first and second-level references have been established, and new *Histo* forms have been placed in synoptic tables (Fig. 3);
- with the aim to complete the humus classification panel, definitions for Hydro, Litho, Peyro, Psammo, Rhizo and Ligno forms were recently established exchanging a sharable draft (Figs. 4, 5, 6, 7).

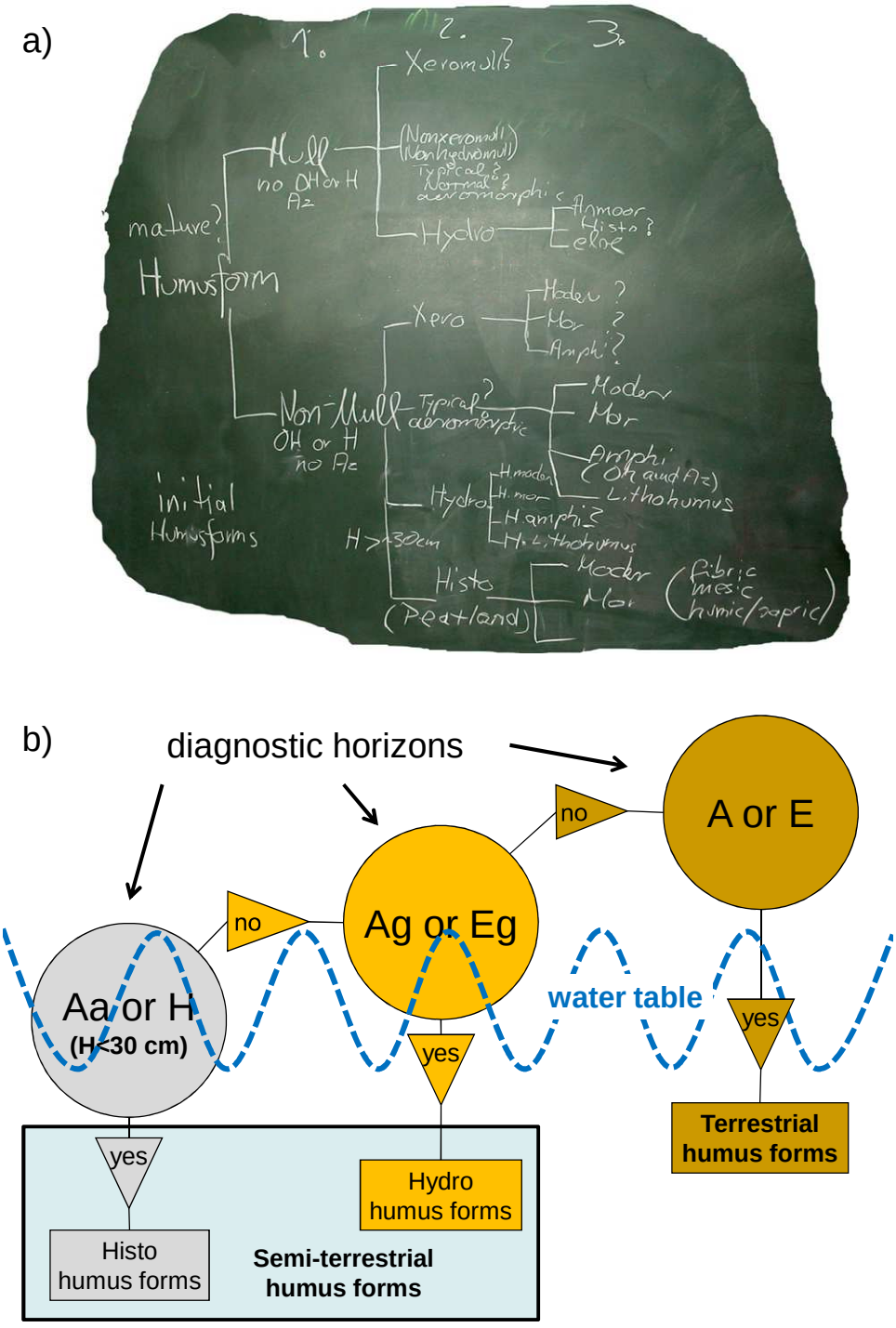

Figure 2. Water table level and mineral diagnostic horizons for semi-terrestrial and terrestrial humus forms. a) Historical blackboard in San Vito di Cadore, on July 2005: three main levels of classification, according to the main ecological factors (temperature, water and biological component) and many question marks. b) Present-day position: "first was the water". Aa = anmoor A; H = organic histic horizon; Ag = hydromorphic A; Eg = hydromorphic E; A = organo mineral horizon; E = mineral horizon (eluviation, podzolization).

