Soils with Sodic Salinization in Rumania

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The halomorphic soils extend in Rumania over approximately 250,000 ha i.e. 1 per cent of the whole area of the country; most of them display a sodic salinization.

In Rumania the soils with sodic salinization are predominantly widespread all over the Rumanian Danube Plain and the Tisza Plain (the part located in the Rumanian territory); sporadically the soils with sodic salinization occur in some table-land regions (Transylvanian Table-land, Moldavian Table-land) and the hilly regions (Sub-Carpathian Bend, etc.).

The Rumanian Danube Plain represents an extended area with generally level or gently sloping relief, within which two large units are separated by the Arges river: *a)* Western Rumanian Danube Plain is higher and, in general, more dissected and better drained, and *b)* Eastern Rumanian Danube Plain, lower (in the north-eastern part the elevations descending to less than 20 m) practically non-dissected, displaying vast areas within which the ground water is to be found at small depths (2 – 5 m). The head deposits are varied: red clays, loess and aeolian sand deposits within the Western Rumanian Danube Plain; predominantly loess, aeolian and deposits and alluvial deposits in the Eastern Rumanian Danube Plain.

Tisza Plain (within the Rumanian territory) represents the eastern part of the so-called Alföld. It shows as a practically horizontal surface whose elevations are below 115 m (80 – 115 m within the Rumanian territory). Before the last century when important land reclamation works have been carried out, large areas of this plain were covered with bogs and swamps. Nowadays the ground water is generally to be found at depths smaller than 5 m (predominantly between 1 – 3 m). Parent materials are varied: alluvial deposits, loess, aeolian sand deposits, etc. the main feature of these deposits is their relatively low lime content.

The soils with sodic salinization occur in Rumania under the conditions of a steppe and forest-steppe moderately continental climate: annual temperature (T) = 8.3 – 11.5 °C; annual precipitation (P) = 440 – 620 mm; annual evaporation (E) = 630 – 700 mm. Within the steppe zone the halomorphic soils (as a rule solonchaks and solonetz-solonchaks) are characterized by a marked predominance of chloride and sulphate accumulation. The largest widespreading of sodic soils is stated in the more humid part of the steppe and in the forest-steppe ($P = 520 - 620$ mm, $E < 700$ mm) where in the composition of salts within the halomorphic soils there predominate both sodium sulphate and sodium bicarbonate (including sodium carbonate) or sometimes only sodium bicarbonate and carbonate.

Under the above mentioned climatic conditions the areas with sodic

soils are related to forms of relief with slow flow of ground water, located at small depth: areas situated at the outermost border of piedmontan plains, low surfaces of accumulative plains, contact regions between various relief units, lower terraces and unflooded plains, etc. The most extended areas with sodic soils are, therefore, located within the Tisza Plain, the Eastern Rumanian Danube Plain, on lower terraces and in unflooded plains of some rivers of the Moldavian Table-land and of the Western Rumanian Danube Plain.

Within the relief units with a stronger drainage the sodic soils are associated with meadow chernozems and meadow leached chernozems and cover the lowest forms of relief; in the lowest and weakly drained areas (ex. Low Plain of Banat south of Bega) these soils are frequently associated with humic gley soils, occupying in this case the higher parts of the relief. On unflooded plains and lower terraces the sodic soils are associated, as a function of local conditions, either with hydromorphic soils, or with alluvial soils, in various evolution stages towards the zonal steppe and forest-steppe soils.

Salts accumulated in halomorphic soils from different parts of the country are quite varied, their nature depending, to a great extent, upon the main source of salts. Within the Tisza Plain and the Western Rumanian Danube Plain where head deposits and ground water originate from mountainous zones chiefly built up of crystalline rocks, in halomorphic soils there predominate sodium bicarbonate (including sodium carbonate) and sodium sulphate; in these regions a clear-cut predominance of the sodic soils among the halomorphic soils may be noticed. In the Eastern Rumanian Danube Plain, one may observe in halomorphic soils an intense accumulation of chlorides and sulphates proceeding especially from the neighbouring hilly region with deposits rich in salts (diapir fold zone). Within the table-land regions (Moldavian Table-land; Transylvanian Table-land) the nature of salts present in halomorphic soils is determined by salts existing in salt-bearing rocks which crop out here and there. Dominantly these salts are sulphates in Moldavian Table-land and chlorides in Transylvanian Table-land. In these regions the occurrence of sodic soils is, in general, seldom met with.

