SWAMPY SOILS IN THE LOWER DNIESTER MEADOW OF MOLDOVA

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Abstract

Swampy soils in the Lower Dniester floodplain are distinguished by high biogenesis at the early stage of their development. This is due to the fact that not abiotic rocks are involved in the primary soil formation, but redeposited of river basin erosion products, which are the upper, most fertile soils - grey soils, chernozems and alluvial soils. The swampy soils at the beginning of the silty stage and long before the vegetation settled on them already contain enough organic matter and all the necessary nutrients for plants. For the same reason, the development rate of most floodplain swampy-silty soils turns out to be extremely high fertility and they acquire signs of zonal soil formation relatively quickly. The phenomena of salinization and alkalinization of swampy-silty soils are confined to a later stage of their development (meadow-swampy). Usually, salinization starts from the marginal periphery of the marshes and very slowly penetrates into the inland areas of the floodplain. The riverbed edge of the marshes can remain non-saline for a very long time. Without drainage the development of swampy soils, the salinization begins immediately after its embankment and drainage. The inevitability of this process has been confirmed by the improvement practice of melioration the swampy soils in the lower reaches of Dniester floodplain.

Key words: Lower Dniester, Soil fertility, Swampy soils, Soil genesis.

In the Dniester floodplain the swampy soils are spread mainly in its lower reaches. They occupy large areas in the flat and wide depressions of the near-central and central regions of the floodplain terrace. Higher along the valley, they are found in fragments and are confined to the mouths of areas of the right-bank tributaries - the Bothna, the Bull, the Ikel (Calașnic A., 2008).

The total area of swampy soils, including those already drained and reclaimed is about 5.7 thousand hectares or 10.4% of the entire floodplain area within the borders of Moldova. They are formed under various associations of marsh or meadow-marsh vegetation under conditions of constant (within 30 cm of the surface) or periodic excessive moistening of both surface and ground waters (Подымов Б.П., 1969).

Depending on the nature and moisture regime, as well as the characteristics of the oxidation-reduction processes and other chemical properties, the swampy soils are divided into three subtypes: sub-aquatic, clayey-marshy, and clayey-peaty-marshy (Подымов Б.П., 1970).

The soils of the last subtype in the territory of the Dniester floodplain of the Moldavian territory have limited distribution; their total area does not exceed 200 hectares. They are not well understood in present.

After another opinion (Ursu A., 2011) the swampy soils are hydromorphic soils formed under the influence of permanent moisture surplus and are divided into: typical, gleyic, and peaty.

After Cerbari V. (2001) the swampy soils are formed under the influence of permanently groundwater in the 30 cm from the surface. In the formation of these soils contributes the gleyic processes, which manifests them from the surface horizon. The gleyic horizon has the upper limit in the first 50 cm. In accordance with the characteristics and structure of the genetic horizons of the profile, determined by the pedogenetic conditions, the swampy floodplain soils are classified in the following subtypes: peaty, humiferous, silty, and fluvial.

The profile of the swampy soil combines the morphological features of both the marshy and meadow processes. Under conditions of groundwater salinity, swampy soils are saline to varying degrees (Florea N., Munteanu I., 2012). Swampy soils are characterized by the accumulation of the finest mineral particles (silt) and semi-decomposed remains of bog vegetation (Урсу А. *et al*, 1988).

Drainage and subsequent cultivation of swampy soils leads to a drastic change in their structure and water-physical properties: intensive decomposition of plant residues occurs, the activity

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of aerobic microflora increases, etc. (Подымов Б.П., 1970).

MATERIAL AND METHOD

The profile of the swampy soil was laid in the in the acclivous lowering of terrace of right bank of the Dniester River near the village of Kopanka (Republic of Moldova) at the distance of 250 m from the foot of the slope of the floodplain terrace and 50 m from the shallow drainage canal. The site is used for agricultural crops, but cane rhizomes have retained their viability. The profile of the swampy soil is poorly differentiated into horizons.

