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Study of the soil-vegetation relationships of some chamaephytes in the southern landscape of Tlemcen (Oranie, Western Algeria)

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Abstract: Soil and plants are intimately linked and interdependent, since the availability and flux of soil resources, as well as the structure of the soil as a habitat, are important determinants of the identity and activity of living organisms, especially plants.
In this paper, we investigate the influence of the physicochemical composition of the soil of a steppe region on the abundance of some chamaephytes.
The physicochemical analysis of the soil shows that the soil of these halophyte-dominated formations is characterised by a sandy-silty texture and a particularly low organic matter content, resulting in a moderately low alkalinity but also a significant salinity. This reflects the fact that the study area belongs to an arid or semi-arid climate, where evaporation seems to prevail.
These edaphic conditions probably explain to a large extent the presence of halophytes, in particular Artemisia inculta, Atriplex halimus, Lygeum spartum, as well as the low abundance of accompanying vegetation, whose salts can considerably slow down or even inhibit the growth of young plants.

Keywords: salinity, steppe, phytoecology, chamaephytes, Artemisia inculta.

INTRODUCTION

At a more local scale and within a particular climatic type, soil properties (influenced in particular by the history of the site, its topography and the nature of the parent rock) and the disturbance regime are two of the main factors that determine the presence of species and plant communities [1].
However, environmental variables, in particular soil properties, act as filters that eliminate certain species in favour of others, depending on their ability to tolerate more or less unfavourable conditions for their growth and survival.
The migration and deposition of dissolved salts in water depends on the characteristics of the natural environment and precipitation. In arid and semi-arid regions [2], leaching and deep transport of dissolved salts cease and significant evapotranspiration promotes the concentration of salts in the soil.
The steppes of El Aricha are natural ecosystems where a continuous herbaceous vegetation coexists with a more or less discontinuous woody layer.
The flora of this region plays an important economic role in terms of pastoralism, especially for livestock, since the natural vegetation makes up most of the diet of domestic herbivores. However, overgrazing brings perennials to the ground and prevents the flowering and fruiting of palatable annuals, which are gradually replaced by commensal species of low nutritional value. Land clearance (in the case of Stipa tenacessima and Artemisia herba alba steppes) changes the physiognomy of the rangelands and exposes the soils to water and wind erosion [3].
In the area under consideration, the Saharan influence is manifested in the form of sandstorms in summer and autumn, while the Mediterranean influence is manifested in the form of an irregular rainfall regime [4]. The latter causes a long dry season of 6 to 8 months with rainfall of 150 to 300 mm, so that the Mediterranean characteristics disappear and the Saharan vegetation with chamaephytes appears in the El Aricha region.
This study allows us to highlight some of the characteristics of the steppe soils that allow the establishment of Amaranthaceae.
Overview of the El Aricha site
This station is characterised by the following Lambert coordinates
X = -1.22516 and Y=34.55180
The whole area, characterised by a sedimentary substratum inherited from the marine transgressions of the Secondary and Tertiary periods, would have experienced, towards the end of the Oligocene, a phase of extremely active orogenesis

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that led to the rise of the Saharan Atlas. At the end of the Tertiary, a phase of erosion led to the formation of the Jurassic forms and the filling of the depressions by continental deposits [5].
Following the work of Benabadji [6], Benest and Elmi [7] carried out in the region, two structural ensembles can be distinguished:The depression: characterised by Quaternary material of alluvial origin.
The mountain massifs: formed by fractured limestones, the rocks of these massifs rest on porous sandstones. These in turn rest on clays and marls.
The region has a semi-arid climate, with a moderate average annual temperature and low rainfall, which means that the El Aricha steppe is characterised by a lack of rainfall. The rainy season, which lasts from June to October, can be divided into two periods: a dry season of 7 to 8 months and a rainy season of 3 to 5 months.
The El Aricha steppe lies to the south-southwest of Tlemcen, with a slope of no more than 15%. This station shelters particularly abundant plant species, which are Artemisia inculta, Spartium junceum, Lepidium glastifolium, Mathiola tricuspidata.
The presence of Stipa tenacissima is less important. This species does not exceed 25 cm, with the presence of Phillyrea angustifolia, Ulex boivinii, thus testifying to a matorral-type vegetation; it has a coverage rate of 35%.