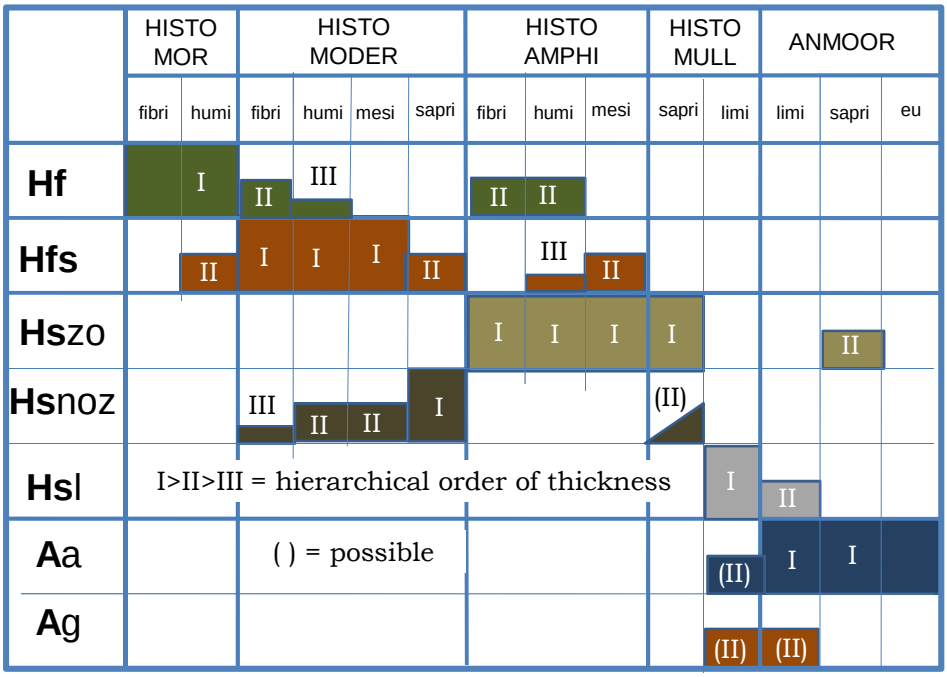

Figure 3. Synoptic table of HISTO humus forms classification. Hf = fibric H; Hfs = fibric-sapric H; Hsnoz= sapric non zoogenous H; Hszo = sapric zoogenic H; Hsl = sapric-limnic H; Aa = anmoor A; Ag = hydromorphic A.

