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A PRELIMINARY ANALYSIS OF RELATIONS BETWEEN PHYSICAL, CHEMICAL AND BIOTIC FACTORS IN HYDROGENIC SOILS

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S y n o p s i s. Some physical properties (such as the degree of mucking, muck depth, volumetric density, total porosity, moisture content), together with some chemical properties, (such as the value of absorbance λ_{280}, λ_{664}, the content of exchangeable basic cations bound to the sorption complex, the content of hydrogen and organic carbon), and the biotic properties, (such as the number of microflora: amonificators, Actinomycetes and microorganisms using mineral nitrogen, and the biomass of invertebrates: saprophages, phytophages, predators) have been studied on meadow-sites situated on peat soils of differentiated peat origin and the period of dehydration. It has been observed that the studied properties differentiated the studied environments in a statistically significant way, and that the changes are correlated with the gradient of mucking.

INTRODUCTION

Dehydration and meadow management on low-bog peat sites causes physical and water changes in the soil [1,2] as well as changes in its chemical composition [5-8] and biotic structure [3,4]. The rate of these changes depends on the peat origin. Differences result also from a biocenotic succession that takes place after dehydration.

The aim of the present paper is to establish whether: 1) the basic physical, chemical and biotic properties are interrelated and act as a whole in meadow-sites on hydrogenic soils of differentiated degrees of changes, i.e. whether the variability of these properties differentiates these sites, and whether the changes of the above mentioned properties are the same in different sites, and 2) what are the relations between physical, chemical and biotic properties of hydrogenic soils.

MATERIALS AND METHODS

The present paper was based on published materials or materials that are ready for publication describing the same sites. Six sites in the Biebrza valley and in the Narew valley of differentiated peat origin (moss, sedge, and umbelliferous) simultaneously dehydrated or on sedge peat differentiated by the time of dehydration (1-3, 15-20, 20-25 and over 100 years). Such physical properties as: a degree of mucking, muck depth, volumetric density, total porosity were taken into account. Such chemical properties as: the value of absorbance of λ_{280}, λ_{664} of 0.5 M alcalic soil solution, the content of basic exchangeable cations bound to the sorption complex and hydrogen, the content of organic carbon, and such biotic properties as: the number of microflora, that is the number of amonificators. Actinomycetes and organisms using mineral N, as well as the biomass of invertebrates from different trofic layers, i.e. saprophages- disintegrators, saprophages- humificators, phytophagous organisms and predators were also considered.

All the studied material was analyzed by means of non-parametric statistical tests. To evaluate the differentiation of environments by these parameters a Friedman test was used; and to evaluate a consistency of changes of the parameters in the studied environments - the consistency test W by Kendall, whereas relations between individual parameters were analyzed by means of a T Kendall's test.

RESULTS

Basic physical and water properties of the soils

The studied sites are localized on peat and muck soils of differentiated degrees of mucking, and with differentiated structures of peat in the deeper layers of soil profiles. These soils are characterized by a low content of organic substance rarely exceeding 20% absolute m.d. and low volumetric density up to 0.3-0.4 g cm^{-3} in the strongly mucked layers of peat. The total porosity ranges from 75 to 90% of the volume. Average moisture content of the soil is distinctly differentiated that is from 60 to 80% in the soil layer from 0 to 10 cm.

On the soils where peat is of different origins these parameters are in agreement with the degree of mucking, whereas on sedge peat of differentiated dehydration periods the tendecies are less obvious and clear (Tab. 1).

Table 1

Physical and water properties of peat soils

Properties	Soils of different peat origins simultaneously dehydrated			Soils on sedge peat dehydrated in different periods of time		
	Wizna[A]	Wizna[B]	Wizna[C]	Lipniki	Biebrza	Modzelówka
Degree of mucking	Mt I aa	Mt I bb	Mt II cc	Mt I bb	Mt II bc	Mt III c
Muck depth, cm	18	19	24	18	19	28
Bulk density, g cm^{-3}	0.206	0.208	0.236	0.20	0.25	0.4
Total porosity, %	80	85	90	90	85-90	75-80
Moisture content, % at the depth 0-10 cm	79.55	78.28	59.42	62-77	69-75	70-73

A,B,C - different moisture content complexes.
Mt I, II, III - different degree of mucking.
aa, bb, cc, bc, c - scales within the degree.

Table 2

Chemical properties of peat soils

Properties	Soils of different peat origins simultaneously dehydrated			Soils on sedge dehydrated in different periods of time		
	Wizna[A]	Wizna[B]	Wizna[C]	Lipniki	Biebrza	Modzelówka
C org	10.2	11.6	18.6	15.6	10.4	15.4
A 280	3.56	3.24	7.63	7.13	3.60	6.52
A 664	0.044	0.048	0.121	0.108	0.056	0.196
S meq/100 g	134.2	136.4	149.2	101.6	142.3	-
Hw/100 g	43.7	37.5	45.4	34.6	51.1	-

Chemical properties of the soils

All the analyzed chemical parameters of the studied sites appeared to be very differentiated (Table 2). The value of λ_{280} absorbance, which shows the contribution of lignin-type compounds in the soil extract ranged from 3.24 to 7.63, and the value of λ_{664} absorbance, that showed the contribution strongly coloured humus substances in the alcalic soil extract ranged from 0.044 to 0.196. The value of the above parameters increases together with the increase of the degree of mucking in the soils originating from different types of peat, the tendency to increase was also observed in the values of these parameters in the soils from sedge peat with the increase of the period of time from the dehydration. The number of alcalic cations exchangeably bound to the soil sorption complex was from 100 to 150 μeq in 100 g of the soil, and the content of organic carbon from 10 to 15%. These values show the same tendencies towards changes as the values of absorbance.