Sodic soils of Rumania may be divided accordingly to the character of the B horizon, nature of accumulated salts and the thickness of eluvial horizon. Two main groups of sodic soils are thus distinguished, namely sodic soils without structural B horizon and sodic soils with structural B horizon.

Classification of sodic soils

Sodic soils without structural B horizon
- Sodic solonchak
- Sodic solonchak-solonetz (alkali-saline soil)
  - sulphatic-sodic
  - sodic-sulphatic

Sodic soils with structural B horizon
- Sodic solonchak-like solonetz
  - sulphatic-sodic
  - sodic-sulphatic
- Sodic salinized solonetz (alkali soil)
  - sulphatic-sodic
  - sodic-sulphatic (chloride)
  - sodic-schloride (sulphatic)
- Sodic solodized solonetz (sodic solodized alkali soil)
  - sulphatic-sodic
  - sodic-sulphatic
- Sodic soloth-solonetz (sodic soloth-alkali soil)

The first group is represented particularly by sodic solonchaks and sodic solonchak-solonetzes, inclusively those sulphatic-sodic and sodic-sulphatic. A characteristic feature of these soils is the absence of the structural B horizon, nevertheless frequently on the surface (10—20 cm at the profile top) the solonchak-solonetzes may display a strong compactness and a coarse blocky structure.

As it may be noticed from the annexed diagram (Fig. 1) in sodic solonchaks the maximum content in alkaline carbonates and bicarbonates (10 meq/100 g soil, respectively 0.70 per cent) is practically reached in the first cm of the surface; in case of the solonchak-solonetzes the values of contents in CO_3^{2-} and HCO_3^- are to a great extent the same as for the solonchaks,

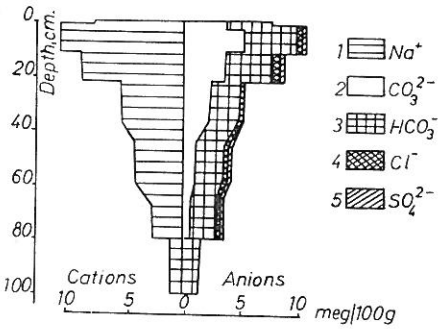

Fig. 1

Salt profile of a sodic solonchak (613-Gruiu, Argeș Flood-Plain, Western Rumanian Danube Plain)

but the maximum salt accumulation occurs at some cm below the soil surface (Table 1). The reaction of soil may reach pH values exceeding 10 (10.2—10.5) even at the surface in case of sodic solonchaks; the solonchak-solonetzes display an alkaline reaction (pH = 9—9.5) over the first 3—5 cm but immediately below, the pH values may exceed 9.5—10. The sodic solonchaks and sodic solonchak-solonetzes are but to a lesser extent widespread over the Rumanian territory. They are chiefly encountered on unflooded plains with alluvions devoid of carbonates belonging to some rivers from the Western Rumanian Danube Plain (Călmățui, Vedea, Argeș). Sodic solonchak-solonetzes also occur sporadically in the north-western part of the Eastern Rumanian Danube Plain where they are associated with chloride-sulphatic (or sulphatic-chloride) solonchaks and solonetzes.

The second group is represented by sodic soils with structural B horizon and comprises: sodic solonchak-like solonetz, sodic salinized solonetz and sodic solodized solonetz, including sulphatic-sodic and sodic or sulphatic (or chloride) ones. Morphologically the soils of this group are characterized by the presence of an extremely hard and compact B horizon showing a specifical strong columnar structure whose elements are, as a rule, rounded off at the top. Depending on the depth at which occurs the B horizon (respectively according to the thickness of the eluvial horizon) the soils of this group are divided into: sodic solonetz soils with columns at small depth (5—6 cm), at medium depth (10—12 cm) and deep or at great depth (15—25 cm).