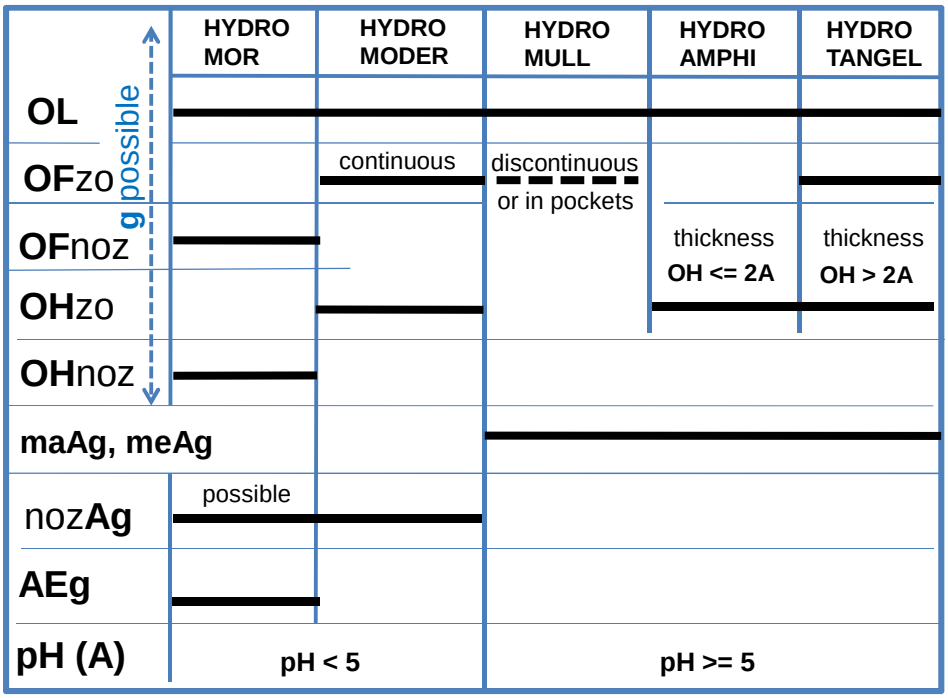

Figure 4. Synoptic table of HYDRO forms classification. OL, OF, OH = organic horizons; A = organo-mineral horizon; E = mineral horizon; zo = zoogenous; noz = non zoogenous; ma = macrostructured; me = mesostructured; g = hydromorphic. The pH is measured in water.

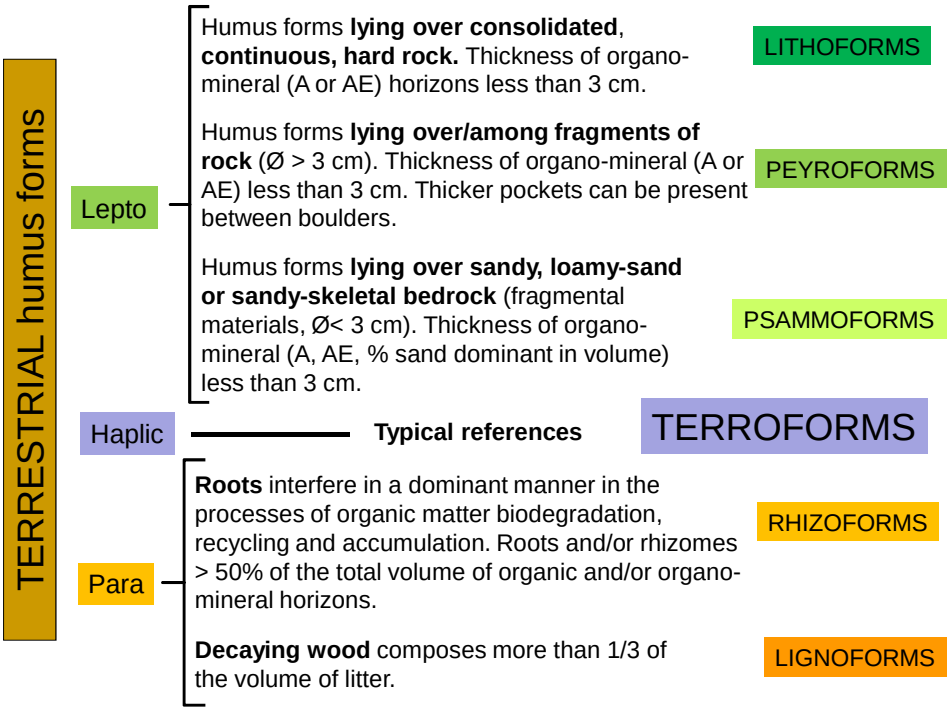

Figure 5. Terrestrial humus forms subdivision based on strongly expressed morphological properties.

