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THE CLIMATIC AND THE RELIEF CHARACTERISTICS SPECIFIC TO THE MARONIC SOIL SUBTYPE FROM DOBROGEA

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Abstract

The maronic subtype was introduced in Romanian Soil Taxonomy System (RSTS) in 2003. Previously named „brown soils of xerophile woods", it was described by N. Florea and Ana Conea in 1962. The soils with maronic subtype are formed under specific conditions, with the climatic and relief specificity which favored the manifestation of two main pedogenetic processes: a process characteristic for the soils formed under xerophile woods; and a process characteristic to the soils formed in the steppe zone (under grasses). In what concern the influence of the relief on the soil formation, it was observed that soils with maronic subtype are spread mainly on the north-facing or west-facing slopes and usually occupies the lower part of the slopes. In these relief and climatic conditions and under the forest vegetation, an Amf (A mollic forestalic) horizon was formed. Although formed under forest vegetation, the soils with maronic subtype showed a horizon succession similar to that of the steppe soils.

Key words: *forestalic horizon, maronic soil subtype, silvosteppe.*

INTRODUCTION

Formerly named (Florea N., Conea Ana, 1962; Florea N. et al., 1968) „*soils of xerophile forests and siblyaks*", the soils with maronic subtype are defined by the presence of a special diagnostic horizon, *Am forestalic* (Amf); feature applies to the Kastanozems and to the Chernozems.

According to SRTS-2003 (Florea N., Munteanu I., 2003), Amf horizon is defined as „a variety of mollic horizon which meets the conditions for mollic horizon and further presents the following characters induced by their formation under the xerophile forests:

- medium and coarse blocky structure in the middle and/or lower part of the horizon, often associated with uncoated grains, and
- a minimum in the variation of the pH values, base saturation (BS) and the degree of base saturation (V%)".

The SRTS-2012 change the subtype designation from maronic to „*forestic*", but the defined characteristics remained unchanged (Florea N., Munteanu I., 2012).

The soils with maronic subtype have been identified only in Dobrogea, making the transition between the steppe soils (formed under grasses) and the forest steppe soils.

Their pedogenesis is specific to the steppe soils, aspect highlighted by the absence of a B horizon in their morphological profile, the transitions between Am and Cca horizons being made through AC horizon. Nevertheless, the A horizon is divided as the upper horizons of the forest soils.

Although it was thought that their formation is dependent on a particular type of vegetation and consequently their previous name was given according to this vegetation (thermophile forest or dense scrubland - *siblyak*), these soils have not been identified in all regions of our country covered by this type of vegetation. As for example, the xerophile forests and siblyaks are found in Banat (Locvei Mountains), Valea Mare Natural Reserve - Iron Gates Natural Park, Semenic Natural Park - Cheile Carasului, areas with a Mediterranean climate influence. In these areas there were not formed soils with maronic subtype.

This could be due to the fact that soils are formed on different types of parent material/rocks: limestone in Banat Mountains (inducing the formation of shallow soils) and loess and loess-like deposits in Dobrogea (favoring deeper soil formation).
The aim of this paper is to emphasize the influence of the local climatic and the relief conditions on the pedogenesis of the soils with maronic subtype from Dobrogea, as well as the closer interdependence between these soils and the relief - climate - parent material - vegetation.

MATERIALS AND METHODS

To achieve the paper objectives, in the first step of the research, there were identified on soil maps (scale 1:25,000) the zones where there are soils with maronic subtype. The area chosen for the study is located in the northern part of Dobrogea, eastern part of the Babadag Tableland.
The main characteristics of the climate, the mean annual rainfall and the mean annual temperatures, were analyzed, for the studied perimeter.
The values of these indicators, provided from the closer Meteorological Stations (Babadag and Jurilovca), have been corrected in relation to the slope and the slope-facing according to the indicators 3 and 4 of the RISSA Methodology (1987 - Vol. III - Ecopedological Indicators).
In the field, the relief conditions of the studied perimeter occupied by the soils with maronic subtypes has been analyzed, regarding the altitude, the slope, the slope-facing and the position on the slope.
The profile description together with the collection of soil samples were also achieved in the field. For the laboratory physical and chemical analysis, large representative samples were taken from each pedogenetic horizon of each soil profile.
To identify the relation between the environmental factors and the pedogenesis of the soils with maronic subtype, the pedologic structure of an N-S oriented soil catena from Babadag Tableland was also studied.