Layer 0-25 cm – dark-gray or almost black color in wet conditions, clayey-loamy, slightly compacted, with an unclearly expressed lumpy-powdery structure; by all indications, it very gradually passes into the next, subsurface horizon, contains shells of mollusks, weakly decomposed stems and rhizomes of reeds; often include small, brown ferrous grains; there are no salt efflorescences.

Layer 25-60 cm – black color, clayey-loamy, with an obscure, poorly expressed lumpy structure, humid; has a very weakly compacted; the lower part of the layer is gleyzation and is in a capillary-saturated state; when drying the cut walls from a depth of 50 cm and below, the salt efflorescence appears. This layer is the same in appearance as the previous one, but contains many rhizomes of reeds, slightly colored from the outside in a brownish color. Part of the rhizomes is in a semi-decomposed state, but the bulk is vital.

Layer 80-120 cm - dark gray color, with a bluish tinge, clayey-loamy, structureless, very weakly compacted and strong gleyzation, is in a water-saturated state; the water level in the section was established at a depth of 110 cm; the smell of hydrogen sulfide is very weak in the layer.

Uniform effervescence from hydrochloric acid was noted throughout the soil profile. Analysis methods of soil samples are classic.

RESULTS AND DISCUSSIONS

Of all the swampy soils in the Dniester floodplain, the most widespread are various subtype species - swampy clayey-loamy, soils. The fresh, varieties of heavy mechanical composition (clayey and silty) are usually confined to the inner regions. Along the periphery there are gleyzied, salinized, solonetzated, alkaline-salinized, saline-solodized, and even solodized silty-swampy soils are found. They are formed under the cover of continuous reed or reed-rigorous thickets in conditions of periodic flooding by river waters on clayey and loamy lake-estuary floodplains during the evolution of subaquatic soils (Cerbari V., Strgărecku Gh., 2016).

The frequency and duration of flooding varies widely, depending on the hydrological features of the year and the topographic conditions of a particular section of the floodplain.

In dry years, the territories occupied by these soils are flooded only during the spring flood for 40-80 days. In wet years the surface of these soils almost all the time did not come out from under the water. Corresponding to the hydrological conditions, the oxidation-reduction conditions of soil formation it also differ extremely pronounced impermanence and may experience sharp changes in one direction or the other (Ursu A., 2011).

The humus horizon of the swampy clayey-loamy, soil may have different thickness, but signs of gleyzation process in it are always found from the surface itself and to the full depth of the profile. Neoplasms of trivalent iron compounds are confined to the upper part of the profile in the form of very fine solid brown color grains and reddish brown efflorescence and membrane on the edges of structural units.

The color of the humus horizon in a wet state is black or dark-gray with a bluish or greenish tint. For comparison the surface of virgin soils is everywhere covered with a thin layer of felt from semi-decomposed stems of reed, cattail, kugi and algae. At a depth of 25-60 cm there is an accumulation of reed rhizomes - live and dead.

In the present, the most of the swampy clayey-loamy, soils of the Dniester floodplain have been drained, plowed up and used in agricultural production mainly under vegetable and field crops. The virgin areas are preserved in the lower reaches of the river. Swampy clayey-loamy, soils after drainage and plowing oxidize relatively quickly and lose most of the previously acquired signs of the marshy (swampy) process.

The considered swampy soil is characterized by clayey-loamy mechanical composition of the entire upper one meter thick. Deeper, it is somewhat easier; the content of the physical clay fraction is reduced to 45%, and silt - to 25%. The silt fraction is relatively weakly micro-aggregated, about one fifth of it is in a free state. The content of the fraction >0.1 mm is about 5%. Dispersion coefficient (after Kaczynski) show increasing values with depth of profile *(table 1 and 2).*

In general terms, the soil to a depth of 100 cm is granulometric uniform, which indicates the relative stability of hydrological conditions throughout the entire period of its formation.

The morphological profile of the soil is not clear differentiated by genetic (soil-genetically) horizons. The content of organic matter in the 0-10 cm is 5.1% and carbonates are 3.1% *(table 3).*

Compared to other soils of the Dniester floodplain, the highest humus content (4-5%) in the layer 0-70 cm is observed.