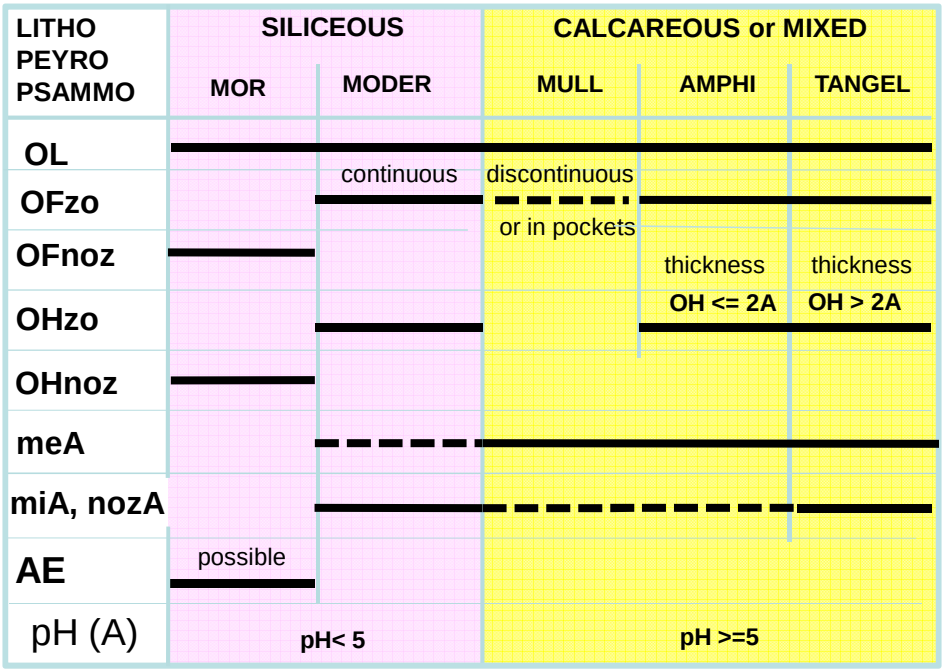

Figure 6. Initial terrestrial forms on siliceous or calcareous substrates. OL, OF, OH = organic horizons; A = organo-mineral horizon; E = mineral eluvial horizon; zo = zoogenous; noz = non zoogenous; me = mesostructured; mi = microstructured.

RHIZOMULL = MULL with roots dominant in the A horizon. Roots (essentially from grasses) and earthworms coact in producing the A horizon (at least in the first top centimeters) an aereated mesostructure with a light consistence. Typical under pastures, especially at high altitude/latitude.

RHIZOMODER, RHIZOMOR, RHIZOTANGEL = FORMS with organic horizons very rich in roots and/or rhizomes (> 50% of the total volume of organic horizons, OL+OF+OH).

RHIZOAMPHI = Amphi with roots dominant in O and/or A (roots and/or rhizomes > 50% of the total volume of organic and/or hemorganic horizons , OL+OF+OH and/or A).

LIGNO is used as prefix when decaying wood composes more than 1/3 of the volume of litter: **LIGNOMULL (rare but possible), LIGNOMODER, LIGNOAMPHI, LIGNOMOR, LIGNOTANGEL**

Figure 7. Rhizo- humus forms. OL, OF, OH = organic horizons.

2. The European Humus Forms Classification

The first general principles of a European classification of terrestrial haplic forms have now been finalized (Figs. 8, 5). Protocols for the assessment and sampling of organic and organo-mineral horizons are set up as well as definitions of the different kinds of organic and mineral horizons and their designation. The *recognizable remains* are separated from *humic* and *mineral components.* In fact, the Babel (1980) definition of "fine organic matter", used in other systems of humus forms classification, did not work in an efficient way in order to describe the organic horizons with an appreciable content of large organo-mineral large structures (earthworm faeces). The definitions of *zoogenic* and *non zoogenic materials* allow to better differentiate between some key diagnostic horizons, improving the field estimate of the part of the organic matter degraded by fungi. Concerning Histo forms, *fibric* and *sapric components* of the horizons were defined.