RESULTS AND DISCUSSIONS

Analyzing the soil map of Dobrogea, it can be observed that soils with maronic subtype are spread mainly in the Northern part of Dobrogea, in the Babadag Tableland, where they occupy more compact and larger areas, while in the SW Constanta (in the neighborhood of Aliman, Oltina, Baneasa and Dobromir localities) these soils occupy small areas.
In this view, for the research it was selected the North-Eastern part of the Babadag Tableland, where the climate is characterized by an average annual temperatures of 10.7-11.2^{o}C, an average annual precipitations of 345- mm, and an evapotranspiration potential (ETP - after Thornthwaite) of 688 mm. The humidity deficit recorded in the studied area is between 273 mm and 343 mm. The torrential rains have a particular strong character.
The average depth of the soil freezing is 12 cm, and up to 43 cm during the frostiest winters. The amplitude of the annual monthly average of temperatures is 23.8^{o}C.
A special influence on the dynamic of the meteorological elements is due to the other environmental factors such as: topography (characterized by the slope and orientation), type of vegetation and land coverage.

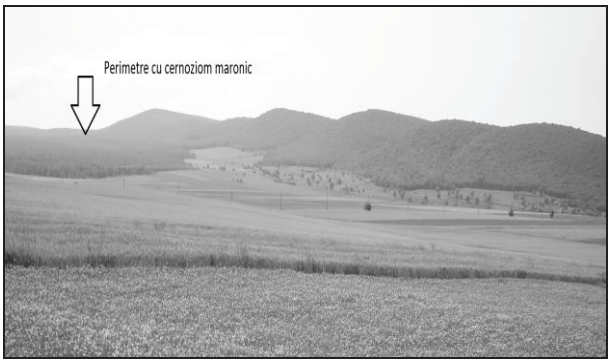

Figure 1. Perimeter with Maronic Chernozems

In order to characterize the landscape, the topographic map (1: 25000) was analyzed. In the studied area (Moise Irina, 2003), the highest altitudes are in the hills, near the Babadag town, ranging of 230 - 240 m and the lower altitudes, for the afforested areas, are achieved in Visterna Hill, 221 m and in Golovarf Hill, 164 m (Figure 1 and 2).
Some hills from the studied perimeter have

bare and/or rocky surface and shallow soils, as in the Visina Hill (99.0 m high), Dolosman Hill (56.5 m) and Iancina Hill (62.5 m).

Figure 2. Visterna Hill covered by forest vegetation and surrounding by agricultural flat lands

The soils with maronic subtype are located in the lower part of the north-facing or north-west-facing slope, with altitudes ranging from 50 - 80 m, gently - moderately sloping and with very low density fragmentation. The values of the relief energy intensity are ranging between 10 to 20 m.

The parent material is loess and has high $CaCO_3$ content.

Table 1. Annual average temperature corrected according to the slope and the slope-facing

Nr.	Slope %	Slope facing	Registered temperatures °C	Corrected temperatures °C
1.	10-15	N	10.7	10.7
		E	10.7	10.7
		S	10.7	11.5
		W	10.7	10.7
2.	15-20	N	10.7	9.5
		E	10.7	10.7
		S	10.7	11.5
		W	10.7	11.5
3.	10-15	N	11.2	11.2
		E	11.2	11.2
		S	11.2	12.5
		W	11.2	11.2
4.	15-20	N	11.2	10.5
		E	11.2	11.2
		S	11.2	12.5
		W	11.2	12.5

Analyzing the data from Tables 1 and 2, it could be observed that the temperatures are corrected for the lands with the slope higher than 10%. In what concerning the slope-facing, the temperature for the lands located on the south-facing slopes will fall, after correction, within a higher range of values (from 10.5°C to 11.5°C, and from 11.5°C to 12.5°C respectively), while for the north-facing slopes no differences were observed.

Table 2. Annual average precipitations corrected according to the slope and permeability

Nr.	Slope %	Permeability	Registered precipitations mm	Corrected precipitations mm
1.	2.1 - 5	Extremely low- very low	425	350
		Low-medium	**425**	**425**
		High - very high	425	425
2.	5.1 - 10	Extremely low- very low	425	350
		Low - medium	**425**	**350**
		High - very high	425	425
3.	10 - 15	Extremely low- very low	425	350
		Low - medium	**425**	**350**
		High - very high	425	350
4.	15 - 20	Extremely low- very low	425	350
		Low - medium	**425**	**350**
		High - very high	425	350

For a strongly sloping (of 15%), the lands located on the south-facing slopes have the same correction (as the previous one), while for that ones located on the north-facing slopes, the temperature will fall, after correction, in a lower range (from 10.5°C to 9.5°C and from 11.5°C to 10.5°C respectively).

