Applied Soil Ecology 122 (2018) 75–86

Contents lists available at ScienceDirect

Applied Soil Ecology

journal homepage: www.elsevier.com/locate/apsoil

Applied Field Research Article

Humusica 1, article 5: Terrestrial humus systems and forms — Keys of classification of humus systems and forms☆

Augusto Zanella[a,*], Jean-François Ponge[b], Bernard Jabiol[c], Giacomo Sartori[d], Ekart Kolb[e], Renée-Claire Le Bayon[f], Jean-Michel Gobat[f], Michaël Aubert[g], Rein De Waal[h], Bas Van Delft[h], Andrea Vacca[i], Gianluca Serra[j], Silvia Chersich[k], Anna Andreetta[l], Raimo Kõlli[m], Jean Jacques Brun[n], Nathalie Cools[o], Michael Englisch[p], Herbert Hager[q], Klaus Katzensteiner[q], Alain Brêthes[r], Cristina De Nicola[s], Anna Testi[s], Nicolas Bernier[b], Ulfert Graefe[t], Ugo Wolf[l], Jérôme Juilleret[u], Andrea Garlato[v], Silvia Obber[v], Paola Galvan[w], Roberto Zampedri[x], Lorenzo Frizzera[x], Mauro Tomasi[y], Damien Banas[z], Fabrice Bureau[g], Dylan Tatti[h], Sandrine Salmon[b], Roberto Menardi[a], Fausto Fontanella[a], Vinicio Carraro[a], Diego Pizzeghello[a], Giuseppe Concheri[a], Andrea Squartini[a], Dina Cattaneo[a], Linda Scattolin[a,1], Serenella Nardi[a], Gianni Nicolini[A], Franco Viola[a]

[a] University of Padua, Italy
[b] Museum National d'Histoire Naturelle, Brnoy, France
[c] AgroParisTech, Paris, France
[d] MUSE - Museo delle Scienze, Trento, Italy
[e] Technical University of Munich, Germany
[f] University of Neuchâtel, Switzerland
[g] Normandie Univ, UNIROUEN, IRSTEA, ECODIV, 76000 Rouen, France
[h] Bern University of Applied Sciences, Zollikofen, Switzerland
[i] University of Cagliari, Italy
[j] Freelance Researcher, Cagliari, Italy
[k] Freelance Researcher, Milano, Italy
[l] University of Firenze, Italy
[m] Estonian University of Life Sciences, Tartu, Estonia
[n] Univ. Grenoble Alpes, Irstea, UR EMGR, France
[o] Research Institute for Nature and Forest, Geraardsbergen, Belgium
[p] Bundesamt für Wald, Vienna, Austria
[q] Universität für Bodenkultur, Vienna, Austria
[r] Office National des Forêts, Boigny-sur-Bionne, France
[s] Università La Sapieza, Roma, Italy
[t] Institut für Angewandte Bodenbiologie GmbH, Hamburg, Germany
[u] Luxembourg Institute of Science & Technology, Belvaux, Luxembourg, Luxembourg
[v] ARPAV, Agenzia Regionale per la Protezione e Prevenzione dell'Ambiente del Veneto, Treviso, Italy
[w] Freelance Researcher, Trento, Italy
[x] Research and Innovation Centre, Fondazione Edmund Mach (FEM), Trento, Italy
[y] Freelance Researcher, Bolzano, Italy
[z] Université de Lorraine, France
[A] Servizio Parchi, Provincia Autonoma di Trento, Italy

☆ Background music while reading: BEST Of Street Performers Musicians Singing – Amazing Top 10 Videos: https://www.youtube.com/watch?v=KznaS26xSTg.

* Corresponding author and not mentioned author of figures and photographs.
E-mail addresses: augusto.zanella@unipd.it (A. Zanella), ponge@mnhn.fr (J.-F. Ponge), bernard.jabiol@agroparistech.fr (B. Jabiol), giacomo.sartori@sfr.fr (G. Sartori), kolb@wzw.tum.de (E. Kolb), claire.lebayon@unine.ch (R.-C. Le Bayon), jean-michel.gobat@unine.ch (J.-M. Gobat), michael.aubert@univ-rouen.fr (M. Aubert), rein.dewaal@wur.nl (R. De Waal), bas.vandelft@wur.nl (B. Van Delft), avacca@unica.it (A. Vacca), lserra@tiscali.it (G. Serra), silvia.chersich@gmail.com (S. Chersich), anna.andreetta@unifi.it (A. Andreetta), raimo.kolli@emu.ee (R. Kõlli), jean-jacques.brun@irstea.fr (J.J. Brun), Nathalie.COOLS@inbo.be (N. Cools), michael.englisch@bfw.gv.at (M. Englisch), herbert.hager@boku.ac.at (H. Hager), klaus.katzensteiner@boku.ac.at (K. Katzensteiner), alain.brethes@orange.fr (A. Brêthes), kridn@libero.it (C. De Nicola), anna.testi@uniroma1.it (A. Testi), bernier@mnhn.fr (N. Bernier), ulfert.graefe@ifab-hamburg.de (U. Graefe), ugo.wolf@unifi.it (U. Wolf), jerome.juilleret@list.lu (J. Juilleret), agarlato@arpa.veneto.it (A. Garlato), obbber@arpav.it (S. Obber), paola.galvan@gmail.com (P. Galvan), roberto.zampedri@fmach.it (R. Zampedri), lorenzo.frizzera@fmach.it (L. Frizzera), tomasi@panstudioassociato.eu (M. Tomasi), damien.banas@univ-lorraine.fr (D. Banas), fabrice.bureau@univ-rouen.fr (F. Bureau), dylan.tatti@bfh.ch (D. Tatti), sandrine.salmon@mnhn.fr (S. Salmon), roberto.menardi@unipd.it (R. Menardi), fausto.fontanella@unipd.it (F. Fontanella), vinicio.carraro@unipd.it (V. Carraro), diego.pizzeghello@unipd.it (D. Pizzeghello), giuseppe.concheri@unipd.it (G. Concheri), squart@unipd.it (A. Squartini), dina.cattaneo@unipd.it (D. Cattaneo), serenella.nardi@unipd.it (S. Nardi), gianni.nicolini@alice.it (G. Nicolini), franco.viola@unipd.it (F. Viola).