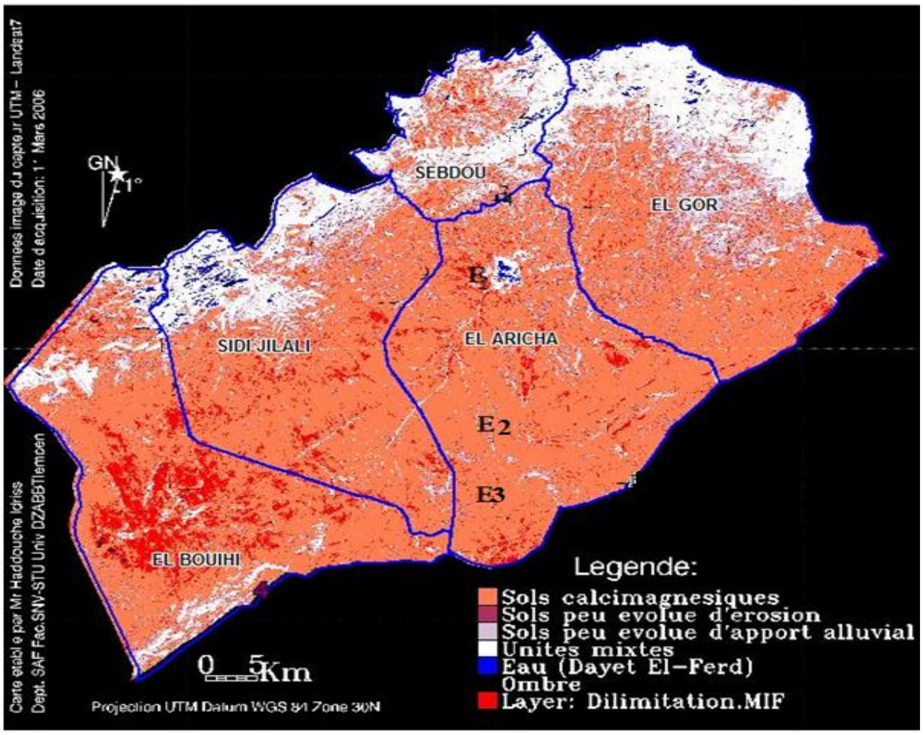

Figure 1: Location of study sites

METHODOLOGY
The pedological trenches were dug where there were homogeneous plant communities, where soil samples were taken at different depths, distributed over three profiles.Physical analyses such as the determination of soil texture (sand content, gravel content of the horizons and their depth) and chemical analyses were carried out for each profile in order to highlight the relationships between the underlying substrate and the halophytic vegetation

RESULTS

Table 1: Results of the analysis of soil profiles taken at 1240 m in the

	Profile I		Profile II		Profile III	
Horizon depth (cm)	0-3	3-32	0-2,5	2,5-40	0-2,5	2,5-38
Munsell colour	5YR 4/8	5YR 4/6	5YR 4/8	5YR 4/6	5YR 4/4	5YR 4/8
Grain size distribution						
Pebbles > 2mm	0	17	0	21	0	10
Coarse sands	4	28	16	34	10	27
Silts	50	28	48	25	52	32
Fine silt	24	30	17	23	21	20
Clays	22	14	19	18	17	21
	Organic matter					

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http://www.veterinaria.org
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OM	16,55	26,55	27,93	27,72	14,13	19,83
Humic acid/Fulvic acid	0,45	0,5	0,4	0,59	0,38	0,49
Q 4/6	3,64	5,07	4,32	4,7	5,1	4,9
C ‰	9,6	15,4	16,2	16,08	8,2	11,5
N ‰	0,6	0,62	0,62	0,5	0,44	0,76
C/N	16	24,8	26,13	32,16	18,64	15,13
	Mineral Reserves					
CaCO3 % P2O5	12,73	10	10,91	11,82	10	12,73
P2O5 ‰O	0,5	0,82	1,19	0,84	0,78	0,5
	Absorbent complex					
Ca meq/100g	18,8	21,6	23,8	22,2	18,8	23
Mg meq/100g	2,55	5	5,08	4,75	3,73	6,23
K meq/100g	0,75	0,92	1,2	0,99	0,61	0,85
Na meq/100g	3,1	3,8	2,9	1	2,4	6,4
S meq/100g	25,2	31,32	32,98	28,94	25,54	36,48
T meq/100g	6,4	10,2	9,2	7	4,8	14
Na/T meq/100g	0,48	0,37	0,3	0,14	0,5	0,46
Soil solutions						
pH	8,6	8,41	8,49	8,54	8,4	8,6
Conductivity µ,S/cm	126	275	529	123	115,4	132
SO4	0,218	0,132	0,304	0,177	0,181	0,271
Cl %	0,0142	0,0355	0,0781	0,0142	0,0142	0,0142