These data showed that after corrections, appear a significant difference in temperature (of 2°C) of the slopes with various facing (south-facing and north-facing slopes respectively).

Regarding the precipitations, there were registered differences after the corrections, only for the lands located on the slopes greater than 5%.

For the soils with medium permeability, the lands with the slopes ranging from 5.1-20.0%, the corrections framed the lands in a lower range of values (425-350 mm respectively) from the precipitations point of view.

The flat or gently sloping lands benefit of the entire quantity of precipitations.

Natural vegetation is represented by the xerophile forests composed mainly of the following species: *Quercus pubescens*, *Quercus pedunculiflora*, *Carpinus druinensis*, *Fraxinus ornus* and Mediterranean shrubs of *Cornus mass*, *Crataegus monogyna*, *Cotinus coggigria*, *Siringa vulgaris* and the *Cerasus mahaleb* as well as the wild apple and hair. These species formed vegetal formations called *șibleacuri* which consists of dense shrubs, difficult to cross.

Being located at the contact with the cultivated lands, the forests has numerous clearings where the grass vegetation covering the soil at a rate of 80 - 90%. The vegetation of these clearing is composed of *Poa bulbosa*, *Poa angustifolia*, *Festuca valesiaca*, *F. mezoxerofile pseudovina* and other species.

Due to the specificity of the environmental conditions (Mihalache M., 2014; Ciolacu T., 2015), the pedogenetic process is oriented on the one hand towards the intense and deep accumulation of the organic matter , in the soil profile (as a result of abundant grass vegetation, Cernisols are formed), on the other hand, towards a slightly debazification of the colloidal complex of the upper part or the soil profile, induced by the forest vegetation and favored by the water percolation (Rusu T., 2013).

In these environmental conditions, the soil pedogenesis is oriented through intense bioaccumulation and, as a result, a large amounts of humus in the upper A horizon and in the intermediate part of the soil profile has been acquired (Figure 3).

As a consequence of this specific pedogenesis of the soils with moronic subtype, the morphological profile is: Ol-Amf_1-Amf_2-A/C-Cca.

These conditions lead to the formation of the Amf (A mollic forestalic) horizon, specific to the maronic subtype, which has two subhorizons with different degrees of debazification.

In all the studied soil profiles it was identify the A mollic forestalic horizon (Amf), clearly individualized in the soil surface, with two sub-horizons: Amf_1 and Amf_2 respectively. In its upper part, a well structured, porous and humus-rich sub-horizon was formed. This subhorizon can have at about 10 cm thick.

From the morphologically point of view, the Amf_1 subhorizon showed the following properties: loamy texture; very dark grayish brown (10YR 3/2) to wet and dark grayish brown to grayish brown (10YR 4.5/2) when dry; medium crumb structure in the lower part of the horizon and medium subangular blocky structure, well developed.

Figure 3. A Maronic Chernozem profile

Amf_2 subhorizon has a loamy texture; a color of very dark grayish brown (10YR 3/2) to wet and dark grayish brown (10YR 4/2) when dry; medium to coarse subangular blocky structure, well developed.

The morphological characteristics, as well as the physical and chemical properties of analyzed profiles, submit the requirements of the definition of the moronic subtype and allowed its classification as Chernozem type and moronic subtype (according the SRTS-2003). The main chemical properties of soil horizons are shown in Figures 4 and 5 and in the Table 3.

These data showed (Figure 4) the high values (12.0-15.0%) of humus, in the Amf_1 subhorizon, values specific for the forest soils. In the Amf_2 subhorizon, the humus strongly decrease (3.8-4.2%) to the values specific for the cultivated steppe soils.

In the transition horizon, A/C, the humus values are even lower (1.8-2.0%).

The depth of humus accumulation in the studied soil profiles is high, reaching up to 70 - 80 cm, as the steppe soils.

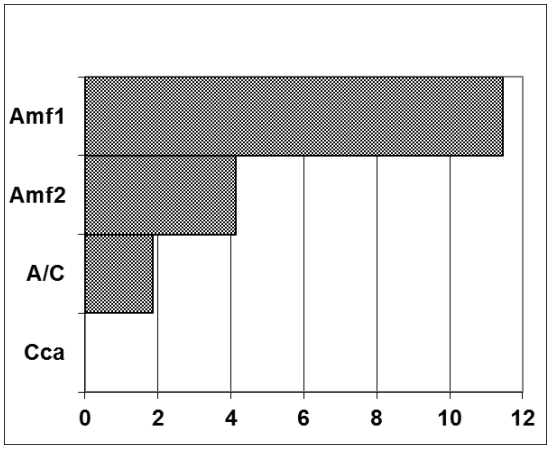

Figure 4. The humus content (%) of a Maronic Chernozem from North Dobrogea

Table 3. Analytical data of a Maronic Chernozem from North Dobrogea

Horizon	Depth (cm)	pH	BS	V %	H %
Amf_1	0-12	6.27	32.09	86.5	11.46
Amf_2	12-40	6.34	23.31	88.5	4.14
A/C	40-77	6.69	21.36	94.4	1.86
Cca	77-110	7.95	-	100	-