Table 1

Granulometric composition of the Swampy clayey-loamy soil

Depth, cm	Fractions content, %; particle size. mm					
	1.00-0.25	0.25-0.10	0.10-0.05	0.05-0.01	0.01-0.005	0.005-0.001
0-10	0/0	4/8	18/26	24/40	6/10	18/11
30-40	0/0	3/6	14/22	34/44	13/12	14/12
50-60	1/2	5/8	13/20	24/27	7/12	16/14
90-100	0/2	4/6	12/22	30/36	9/12	15/15
110-120	2/3	5/8	10/15	37/25	10/8	13/16

Table 2

Silt and physical clay fractions content of the Swampy clayey-loamy soil

Depth, cm	< 0.001 mm, %	<0.01 mm, %	Dispersion coefficient
0-10	31	58	17
30-40	21	49	18
50-60	34	56	21
90-100	30	54	23
110-120	25	45	22

Table 3

Physical-chemical parameters of the Swampy clayey-loamy soil

Depth, cm	Hm*	$CaCO_3$	Humus	N_{total}	C:H	pH
	%				units	
0-10	3.9	3.1	5.1	0.36	8	7.8
10-20	3.8	2.8	4.8	-	-	7.9
20-30	4.0	2.5	4.9	-	-	8.0
30-40	4.2	2.3	4.6	0.29	9	8.0
40-50	4.1	1.9	4.0	-	-	8.0
50-60	4.3	3.4	4.3	-	-	8.2
60-70	3.7	3.0	4.6	-	-	8.1
70-80	3.7	4.2	3.9	0.24	9	8.2
80-90	3.9	4.4	3.6	-	-	8.2
100-110	3.6	5.5	2.8	-	-	8.5
110-120	3.6	3.8	3.5	0.28	7	8.6
120-130	3.7	4.1	2.0	-	-	8.4

HM - Hygroscopic moisture*

This is probably due to the presence of raw organic matter previously accumulated under anaerobic conditions and not yet fully mineralized. In any case, even more mature soils (meadow-marshy and meadow) rarely contain such humus content in them (Martin C.W., 2010; Junhong, *et. al*, 2012).

Calcium dominates in the composition of absorbed cations with a significant proportion of magnesium. Their ratio is 2 : 1 in the upper part of the profile and 1.5 : 1 - in the lower. An increased content of absorbed sodium is also noted here - 2 mg/eq. or 7.3% of the sum. The sum of exchange cations is 30-37 mg/eq. per 100 g of soil.

The content of mobile phosphorus compounds (according to Machighin) varies in profile from 4 to 7, potassium exchangeable - from 20 to 26 mg/100 g of soil *(table 4).*

Table 4

Agrochemical parameters of the Swampy clayey-loamy soil

Depth, cm	Nh*	P_2O_5	K_2O	Ca^{++}	Mg^{++}	Na^{+}	Sum
	mg /100 g soil			mg-eq /100 g soil			
0-10	12	7	26	23.9	12.2	0.4	36.5
30-40	10	7	24	18.3	14.3	0.6	33.2
70-80	10	6	23	17.7	10.8	1.4	29.9
110-120	8	4	20	16.1	11.7	2.2	30.0

**Nitrogen hydrolysable*

Thus, these young hydromorphic and litomorphic swampy soils contain in large quantities the main plant nutrients - nitrogen, phosphorus, potassium and microelements.