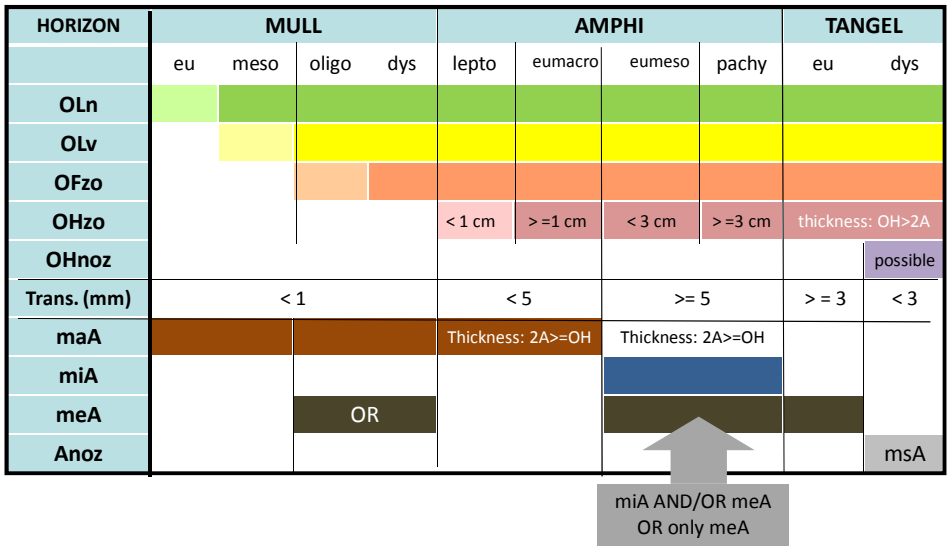

Figure 8. Terroforms on calcareous or lithologically mixed substrates. OL, OF, OH = organic horizons; n = new litter; v = old litter; A = organo-mineral horizon; zo = zoogenous; noz = non zoogenous; ma = macrostructured; me = mesostructured; mi = microstructured; Trans. (mm) = transition between organic and organo-mineral horizons (millimeters).

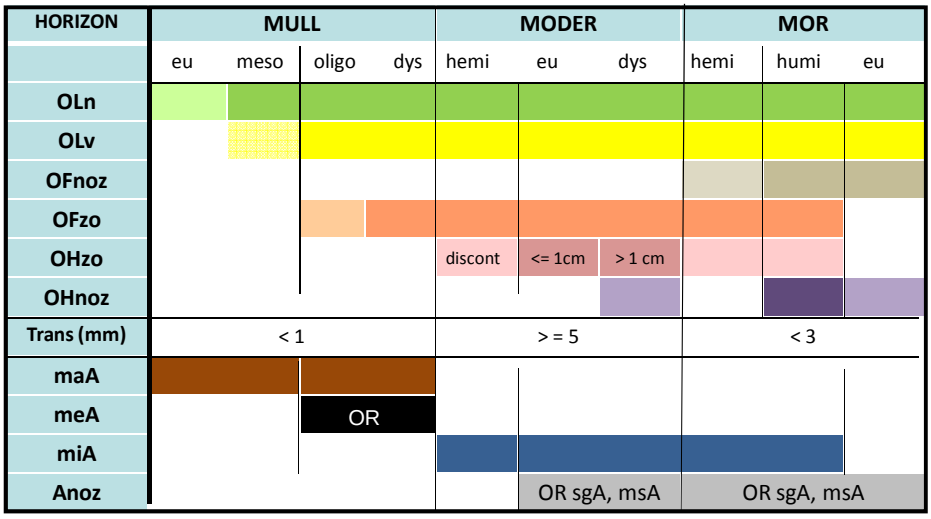

Figure 9. Terroforms on acid siliceous substrates . OL, OF, OH = organic horizons; n = new litter; v = old litter; A = organo-mineral horizon; zo = zoogenous; noz = non zoogenous; ma = macrostructured; me = mesostructured; mi = microstructured; Trans. (mm) = transition between organic and organo-mineral horizons (millimeters).

The Humus Group considers the key of the humus forms classification as its common endeavour, a contribution to the understanding of ecosystem functioning (Fig. 10) and of nutrients cycling, and may introduce humus forms classification as a diagnostic tool for assessing the ecosystem health status. The Humus Group sees the description and the study of humus forms as a tool to characterize ecosystems or biotic communities, which evolve together in response to environmental factors, and humus forms may be indicative for these (Ponge, 2003). We see the very abstract and simplistic procedure of humus forms classification as our common and demanding task, which makes sense only within a functional approach. An effort was done for translating field data (Sartori et al., 2004) and present knowledge (humus forms structure and ecology) in graphical models or tables allowing to use these concepts in ecological procedures. Groups of animals were associated to diagnostic horizons and humus forms (fig. 11).