Degree of base saturation (V%) shows quite high values, ranging between 80-85%, with a little variation between the two Amf_1 and Amf_2 subhorizons.

Analyzing the pH values (Table 3), it could ascertain that in Amf horizon the pH is 6.27, the soil being slightly acid.

These pH values correlated with the degree of base saturation values are indicating that in these soils, the debazification process is in an incipient stage.

The leaching of the slightly soluble bases take place, which determine the pH decrease below 6.5, but the heavy soluble bases are still present in large quantities, enough to maintain the degree of the base saturation, to high values.

This process can be determined, on the one hand, by the moisture addition due to the terrain configuration (flat land) and to the good cover with vegetation, and on the other hand, to the vegetal remains originate in the grass and forest vegetation.

The importance of the environmental factors (mainly the relief together with the local climatic conditions) for the pedogenesis of these soils, N-S oriented soil catena, from the studied perimeter, was analyzed.

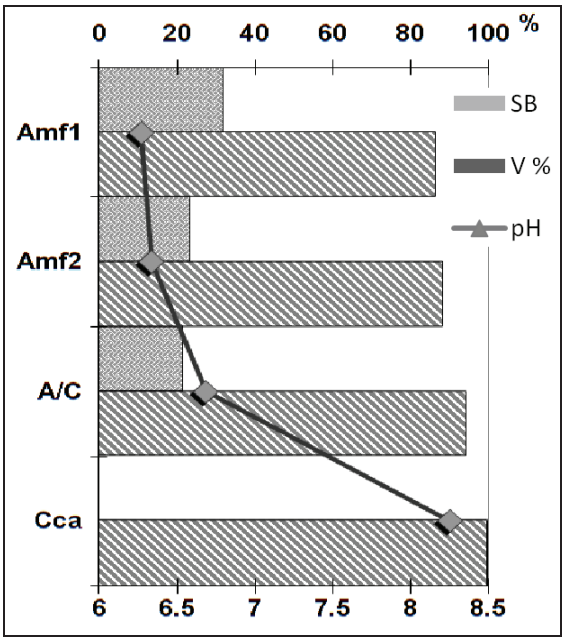

Figure 5. Chemical properties of a Maronic Chernozem from North Dobrogea

Thus, starting from the immediately vicinity of the Lake Babadag and advancing towards the afforested hills, the Typical Carbonated Chernozems appears on the cultivated lands, Maronic Chernozems under the forest vegetation on the flat or gently sloping lands, Eutricambosols on the gently sloping north-facing lands, as well as Rendzinas and Argic Greic Chernozems on the top of the afforested hills.

On the south-facing slopes, with much gently sloping, descending to the Lake Golovita, there were formed Rendzinas which continued with the Typical Carbonated Chernozems, Kastanozems and Mollic Solonchaks.

CONCLUSIONS

Given the specific environmental conditions of the studied perimeter, which lead the pedogenesis throughout the formation of the maronic subtype, the following conclusions could be drawing:

- the formation of the soils with maronic subtype occurs mainly on the lands with gentle sloping, north-facing, under forest

vegetation, located to the north Dobrogea;
- due to the environmental conditions specificity, the pedogenetic process is oriented on the one hand towards the intense and deep accumulation of the organic matter in the soil profile and, on the other hand, towards a slightly debazification of the colloidal complex of the upper part or the soil profile;
- the intense and deep accumulation of the organic matter is a result of the abundant grass vegetation;
- the slightly debazification is induced by the forest vegetation and it is favored by the flat relief which do not permit the flow down of the precipitation but the water percolation;
- the physical, chemical and morphological characteristics of the analyzed soil profiles justify their classification as maronic subtypes;
- by the analysis of both relief and climate, it could be observed the good correlation between them and the wide spread of the soils with maronic subtype;
- because the soil with maronic subtype was not formed in the others regions of the country, under the same type of vegetation, it pointed out the specificity of the north Dobrogea conditions and the closer interdependence between the relief - climate - parent material - vegetation that lead the pedogenesis towards the formation of moronic subtype.

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