Table 1

Analytical data of sodic alkali-saline soil

	Horizons						
	A	Bt	Btg		G		
	Depth, in cm						
	0—3	3—8	10—20	25—38	45—60	65—80	90—105
Hygroscopic water, %	0.6	1.1	1.0	1.7	1.6	1.5	1.2
Particle size distribution %							
<0.002 mm	7.0	25.9	28.4	29.0	28.7	—	26.4
0.002—0.02 mm	7.8	15.5	16.3	17.4	19.0	—	19.2
0.02 —0.2 mm	49.8	35.6	32.7	31.9	32.7	—	36.1
0.2 —2 mm	35.4	23.0	22.6	21.7	19.6	—	18.3
<0.001 mm	5.4	23.0	26.7	27.3	26.9	—	25.3
<0.01 mm	9.9	33.7	37.6	38.6	39.2	—	35.7
Organic matter, %	0.6	1.8	0.7	0.7	0.6	0.4	0.2
Total N, %	0.04	0.07	0.04	0.03	—	—	—
C : N	10.5	17.4	14.3	15.9	—	—	—
$CaCO_3$, %	1.5	2.5	4.6	8.4	13.5	21.4	22.3
pH	9.5	9.7	9.6	9.6	9.7	9.7	9.7
Exchangeable cations T (meq/100 g soil)	4.9	22.2	20.2	—	16.4	—	12.2
% (T = 100) Ca^{2+} / Mg^{2+}	29.5	21.8	17.0	—	32.8	—	51.9
% (T = 100) K^+	7.8	2.6	2.6	—	3.0	—	2.2
% (T = 100) Na^+	62.7	75.6	80.4	—	64.2	—	45.9
% (T = 100) H^+	—	—	—	—	—	—	—
Base saturation %	100.0	100.0	100.0	—	100.0	—	100.0
Soluble salts (water extract 1 : 5) Total salts, %	0.84	1.50	1.05	0.70	0.44	0.33	0.39
me/100 g soil CO_3^{2-}	9.3	6.8	6.7	8.4	11.5	13.5	—
me/100 g soil HCO_3^-	4.4	16.8	13.7	16.8	22.7	24.8	—
me/100 g soil Cl^-	6.3	6.2	7.2	8.8	6.3	4.3	—
me/100 g soil SO_4^{2-}	30.0	20.2	22.4	16.0	9.5	7.4	—
me/100 g soil Ca^{2+}	1.2	8.6	4.2	3.2	3.7	4.3	—
me/100 g soil Mg^{2+}	—	—	—	—	—	—	—
me/100 g soil Na^+	48.8	41.4	45.8	46.8	46.2	45.7	—

Sodic solonchak-like solonetzes are characterized by the presence of a maximum accumulation of salts (Fig. 2, Tabl. 2) in the first 25 cm of the top, as a rule, nearly below the bottom of the structural B horizon.

The content in readily soluble salts relatively small, 0.2—0.3 per cent, in the upper part of the soil profile, may attain 0.5—0.8 per cent within the zone of the maximum accumulation level; among these salts the alkaline carbonates and bicarbonates represent more than a half (0.3—0.5 per cent). The reaction of the soil, slightly — moderate alkaline (pH 7.7—8.5) of the few first cm, become suddenly strongly alkaline (pH 9.5—9.8) at the bottom

Table 2

Analytical data of salinized alkali soil

		Horizons					
		A	B	Bg	G		
		Depth in cm					
		0—6	13—26	33—45	50—63	66—78	100—120
Hygroscopic water, %		3.0	1.9	1.7	1.7	1.6	1.7
Particle distribution %							
<0.002 mm		34.6	28.9	27.8	26.9	—	29.1
0.002—0.02 mm		41.7	28.2	26.4	23.4	—	22.3
0.02 —0.2 mm		23.5	42.8	45.6	49.4	—	48.4
0.2 —2 mm		0.2	0.1	0.2	0.3	—	0.2
<0.001 mm		26.1	19.8	20.4	18.8	—	19.3
<0.01 mm		48.0	31.2	31.2	29.2	—	30.2
Organic matter, %		5.6	0.9	0.7	0.6	—	0.6
Total N, %		0.30	0.03	0.03	0.03	—	0.03
C : N		12.5	18.8	15.6	13.3	—	11.2
$CaCO_3$, %		4.8	20.2	18.6	19.4	19.3	23.5
pH		7.8	9.6	9.8	9.8	9.8	9.4
P_2O_5		0.19	0.15	—	0.14	—	—
Exchangeable cations T (meq/100 g soil)		22.5	14.0	13.8	13.5	—	12.6
% (T = 100)	Ca^{2+}	64.0	74.2	72.0	72.1	—	83.9
	Mg^{2+}	25.0					
	K^+	6.7	4.3	3.8	3.0	—	2.5
	Na^+	3.3	21.5	24.2	24.9	—	1.36
	H^+	—	—	—	—	—	—
Base saturation %		100.0	100.0	100.0	100.0	—	100.0
Soluble salts (water extract, 1 : 5) Total salts, %		0.15	0.57	0.68	0.55	0.49	0.32
me/100 g soil	CO_3^{2-}	—	7.7	12.3	15.1	25.6	8.8
	HCO_3^-	34.5	16.6	20.8	22.3	14.0	33.6
	Cl^-	10.8	7.6	5.3	4.7	4.4	4.2
	SO_4^{2-}	4.7	18.1	11.6	7.9	6.0	3.4
	Ca^{2+}	13.9	0.9	0.4	0.7	1.5	7.0
	Mg^{2+}	6.9	—	—	—	—	—
	K^+	3.7	0.2	0.2	0.3	0.3	0.3
	Na^+	25.5	48.9	49.4	49.0	48.2	40.7

or below the bottom of the B horizon, concomitantly with the occurrence of sodium bicarbonate. Sodic solonchak-like solonetzes are usually met with as associated with sodic solonchak-solonetzes in the unflooded plains of the Western Rumanian Danube Plain. They are likewise present in the north-western part of the Eastern Rumanian Danube Plain.

The sodic salinized solonetzes are characterized by a relatively deeper leaching of readily soluble salts; their zone of maximum accumulation (0.5—0.7 per cent) is to be found at depths exceeding 25 cm. The structural

Table 3

Analytical data of solodised alkali soil

		Horizons					
		A	Bt	Btg	C		
		Depth, in cm					
		0—6	6—22	25—40	45—60	70—90	110—130
Particle size distribution %							
<0.002 mm		17.1	28.7	39.3	43.8	—	39.0
0.002—0.02 mm		34.3	31.1	28.8	28.7	—	35.4
0.02 —0.2 mm		47.7	39.0	31.2	27.0	—	25.5
0.2 —2 mm		0.9	1.2	0.7	0.5	—	0.1
<0.001 mm		14.0	25.6	34.6	39.7	—	34.5
<0.01 mm		34.4	43.0	54.0	58.4	—	57.2
Organic matter, %		6.2	2.0	1.4	1.3	1.1	1.6
Total N, %		0.31	0.10	0.08	—	—	—
C : N		11.5	11.6	10.5	—	—	—
$CaCO_3$, %		0.1	0.7	2.5	2.8	12.7	17.2
pH		6.9	9.4	9.7	9.4	9.3	9.0
Exchangeable cations T (meq/100 g soil)		20.8	20.7	29.5	29.9	—	21.1
% (T = 100)	Ca^{2+}	27.5	70.7	49.6	58.1	—	83.8
	Mg^{2+}	33.4					
	K^+	1.5	2.5	2.5	2.5	—	1.9
	Na^+	15.2	26.8	47.8	39.4	—	14.3
	H^+	22.4	—	—	—	—	—
Base saturation %		77.6	100.0	100.0	100.0	—	100.0
Soluble salts (water extract, 1 : 5) Total salts, %		00.4	0.36	0.45	0.37	0.23	0.10
me/100 g soil	CO_3^{2-}	—	—	—	8.0	4.5	7.4
	HCO_3^-	41.2	34.4	28.5	19.0	33.7	32.6
	Cl^-	5.3	1.0	1.3	1.0	2.0	4.0
	SO_4^{2-}	3.5	14.6	20.2	22.0	9.8	6.0
	Ca^{2+}	4.0	2.5	1.7	1.0	1.8	3.0
	Mg^{2+}	15.0	2.6	4.5	2.0	6.9	18.0
	Na^+	31.0	44.9	43.8	47.0	41.3	29.0

B horizon comprises small amounts (0.2—0.45 per cent) of readily soluble salts and presents a strongly alkaline reaction (pH = 9—9.5) due to presence of the sodium carbonate and bicarbonate. The first 5—8 cm at the top (eluvial horizon) have a neutral — weakly alkaline reaction. More important areas with sodic salinized solonetzes occur in the southern part of the Tisza Plain and in some districts from the north-western part of the Eastern Rumanian Danube Plain.

The sodic solodized solonetzes are characterized by an eluvial horizon of 5—6 cm but which can reach 10—15 cm in thickness, strongly bleached and texturally very strongly differentiated as compared with the structural subjacent horizon (towards which the transition is generally in tongues).

Table 4

Analytical data of soloth-alkali soil

	Horizons								
	A_1	A_2	Bt	Btg		Ccag			G
	Depth, in cm								
	0—15	23—28	35—50	60—76	90—110	110—130	135—150	160—180	180—200
Hygroscopic water, %	0.65	0.30	1.85	2.19	2.30	1.65	1.39	1.12	1.18
Particle size distribution %									
<0.002 mm	9.2	7.8	24.7	28.2	—	21.1	16.3	—	12.4
0.002—0.02 mm	12.4	14.0	14.9	15.6	—	11.6	7.5	—	5.0
0.02 —0.2 mm	43.1	41.3	38.7	38.9	—	51.2	52.9	—	40.3
0.2 —2 mm	35.3	36.9	21.7	17.3	—	16.1	23.3	—	42.3
<0.001 mm	6.7	5.1	22.2	24.1	—	18.7	14.1	—	11.1
<0.01 mm	14.0	14.4	31.7	35.3	—	26.2	42.3	—	14.0
Organic matter, %	1.2	0.5	0.4	0.4	0.3	0.2	—	—	—
Total N, %	0.06	0.03	0.03	—	0.02	—	—	—	—
C : N	14.3	12.6	10.9	—	8.8	—	—	—	—
$CaCO_3$, %	—	—	1.0	0.4	1.4	12.4	6.9	4.7	3.3
pH	6.8	7.9	9.3	9.4	9.4	—	9.5	9.4	9.3
P_2O_5	0.05	0.03	0.06	—	0.09	—	—	—	—
Exchangeable cation T (meq/100 g soil)	8.4	4.0	14.2	17.2	—	13.2	9.7	—	8.9
% (T = 100) Ca^{2+}	54.2	43.2	56.5	52.1	—	55.0	62.7	—	88.8
% (T = 100) Mg^{2+}	13.0	20.8							
% (T = 100) K^+	1.8	1.5	3.1	3.1	—	2.3	2.9	—	2.7
% (T = 100) Na^+	2.0	16.2	40.4	44.8	—	42.7	34.4	—	8.6
% (T = 100) H^+	29.0	18.3	—	—	—	—	—	—	—
Base saturation %	71.0	81.7	100.0	100.0	—	100.0	100.0	—	100.0
Soluble salts (water extract, 1 : 5) Total salts, %	0.014	0.015	0.24	—	0.29	0.25	017.	0.11	0.09
me/100 g soil CO_3^{2-}	—	—	10.3	—	7.2	9.3	4.1	3.2	—
me/100 g soil HCO_3^-	20.8	18.5	36.1	—	35.9	36.1	40.4	39.9	42.4
me/100 g soil Cl^-	15.9	14.4	2.0	—	5.4	2.9	2.9	4.6	3.1
me/100 g soil SO_4^{2-}	13.3	17.1	1.6	—	1.5	1.7	2.6	2.3	4.5
me/100 g soil Ca^{2+}	9.7	7.7	3.3	—	4.4	7.2	6.5	12.8	10.7
me/100 g soil Mg^{2+}	—	—	—	—	—	—	—	—	—
me/100 g soil $Na^+ + K^+$	40.3	42.3	46.7	—	45.6	42.8	43.5	37.2	39.3

The eluvial horizon and often the first part of the B horizon are practically completely leached of readily soluble salts, the maximum accumulation zone (0.6—0.9 per cent) being located below 30 cm or even at 50—60 cm depth (Tabl. 3). The reaction of soil is acid (pH = 5.5—6) in the eluvial horizon and neutral-moderately alkaline (pH = 7.6—8.7) in the first part of the B horizon. In the lower part of this horizon and below, the reaction of the soil solution becomes very strongly alkaline (pH=9.5—11) owing to the occurrence of alkaline carbonates and bicarbonates. The sodic solodized solonetzes (including the sulphatic-sodic and sodic-sulphatic ones) are widespread

in the Tisza Plain. On small areas they are also to be found on the unflooded plains of the rivers of Western Rumanian Danube Plain.

Sodic solodic solonetzes constitute a separate intergrade subdivision to soloth soils, displaying a strongly developed (30—40 cm) and solodized

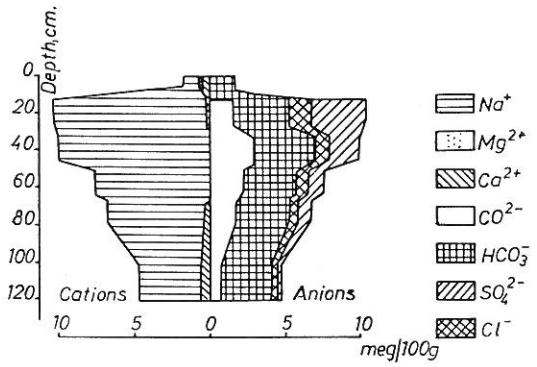

Fig. 2.
Salt profile of a sodic solonchaklike solonetz (1-Greci, North Dobrogea)

eluvial (bleached) horizon and a columnar B horizon, weathered at the top, texturally differentiated as compared to the upper horizon (Tabl. 4).

The reaction of the soil is strongly alkaline (pH = 9.3 – 9.4) in the B horizon where important contents (exceeding 3 meq/100 g. soil, respectively over 0.160 per cent) of alkaline carbonates and bicarbonates are present (Fig. 3). The solodic solonetzes are widespread particularly at the transition area from forest steppe towards the forest zone and is frequently associated with soloths and low gley soils.

They occur on extended areas especially in the eastern part of the Tisza Plain, constituting a large part of halomorphic soils of this geographical unit.

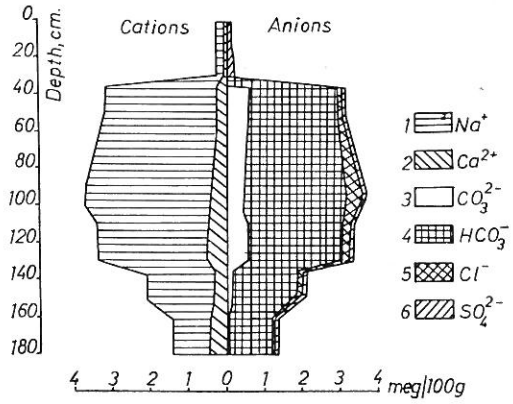

Fig. 3
Salt profile of a sodic solodic solonetz (104/135 — Stoeneşti, Western Romanian Danube Plain)

Locally they may be also encountered in unflooded plains of some rivers within the Western Rumanian Danube Plain, etc.

In the Rumanian Danube Plain and the Tisza Plain the soils with sodic salinization always occur under the influence of some ground waters to be found at small depth (0.8—3.5 m) and whose content in salt is, in general, over 1—1.5 g/l with predominance of sodium salts.

Under these conditions, the soils with sodic salinization occur as a result of an alternative salinization-desalinization process which is cyclically (yearly) repeated. The salinization process takes place either through the periodical uplift of the level of ground water table and of the capillary fringe in the soil profile either through the loss by evapotranspiration — during the dry season — of an important amount of water from the aquiferous layer or, as a rule the most frequently case, through both processes. The desalinization occurs through the descending of the level of ground water table, but particularly through leaching the salts by rainfall waters during the humid seasons.

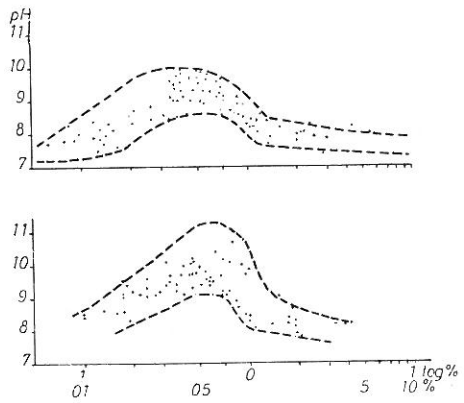

Fig. 4

Correlationship between the pH value and the salt content of soils. Above: in the upper part of the soil profile. Below: in the lower part of the soil profile

As a result of the salinization process, the accumulation of salts, already existing in the ground water, does occur. The desalinization through leaching by rainfall waters involves either the occurrence or growth of the proportion of soda due to the well-known GEDROITZ reaction. The formation of soda by means of the HILGARD reaction is a phenomenon of a minor importance. On the contrary, the occurrence of soda through the reduction of sulphides, especially, under the conditions of the Tisza Plain (where on large areas soils are developed from bog soils) shows a considerable widespreading (SZABOLCS [11]).

The development of the salt accumulation process within various geographical units of Rumania may be traced up in diagrams annexed, built up on semi-logarithmical scale. From the Fig. 4 it may be observed that in the upper part of the profile, the pH values are ranging from 7 to 8, at non-salinized soils, and that they increase noticeably for soils whose content in salts is over 0.1 per cent, reaching its maximum value

(pH $\approx$ 10) for a content in soluble salts of 0.4—0.6 per cent. A marked decreasing is then noticed namely as regards the contents in soluble salts exceeding 1—1.2 per cent; the pH values remain constant, ranging from 7.4 to 8.4. The same variation of the reaction may be also observed for the lower part of the profile, with the difference that the pH maxima values (which sometimes exceed 11) are noticed for a content in salts ranging from 0.5—0.8 per cent, whereas the constant values (pH 7.5—8.5) correspond to a more considerable salt content in soil i.e. 1.2—1.3 per cent. The zone with maxima pH values corresponds to the soil salinity interval where it is stated — as it results from the next diagrams — the maximum accumulation of alkaline carbonates and bicarbonates.

In the Tisza Plain and the Western Rumanian Danube Plain sodic and sulphatic-sodic soils predominate. Earth-alkaline bicarbonate relative contents, high in non-salinized or weakly salinized soils, decrease suddenly when the salinity of soils attains values of 0.1—0.2%. On the contrary, a strong increase of alkaline bicarbonates (including carbonates) which attains values exceeding 56—60 per cent from the total salts — at soil salinities of 0.4—0.5% is observable; furthermore, the relative content of alkaline bicarbonates strongly decreases, marking insignificant values at soil salinities over 1 per cent. The relative content of Na_2SO_4 presents, an accentuated increase, almost linear, concomitantly with the increase of salinity, becoming the dominant salt at soil salinities over 0.8 - 1 per cent. The sodium chloride is also encountered but in an insignificant proportion, about 10 per cent. As a rule, $CaSO_4$ is absent. A similar situation is also to be met with in the Eastern Rumanian Danube Plain, the region with a chloride-sulphate salinization (Fig. 5a). The single difference consists in a more reduced participation of Na_2SO_4 in the composition of salts, however compensated by the presence of $MgSO_4$, and at soil salinities exceeding 0.7—0.9 per cent, and by the presence of $CaSO_4$; a tendency of increasing the relative content in NaCl at high salinities of likewise to be noticed.