Biotic properties of the environments

Biotic arrangements are different on the meadows on the soils formed from peats of different origins dehydrated simultaneously than on the meadows on sedge peat dehydrated in different periods of time (Table 3). In the former sites the number of physiological microflora elements is the highest on the umbelliferous peat and the lowest on sedge peat. Whereas invertebrates biomass decreases in the sequence: moss peat, sedge peat, umbellferous peat. In the latter case a tendency to the increase of changes both in the physiological groups of microflora and in the biomass of invertebrates from different trophic levels was observed in the sequence of sites on the sedge peat dehydrated in different periods of time that agreed with the time flow.

Relations in the pattern of physical, chemical and biotic parameters

A pattern of the analyzed physical, chemical and biotic parameters was specific for each of the studied sites, and differentiated these sites in a statistically significant way. The whole pattern of physical, chemical and biotic properties pointed to a greater distinctiveness of the soils of the same origin and different periods of dehydration (Friedman's test X^2=16.48, significance level = =0.001) than it was observed among the sites differentiated soil origins and the same time of dehydration (X^2=7.18, significance level =0.05). These differences may be well observed in the biotic pattern, whereas chemical and physical proper-

Biotic properties of peat soils

Properties	Soils of different peat origins simultaneously dehydrated			Soils on sedge peat dehydrated in different periods of time		
	Wizna[A]	Wizna[B]	Wizna[C]	Lipniki	Biebrza	Modzelówka
Microflora - population (10^6 g soil d.m.$^{-1}$)						
Amonificators	0.871	0.621	0.922	5.62	5.78	5.87
Actinomycetes	7.1	1.9	21.49	2.68	2.60	4.25
Soil invertebrates using mineral N - biomass, mg d.m.$^{-2}$	1.238	0.676	2.025	8.43	13.31	16.28
Small saprophages (a)	1068.8	703.1	672.8	442.0	1111.0	707.50
Huminificating saprophages (b)	13600.0	2600.0	600.0	2150.0	5230.0	18130.0
Phytophages	4798.9	3382.1	826.0	112.0	664.4	621.6
Predators	494.0	488.1	239.4	193.6	479.0	984.2

Table 4

Differentiation and similarities of changes in physical, chemical and biotic properties of meadows on peat. Statistical verification of results - environmental differentiation - Friedman's test, consistency of changes of the analyzed properties - W Kendall's test

Properties	Soils from peat of differentiated origin		Soils from sedge peat	
	Friedmans test	Kendall's test	Friedman's test	Kendall's test
Physical	x^2 = 10 s.l. = 0.00077	w = 1 s.l. = 0.01	x^2 = 3.48 s.l. = 0.355	w = 0.230 s.l. = n.s.
Chemical	x^2 = 7.6 s.l. = 0.024	w = 1 s.l. = 0.01	x^2 = 6.36 s.l. = 0.10	w = 0.424 s.l. = 0.05
Biotic	x^2 = 3.714 s.l. = 0.192	w = 0.044 s.l. = n.s.	x^2 = 10.028 0.005 s.l. 0.0005	w = 0.301 s.l. = 0.05
The whole arrangement	x^2 = 7.18 0.02 s.l. 0.05	w = 0.211 s.l. 0.05	x^2 = 16.48 s.l. = 0.001	w = 0.323 s.l. 0.01

Table 5

The relation between physical (z), chemical (y) and biotic (z_a - the number of microflora, z_b - biomass of invertebrae from different trofic levels of peat soils), x - coefficient of correlation rank by Kendall

	x	y	z	za	zb
Txy·z		0.930	+		
Txz·y		+	-0.461		
Tyz·x	+		-0.461		
Txy·za		0.873		+	
Txy·zb		0.930			+
Txza·y		+		0.168	
Txzb·y		+			
Tyzb·x					0.038
Tyza·x	+			0.168	
Tyzb·x	+				-0.461

ties differentiated mainly those sites that were of different peat origins, no matter what the time of their dehydration was, (Table 4).

All the physical, chemical and biotic properties are strictly interrelated which may be observed in their high co-changeability in the both analyzed sequences of sites (Table 4). This co-changeability was higher in the sequence of sites with differentiated dehydration periods (the W Kendall consistancy test W=0.323, the significance level =0.01) than in the sequence with differentiated peat origins (W=0.211, the significance level =0.05). The biotic arrangement does not show any clear consistency of changes of individual elements in both sequences of sites. The consistency of changes appeared only in the biomasses of trophic groups of soil invertebrates in the sites of the same peat origins and differentiated periods of dehydration. Whereas the changes in the patterns of chemical and physical properties are more harmonius, especially in the sites of differentiated peat origins.