[1] Deceased.

http://dx.doi.org/10.1016/j.apsoil.2017.06.012
Received 21 December 2016; Received in revised form 7 May 2017; Accepted 16 June 2017
Available online 15 October 2017
0929-1393/

ARTICLE INFO

Keywords:
Humus
Humus systems
Humus forms
Humus classification
Terrestrial humus forms
Humusica

ABSTRACT

This article is an as simple as possible key of classification of terrestrial (aerobic, not submersed) topsoils (organic and organic-mineral series of soil horizons). Based on the introduction exposed in Humusica 1, article 1, and using vocabulary and definitions listed in article 4, a classification is proposed for better understanding the biological functioning of the soil, partially disclosing the process of litter digestion. Five types of terrestrial topsoils, called terrestrial humus systems, are described and illustrated with the help of photographs. Within each humus system, 3–4 humus forms are also revealed, corresponding to similar series of soil horizons generated in a relatively homogeneous environment whose range of ecological factors is not so large to overstep and cause the genesis of another different humus system. The article ends with a figure that shows the relationship between Tangel and Amphi humus systems, and a dichotomous key of classification that one can easily print and bring in the field for practicing humus classification.

Foreword

Even if published as an independent article, if you are not accustomed to soil or humus field classification, this paper lacks of basic information you can find in:

Humusica 1, Article 1: Essential bases – Vocabulary (Soil and humus profiles and horizons, Humus systems and forms classifications, historical overview…);

Humusica 1, Article 3: Essential bases – Quick look at the classification (for beginners);

Humusica 1, Article 4: Terrestrial humus systems and forms – Specific terms and diagnostic horizons.

Humusica recovers keys of classification published in preceding works (Zanella et al., 2011a,b; Jabiol et al., 2013), which are still valid but incomplete. Here an enlarged group of authors updated the old units, created few new references and better illustrated the whole.

1. Key of classification of humus SYSTEMS

On a morpho-functional basis, Terrestrial humipedons are subdivided in five systems (Mull, Moder, Amphi, Mor and Tangel), hereafter identified and described based on diagnostic features.

Essential legend (complete definition in Humusica 1, art. 4): biomacro A = biomacrostructured A horizon; biomeso A = biomesostructured A horizon; biomicro A = biomicrostructured A; zoOF or OF = zoogenic OF horizon; nozOF = non zoogenic OF horizon. OH = implied zoOH (zoogenic OH) and/or possible szoOH (slightly zoogenic OH) horizons.

Caution: “and” written at the end of a phrase means that the exposed preceding diagnostic criteria are not sufficient and need to be completed with others; “or” reported between criteria allows to select among them. The sign “;” is used between two sentences and indicates that the process of classification is not finished.

1.1 Mull

To be identified as Mull, a topsoil must display the following properties:

1) absence of any OH horizon; and
2) presence of biomacro A;

or

2) Presence of biomeso A and at least two of the following:

- presence in the A horizon of living earthworms or their casts, except in frozen or desiccated soil;
- presence of a very sharp transition (< 3 mm) between organic and organic-mineral horizons;
- pHwater of the A horizon ≥ 5.

Correct lecture/interpretation for Mull:

1) must be without OH horizon and
2) must show biomacro

or

2) biomeso A horizon and two of the listed three criteria.

1.2 Moder

To be identified as Moder, the topsoil must display the following properties:

1) presence of an OH horizon (even if sometimes discontinuous); and
2) absence of nozOF; and
3) absence of biomacro A; and one of the following:

- no sharp transition OH/A horizon (transition ≥ 5 mm);
- pHwater of the A horizon < 5;

or

3) presence of biomeso A or biomicro A, or A single-grain or (rare, in case of intergrades to Mor) A massive, and one of the following:

- no sharp transition OH/A horizon (transition ≥ 5 mm);
- pHwater of the A horizon < 5.

1.3 Amphi

To be identified as Amphi, the topsoil must display the following properties:

1) simultaneous presence of OH and biomacro or biomeso A horizons; and
2) absence of nozOF; and
3) thickness of A horizon ≥ thickness of ½ OH horizon; and
4) absence of massive or single-grain A; and
5) presence of biomacro A and one of the following: