FRACTIONAL HUMUS INVESTIGATION OF SOILS UNDER SWARD COMMUNITIES (FESTUCETUM VAGINATAE DANUBIALE, FESTUCETUM WAGNERI) GROWING ON SANDY SITES

by

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Introduction

On the sandy forest steppe sites of the nature conservation area at Csévharaszt investigations are in progress on the production and humification of communities showing different stages of succession. This work is being carried out in the framework of the International Biological Program (IBP).

As a first step, together with other soil factors (pH, hy, $CaCO_3$, total N content and soluble Ca, Na, K), the differences were registered, which manifested themselves in the total humus content of soils of the successional series. It turned out that due to higher cover degrees of the sward the humus content of the soil increases (Fig. 1).

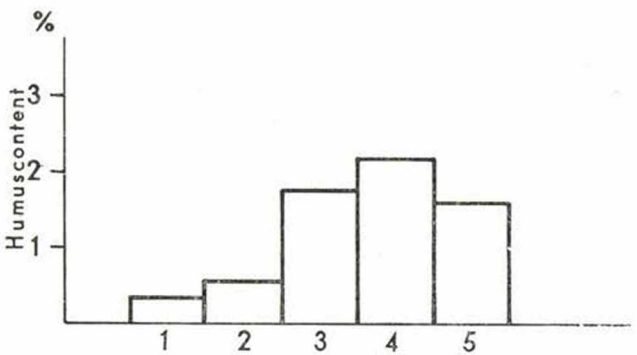

Fig. 1. Humuscontent of soils of sandy communities

1. Festucetum vaginatae fumanetosum
2. Festucetum vaginatae danubiale
3. Festucetum vaginatae holoschoënetosum
4. Festucetum sulcatae
5. Junipero – Populetum

Fractional humus investigations yield more detailed information on humification (cf. Stefanovits 1963), because the quantities of the various humus fractions are correlated with soil conditions and, in the authors opinion, with the developmental degree of plant communities.

The investigations covered the soil of two types (the "nudum" type and the *Tortella inclinata* synusium) of *Festucetum vaginatae*, representing the initial stage of this open perennial sandy sward, and the soil of *Festucetum wagneri*, which is a hitherto scarcely studied sward community of sandy steppe meadows becoming successively closed.

The fractioning of humus substances was performed by applying Na-pyrophosphate solutions of different pH (Bremner 1949, Aleksandrova 1960, Kononova – Belchikova 1961, Kononova 1963, Duchaufour – Jacquin 1963) which permitted the separation of fine fractions.

Na-pyrophosphate induces an irreversible exchange process among the cations. This results in the formation of soluble humus, Al-humus and Fe-humus substances by applying sequentially the solvant of different pH, the compounds may be separated.

Materials and Methods

As material for fractional humus investigations 10 – 10 soil samples were collected from the stands of sandy swards in May 1967. In Hungary the weight of each sand sample must not be less than 10 g. Fractioning was carried out according to Duchaufour – Jacquin – Stefanovits.

I. For the separation of the organic matter a mixture of bromoform and alcohol was used, with a specific weight of 2. In the course of segregation the than 2 was separated by centrifugation from the mineral part of a specific weight higher than 2. The weight of both parts was established after drying at 105° C.

II. Extraction of humus substances

The vegetal and mineral parts of known weight and separated according to their density were submitted to sequential extraction. Due to the influence of 0.1n neutralized Na-pyrophosphate solvent (pH = 7) the free humus substances (fraction I) were obtained, while treatment with Na-pyrophosphate solution of pH 8.5 yielded humus substances which formed loose complexes with Fe and Al (fraction II), and applying 0.1n NaOH resulted in fraction III which consisted of humus substances bound tightly to the mineral parts.

Subsequently in each fraction the dissolved fulvic and humic acids were segregated from one another. In this way from each soil sample 10 fractions were obtained (= the humic and fulvic acids of the vegetal part after two pyrophosphate treatments, as well as the humic and fulvic acids of the mineral part as the result of two pyrophosphate and one NaOH treatment). In all fractions the quantity of humus substances was established by oxidizing with potassium bichromate according to Turin.

The total humus content of the soils was also established according to Turin's method.

Results

In the examined area the original plant cower and the secondary communities the sandhills showed a diversified arrangement. Among the dunes, in the fairly wet depressions, which used to be moor spots in the last century, presently an open sandy sward *Festucetum vaginatae* (A) with a very rich moss layer can be found.

Salix rosmarinifolia and *Holoschoenus romanus* appear in large quantities here and in the profile of this site the traces of high gley formation can be observed even to-day.

The plants of the perennial open sward have invaded during the successive drying-out and are mixed now with hygrophilous species, remainders of the earlier moors. The moss-lichen layer is characterized by *Tortella inclinata* and *Ceratodon purpureus* thriving abundantly.

On the sand which covers the side of depressions, and somewhat higher, at the base and top of the dunes – the typical *Festucetum vaginatae* (B) may be found, which – in so-called "plakor" position – develops to closed sandy steppe meadow – *Festucetum wagneri* (C) – in the course of succession (Fig. 2). The examination and coenological evaluation of this community is in progress (H o r á n s z k y ined.).

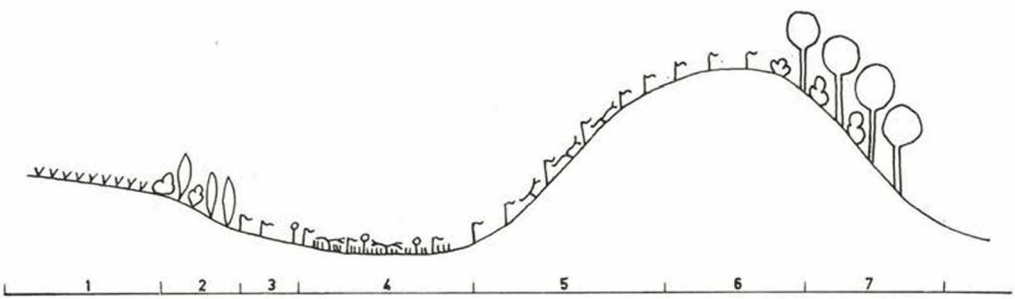

Fig. 2. Profil – diagram of Plant communities in the area examined near Csévharaszt

1. Festucetum Wagneri
2. Junipero – Populetum
3. Festucetum vaginatae danubiale
4. Festucetum vaginatae holoschoënetosum
5. Festucetum vaginatae fumanetosum
6. Festucetum vaginatae danubiale
7. Convallario – Quercetum

The two types of the open perennial sandy sward investigated by the author differ from each other both in their species composition and in the quantity of the constituent species. The richness of the moss layer in the *Tortella* synusium of depression feature is particularly conspicuous (Table I, A, B).

The moss layer of *Festucetum wagneri* is less developed, and, in comparison to the former this community has remarkably fewer species (Table I, C).

Table I.

Zürich – Montpellier surveys of 2 types of Festucetum vaginatae (A, B) and Festucetum wagneri (C)

	A	B	C
Cover of herbs layer	65 – 70	60 – 70	80 – 90
Festuca vaginata	1 – 2	2 – 3	– +
Koeleria glauca	1 – 2	1	+ – 1
Euphorbia seguieriana	+ – 1	1 – 2	– +
Potentilla arenaria	+ – 1	1	– +
Carex liparicarpos	+ – 2	1 – 2	+
Minuartia verna	+ – 1	– +	– +
Fumana procumbens	– +	– +	
Alkanna tinctoria	– +	+	
Medicago minima	– +	– +	
Helichrysum arenarium	– +	+	
Alyssum tortuosum	– +	+ – 1	
Onosma arenaria	+ – 1	– +	
Centaurea arenaria	– +	1 – 2	
Dianthus serotinus	+	+ – 1	
Knautia arvensis	– +	– +	
Teucrium chamaedrys	+ – 1	+	
Alyssum montanum ssp. gmelini	– +	– +	
Silene otites	+ – 1	+ – 1	
Gypsophila paniculata	– 1	+	
Gypsophila arenaria	– +	+ – 1	
Silene conica	– +	– +	
Veronica spicata	+ – 1		+ – 1
Verbascum lychnitis	+		– +
Rumex acetosella	+		– +
Stipa sabulosa		1 – 4	1 – 3
Eryngium campestre		+ – 1	– 1
Equisetum ramosissimum		– +	+
Cynodon dactylon		– +	– +
Salix rosmarinifolia	3 – 4		
Holoschoenus romanus	+ – 2		
Lotus corniculatus	1		
Dianthus pontederae	+ – 1		
Hieracium bauhini	+ – 1		
Poa angustifolia	+ – 1		
Viola arenaria	+ – 1		
Dianthus diutinus	+		
Epipactis atrorubens ssp. borbásii	+		
Asperula cynanchica	– +		
Astragalus austriacus	– +		
Astragalus varius	– +		
Calamagrostis epigeios	– +		
Cytisus ratisbonensis	– +		
Festuca pseudovina	– +		
Hieracium umbellatum	– +		
Linaria angustifolia	– +		
Lithospermum officinale	– +		
Medicago falcata	– +		
Phleum phleoides	– +		
Polygala comosa	– +		
Populus canescens	– +		
Secale silvestre	– +		

	A	B	C
Stachys recta	− +		
Trifolium arvense	− +		
Viola kitaibeliana	− +		
Artemisia campestris		1 − 2	
Stipa capillata		1 − 2	
Euphorbia cyparissias		1	
Scabiosa ochroleuca		1	
Achillea kitaibeliana		+ − 1	
Erysimum diffusum		+ − 1	
Polygonum arenarium		+ − 1	
Thymus glabrescens		+ − 1	
Tragopogon floccosus		+ − 1	
Cerastium semidecandrum		+	
Solidago virga-aurea		+	
Arebarua serpyllifolia		− +	
Astragalus onobrychis		− +	
Bromus tectorum		− +	
Colchicum arenarium		− +	
Echinops ruthenicus		− +	
Ephedra distachya		− +	
Iris arenaria		− +	
Kochia laniflora		− +	
Linum hirsutum ssp. glabrescens		− +	
Lithospermum arvense		− +	
Minuartia setacea		− +	
Poa bulbosa		− +	
Festuca wagneri			4 − 5
Galium verum			− 1
Allium sphaerocephalum			− +
Crepis rhoeadifolia			− +
Cynoglossum hungaricum			− +
Mossis layer			
Cover of mossis layer	30 − 45	10 − 15	20
Tortella inclinata	2		
Cladonia pyxidata	1		
Hypnum cupressiforme	+ − 1		
Cladonia rangiformis	− 1		
Camptothecium lutescens	− +		
Syntrichia ruralis	2	1	
Cladonia foliacea	+ − 1	+	+
Cladonia furcata	− 1		+ − 1
Cladonia magyarica			1 − 2
Diploschistes praematricus			+

Table II.

The percentage of vegetal parts in the different series

Series	Vegetal parts segregated with bromoform
A Festucetum vaginatae, Tortella inclinata syn.	3.73%
B Festucetum vaginatae nudum	2.67%
C Festucetum wagneri	2.71%

The physiognomical differences in the vegetation are also coupled with finer dissimilarities of soil properties. The soil of the open sandy sward which lies deeper and wich is covered with *Tortella* turned out to be somewaht more acidic, showing a pH-value (in H_2O) of 6.3, while the pH values (measured in water) of the soil of *Festucetum vaginatae* nudum and that of the more closed *Festucetum wagneri* were 6.7 and 6.7 to 7.1 respectively.

During the closing process of the sward the total humus content increases. In the mossy community the half decomposed vegetal parts of a smaller specific weight obtained by segregation with alcohol-bromoform and the humus substances attached to them were present in a considerably larger.

Table III reveals that the bulk of soluble humus in the soil of series "A" consists of organic matter independent of mineral parts and shows a soluble specific weight.

Table III.

C content of the humus fractions obtained in the course of segregation and related to the soil

Series	Fractions		
	I	II	III
A			
Festucetum vaginatae, Tortella synusium			
vegetal part	0.12%	0.15%	–
mineral part	0.06%	0.06%	0.16%
B			
Festucetum vaginatae nudum			
vegetal part	0.13%	0.09%	–
mineral part	0.19%	0.17%	0.22%
C			
Festucetum wagneri			
vegetal part	0.28%	0.28%	–
mineral part	0.34%	0.30%	0.24%

Hower, these is less soluble humus than in the other two series, chiefly in comparison to the total amount of the components with reduced density (Table IV).

Table IV.

C content of the vegetal fractions segregated with bromoform and related to the vegetal parts

Series	Fractions	
	I	II
A	3.22%	3.89%
B	4.50%	4.40%
C	10.40%	10.00%

Accordingly, in the soils of series "A" the decomosing but not yet humified organic matter dominates, supplied probably by the richer moss layer. The soils of series "B" and "C" are poorer in organic matter of smaller specific weight, but the greater part of it, especially that from the soil of Festucetum wagneri, is soluble.

The loosely bound fractions segregated with the mineral parts of a specific weight ob ove 2 are represented by a conspicuously small quantity in the soil of the *Tortella* synusium, but this amount increases with the advanced clocure of the sward.

As to the proportion of the fulvic and humic acids it may be seen that among the humus substances found in the densely moss-covered soils of series "A" the fulvic acids dominate, both in the fractions of reduced density and in those wich go into solution together with the mineral parts. On the other hand, the soils of the stands "B" and "C" contain more humic acids indicating advances humification.

The proportion of fulvic and humic acids is shown in Fig. 3.

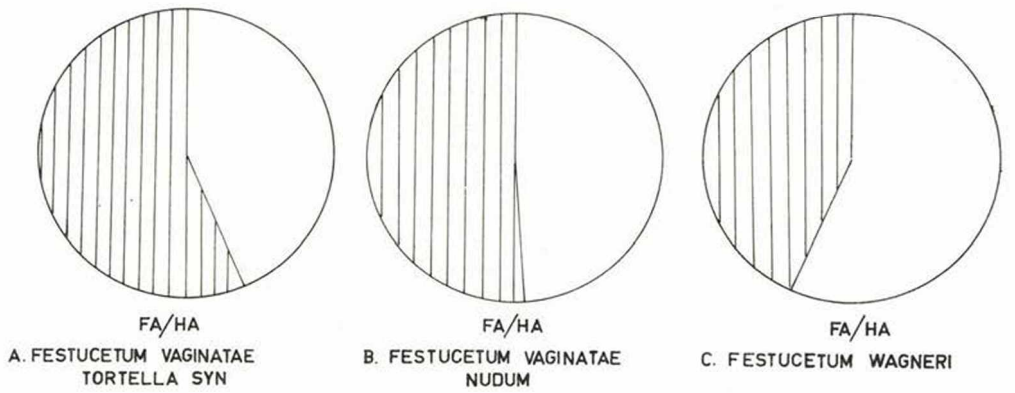

Fig. 3. Fulvie acid humic acid ratio in % obtained from different communities

The sward of the moist, moss-covered soil in the depressions produces more acidic litter, and the supply of decomposing organic matter is more uniform, too. It yields chiefly fulvic acids. the greatest part of which becomes also disintegrated due to steady breakdown.

In the soil of the swards *Festucetum vaginatae* and *Festucetum wagneri* wich occupy the higher sites an inactive period of breakdown takes place in the dry summer season. The disintegration of primary humus compunds ceases, they become converted into humic acids, showing the dynamics steppe, type.

REFERENCES

Александрова, Л. Н. 1960: О применении пирофвсфата натрия для выделения из почвы свободных гумусовых веществ и их органо-минеральных соединений. Почвоведение 2. 90–97.
(On an application of sodium pirophosphat to the isolation of free humus materials and their organo-mineral compound from soils).

Bremner, J. M. 1949. Studies on soil organic matter. – I. J. Agr. Sci. **39**: 183–193.
Duchaufour, Ph. – Jacquin, F. 1963. Recherche d'une méthode d'extraction et de fractionnement des composés humique controlée par l'électrophorése. – Annales Agronomiques. 855–918.
Fekete, Z. – Hargitai, L. – Zsoldos, L. 1964. Talajtan és agrokémia. (Pedology and Agrochemistry) – Budapest, Mezőgazdasági Kiadó.
Кононова, М. М. – Бельчикова; Н. П. 1961: Ускоренные методы опередения состава гумуса минеральных почв. Почвоведение IO. 75–87.
(Rapid methods for determining the humus status of mineral soils).
Коновова, М. М. 1963: Органическое вещество почв СССР. Изд. АнН. СССР. Москва. (Soil organic matter).
Simon, T. – Fülöp, A. 1966. A pH-érték és a humusztartalom periodikus változása Festucetum vaginatae danubiale állományokban a Szentendrei szigeten. – (Periodical changes of the pH value and the humus content in the stands of Festucetum vaginatae on the Szentendre island). Bot. Közlem. **53**: 35–41.
Simon, T. – Kovács-Láng, E. 1964. Relationship of plant communities and soil types on the nature conservation area of Csévharaszt. – Acta Biol. Acad. Sci. Hung. Suppl. **6**: 25–26.
Simon, T. – Kovács-Láng, E. 1968. A humuszprodukció frakcionált vizsgálata homoki pionir növénytársulás talajában. (Fractional examination of humus production in the soil of sandy pioneer plant community). – A VIII. Biol. Vándorgyűlés előadásai, Budapest. p. 12. (Lectures of the 8^{th} Biological Itinerary Congress).
Soó, R. 1964. A magyar flóra és vegetáció rendszertani és növényföldrajzi kézikönyve. I. Synopsis systematico-geobotanica florae vegetationsque Hungariae. I. Budapest, Akadémiai Kiadó.
Stefanovits, P. 1963. Magyarország talajai. (The soils of Hungary) – Budapest, Akadémiai Kiadó.