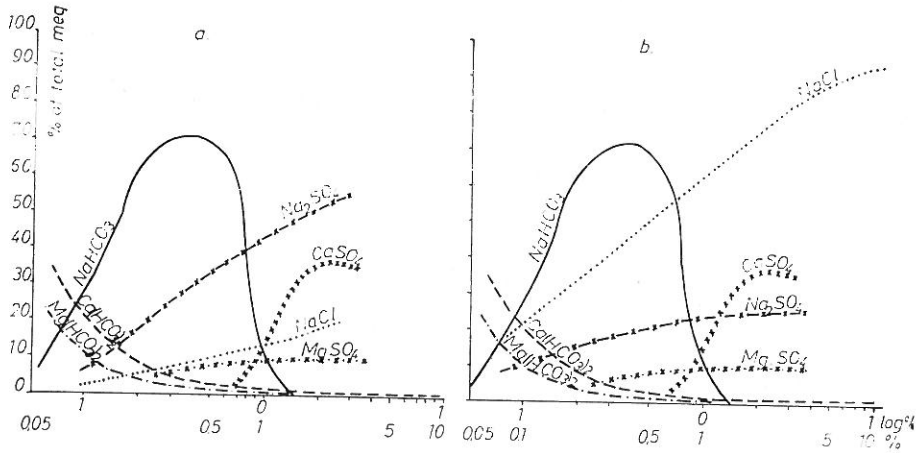

Fig. 5

Variation of the relative content in different salts as a function of their salinity in the soils from the Eastern Rumanian Danube Plain: a) chloride-sulphatic region and b) sulphatic-chloride region

Within the Eastern Rumanian Danube Plain, the region with a sulphate-chloride salinization (Fig. 5b), it has been stated that the place of Na_2SO_4 is taken by NaCl, so that it is the dominant salt at soil salinities exceeding 1—2 per cent.

A rather peculiar situation is to be noticed for residual and semi-residual sodic soils developed on sedimentary rocks rich in readily soluble salts or those formed under the influence of sources proceeding from such rocks. These soils may be encountered under various conditions of relief: slopes, summits, unflooded plains and even in humid zones (Moldavian Table-land, Transylvanian Table-land, Sub-Carpathians Bend). In the Fig. 6 the va-

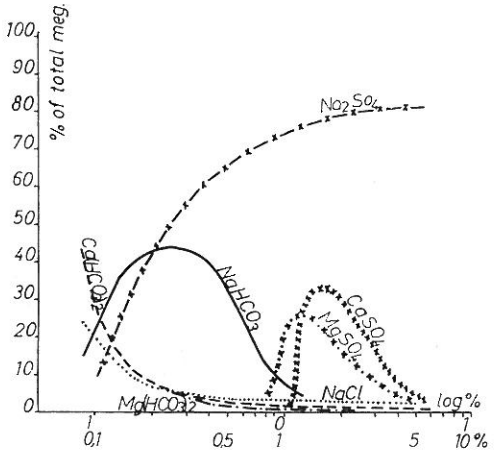

Fig. 6

Variation of the relative content in different salts as a function of their salinity in the soils from the Moldavian Table-land

riation of the salt content within such soils in the Moldavian Table-land where marls with sulphates occur, is shown. In case of non-salinized soils, the predominance of earth-alkaline bicarbonates, whose relative content decreases suddenly in salinized soils, is noticed. The relative content of alkaline carbonates and bicarbonates is considerably reduced as compared to previous regions, but their accumulation is extending according to the same range of salinity values. The most important salt is Na_2SO_4 whose relative content marks a rapid increase and becomes predominant even starting with the soil salinity 0.2—0.3 per cent; at high salinities the increase of Na_2SO_4 is diminishing. In the above soils, at salinities ranging from 0.8—5 per cent, $MgSO_4$ and $CaSO_4$ frequently occur. The relative content of NaCl is moderate in non-salinized soils and decreases considerably in salinized soils, fact that determines the character of clearcut sulphatic or sodic-sulphatic salinization of these soils.

As it may be observed from diagrams presented, the occurrence of soda in halomorphic soils is noticed only in salinities ranging from 0.1—0.8 (1.0) per cent. Thus, KOVDA's [7] assertion that the accumulation of soda represents the first salinization stage of soils is also confirmed for the Rumanian

territory. Likewise the salinity limit of 0.1 per cent established for the Rumanian territory between the non-salinized and salinized soils and that of about 1 per cent between chloride or sulphatic solonetzes and solonchaks are justified.

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