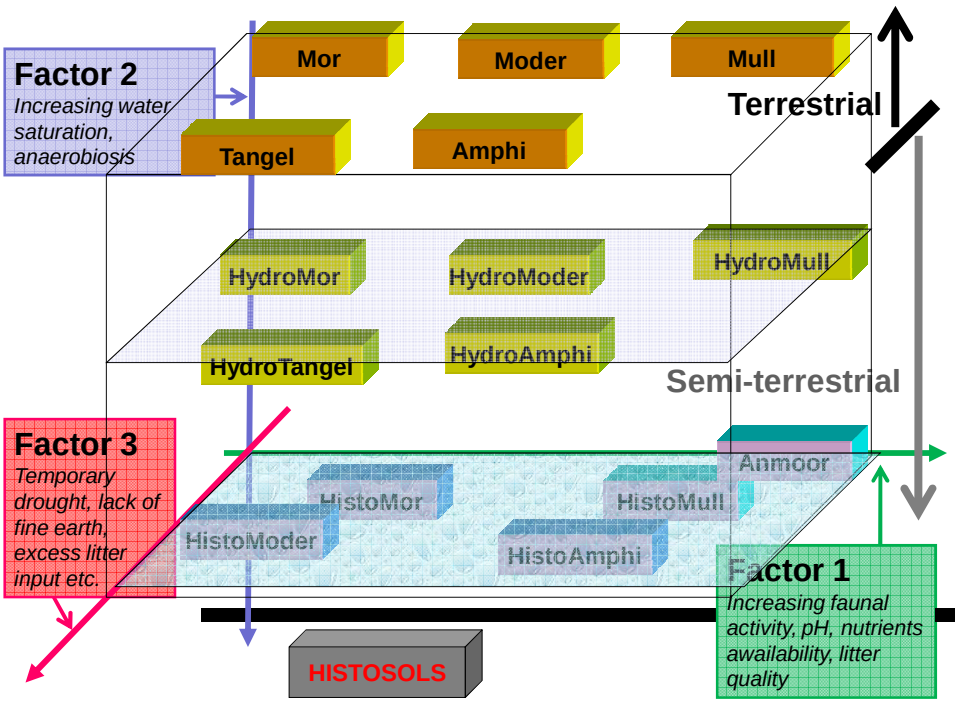

Figure 10. Eco-diagram for humus formation.

3. Issue

The publication is perceived by the Humus Group as a forum which allows us to introduce the wider scientific community to our work and to further our efforts towards an internationally agreed classification and standardization of defined humus forms. To achieve these goals the paper is organized as following:

- Introduction and general synoptic tables of humus forms classification.
- Terro forms and Histo forms classification.

- Vocabulary, definition of main horizons, synoptic tables for field classification. A biological point of view is also given for linking bio-degraders and structure of the main diagnostic horizons.
- Functional aspects.
- Practical value of the delivered classification.

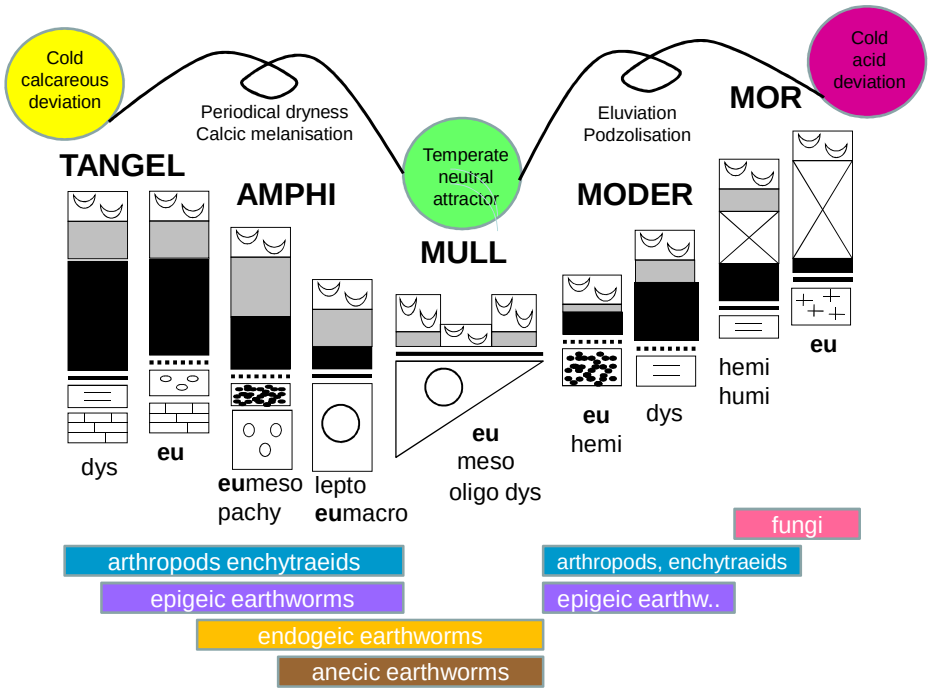

Fig. 11. Ecological attractors and humus forms. The scheme shows a chained list of horizons and actors of biodegradation.

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