The force of mutual conditioning of chemical, physical and biotic arrangements was tested by means of Kendall's partial rank correlation test by the sequential stabilization of the individual arrangements (Table 5). When the biotic properties were excluded, a high correlation between the physical and chemical arrangements was noticed (Txy·z=0.930). On the other hand the relations beween the biotic and physical arrangements, and the biotic and chemical arrangeents are similar and negative (Txz·y = Tyz x = -0.461). After microflora (z_a) nd soil invertebrates (z_b) got excluded from the biotic pattern, a very low dependence of microflora from the physical and chemical arrangements may be observed ($Txz_a \cdot y = Tyz_a \cdot x = 0.168$), and a considerably higher but negative relation between the invertebrates' biomass in trophic levels and the chemical properties ($Tyz_b \cdot x = -461$). It explains the fact that the changes of the organic matter in the peat soils expressed as the increase of the quantity of humus substances such as lignin, strongly coloured substances, basic cations exchangeably bound to the soil sorption complex and organic carbon depend, on one hand, on the rate of peat mucking and all the physical and water changes that accompany it, and, on the other hand, on the modifications caused by soil organisms. What is more, the changes in the number of physiological groups of microflora agree with the changes in the indices of organic matter disintegration; soil invertebrates expressed as the structure of biomasses on trofic levels stand in opposition to these changes, as their decreasing contribution in the gradient of mucking accelerates, and probably simpliefies, the rate of chemical changes.

CONCLUSIONS

1. Basic properties of the hydrogenic soils analyzed in the present paper, -physical, chemical and biotic, i.e. the number of physiological microflora groups and the structure of soil invertebrates biomasses, differentiate meadow sites localized on the soils from peats of different origins simultaneously dehydrated, as well as on sedge peat of varied dehydration time in a significant way from the point of view of the statistics. Changes of the whole arrangement of physical, chemical and biotic properties are interrelated in all the environments.

2. Physical properties of peat soils are highly correlated with chemical properties, and biotic properties as a whole are negatively related to physical and chemical properties. What is more, microflora and soil invertebrates react to the physical and chemical changes in a different way; microflora is positively dependant, whereas invertebrates' biomasses negatively.

3. Transformations in the organic matter in low peat bogs dehydrated and used as production meadows are realized mainly as the changes in the physical and water conditions. They are, nevertheless, modified by the biotic arrangement; all the microorganisms participate in these changes. The role of soil invertebrates is different as they probably oppose and complicate the rate of changes of the organic matter.

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WSTĘPNA ANALIZA ZALEŻNOŚCI CZYNNIKÓW FIZYCZNYCH, CHEMICZNYCH I BIOTYCZNYCH W GLEBACH HYDROGENICZNYCH

S t r e s z c z e n i e

W ciągu stanowisk łąkowych położonych na glebach torfowych różniących się genezą torfu oraz okresem odwodnienia analizowano niektóre właściwości fizyczne (stopień zmurszenia, głębokość murszu, gęstość objętościową, porowatość ogólną, wilgotność), chemiczne (wartość absorbancji λ_{280} i λ_{664}, zawartość związanych z kompleksem sorpcyjnym zasadowych kationów wymiennych i wodoru oraz węgla organicznego) i biotyczne (liczebność mikroflory: amonifikatorów, promieniowców i mikroorganizmów zużytkowujących azot mineralny oraz biomasy bezkręgowców glebowych: saprofagów, roślinożerców i drapieżców). Stwierdzono, że właściwości te różnicują statystycznie istotnie badane środowiska, a zmiany ich przebiegają współzależnie w gradiencie murszenia.

Й. Пенталь, Т. Хурски

ПОДГОТОВИТЕЛЬНЫЙ АНАЛИЗ ЗАВИСИМОСТЕЙ ФИЗИЧЕСКИХ, ХИМИЧЕСКИХ И БИОТИЧЕСКИХ ФАКТОРОВ В ГИДРОГЕНИЧЕСКИХ ПОЧВАХ

Р е з ю м е

На луговых постах, расположенных на торфяных почвах, различающихся происхождением торфа и периодом дегидратации, были анализованы следующие качества почв: физические (степень гумусообразования, глубина полуболотного гумуса, объёмная густота, общая пористость, влажность); химические (значение абсорбанции λ_{280} и λ_{664}, содержание связанных с сорбционным комплексом основных заменных катионов и водорода, а также органического углерода); биотические (численность микрофлоры: аммонификаторов, активномицетов и микроорганизмов, использующих минеральный азот, а также биомассы почвенных беспозвоночных: сапрофагов, травоядных и хищников). Установлено, что эти качества в существенной степени статистически дифференцируют исследуемые среды, а их изменения проходят взаимозависимо в градиенте гумусообразования.