The distribution and accumulation of total form of Zn, Ni, Pb, Cr and Cd is associated with biogenic accumulation in the soil layer of 0-10 cm. The accumulation of the geochemical barrier (30-40 cm) is obvious - the beginning of the gleyic horizon. In the 60-80 cm of soil layer the total Zn (77 mg/kg) and Cr (275 mg/kg) was accumulated *(table 5).*

Table 5

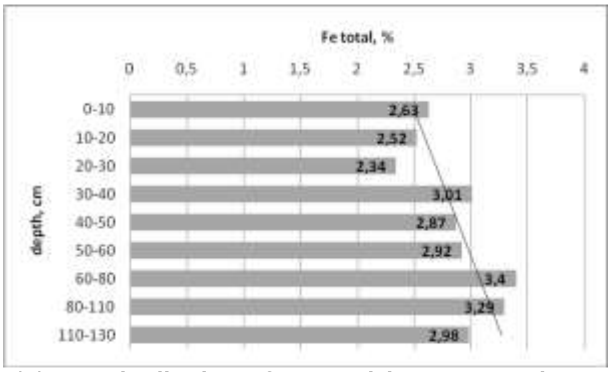
Content of total microelements of the Swampy clayey-loamy soil

Depth, cm	Zn	Co	Ni	Pb	Cr	Cd
	mg/kg					
0-10	68.5	8.4	12.6	16.7	250.1	1.19
10-20	67.7	7.8	12.1	17.6	250.8	1.09
20-30	38.2	7.7	12.1	16.4	176.8	1.10
30-40	54.0	12.6	11.8	16.0	242.3	1.10
40-50	52.0	12.8	11.8	12.2	241.6	1.05
50-60	60.6	12.3	12.4	11.6	238.2	1.05
60-80	77.1	11.7	12.2	13.1	275.0	0.95
80-110	71.9	10.5	9.9	14.3	251.8	0.83
110-130	71.9	11.0	11.8	10.4	285.6	074
Content limits	**0.4-195**	**0.1-4.7**	**0.1-1.5**	**0.01-0.6**	**200-300**	**0.01-0.3**

The swampy soils contain enough iron total forms: 2.34-3.40%. The distribution laws are manifested by the increase of the content in depth, highlighting the gleyic horizons with higher content of Fe total *(figure.1).*

The average content of chemical elements determined in swampy soils has been shown to fall within the "total content limit in Republic Moldiva soils". This content is considered to be normal for swampy soils, considering their pedogenesis and evolution. Therefore, immediately after draining, they acquire high agricultural production qualities.

However, one should take into account the real possibility of their salinization in the conditions of insufficiently effective artificial drainage of the territory.



Figire.1. **Distribution of Fe total in swampy clayey-loamy soil**

In the profile under consideration, there are clear signs of salt pulling to the upper horizons. Despite the still very low degree of salinization (0.2-0.4%), the current trend is a certain danger, since the level of groundwater is located at a depth at which the capillary rim can rise to the very surface of the soil.

The above data characterize one of the most widespread varieties of swampy soils, but others, despite some features of their material composition and properties, differ slightly from it. Sharp differences in the soils of this subtype are at a later stage of their development. With the gradual natural drainage and slugging of the floodplain, the marshy process of soil formation diminishes, is replaced by meadow, and in the process of further evolution, swampy soils give rise to numerous varieties of meadow soils.

From the ecological actions point of view to improve the ecological situation in the region, local development plans for the territory are not yet available, including landscape development plans, anti-erosion measures and soil status monitoring. One of the reasons is that the legislation does not provide for a control mechanism and an obligation to take appropriate action.

CONCLUSIONS

At the beginning of the meadow stage, there is a sharp differentiation of the former bog soils according to the degree and types of salinization, alkalinity, "graininess" and other characteristics. It is at this stage of development that the marsh soils with the most mechanical structure acquire the properties of fusion, which in the future turn out to be a difficult obstacle to the formation of the soil profile corresponding to the peculiarities of the zonal soil formation.

Flooded swampy soils are distinguished by high biogenesis at an early stage of their development. The swampy soils at the beginning of the silt stage and long before the vegetation settled on them already contain enough organic matter and all the plant nutrients. For the same reason, the development rate of most floodplain swampy soils turns out to be extremely high, and they acquire signs of zonal soil formation relatively quickly.

Currently, the most of the swampy soils in the Dniester floodplain have been drained, plowed up and used in agricultural production mainly under vegetable and field crops. Swampy soils after drainage and plowing oxidize relatively quickly and lose most of the previously acquired signs of the swampy process.

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