Classificatio Isohumic arid soils

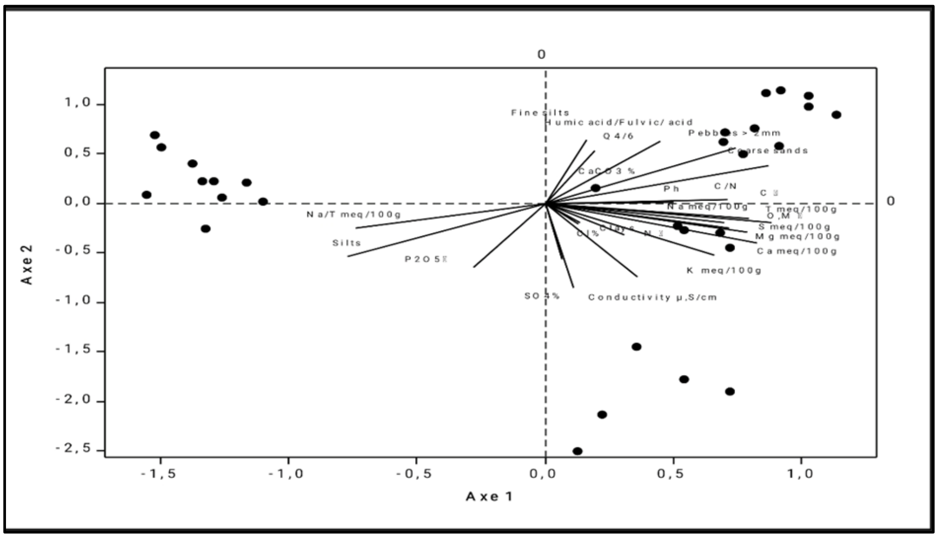

Figure 2: Principal component analysis (PCA) performed on the edaphic variables of three soil profiles located at an altitude of 1240 m in the El Aricha region.

Table 2:Results of the analysis of soil profiles located at an altitude of 1100 m in the El Aricha region.

	Profile I		**Profile II**		**Profile III**	
Horizon depth (cm)	0-4,5	4,5-25	0-4	4-33	0-3,5	3,5-41
Munsell colour	5YR 4/8	5YR 4/8	5YR 4/8	5YR 4/6	5YR 4/4	5YR 4/6
Grain size distribution						
Pebbles > 2mm	9	1	20	10	0	0
Coarse sands	5	10	25	13	44	21
Silts	20	20	23	25	28	30
Fine silt	52	46	36	43	17	28
Clays	23	24	16	19	11	21
	Organic matter					
OM	17,77	21,89	19,67	27,93	16,09	28,61
Humic acid/Fulvic acid	0,42	0,42	0,4	0,5	0,51	0,42

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Vol 25, No. 1 (2024)
http://www.veterinaria.org
Article Received: Revised: Accepted:

Q 4/6	4,5	4,04	4,27	4,62	4,1	4,18
C ‰	10,31	12,7	16,2	11,41	9,68	16,6
N ‰	1,49	1,33	0,89	0,38	0,5	0,68
C/N	6,92	9,55	18,2	12,96	19,36	24,41
	Mineral Reserves					
CaCO3 % P2O5	20	18,18	18,18	14,54	10,91	9,09
P2O5 ‰O	0,44	0,44	0,94	0,5	1,06	0,84
	Absorbent complex					
Ca meq/100g	22,4	22,2	30,4	26,8	19,6	18
Mg meq/100g	4,9	3,53	6	4,7	3,33	5,1
K meq/100g	0,95	1,35	0,23	1,26	1	0,96
Na meq/100g	2,7	2,55	1	4,2	1,2	2
S meq/100g	30,95	29,63	60,4	36,96	25,13	26,04
T meq/100g	7,4	15,8	17	16,4	6	2,8
Na/T meq/100g	0,36	0,16	0,06	0,26	0,2	0,71
Soil solutions						
pH	8,89	8,83	8,83	8,68	8,49	8,34
Conductivity µ,S/cm	125,2	140,5	103	104,2	208	122,9
SO4	0,16	0,214	0,152	0,156	0,164	0,247
Cl %	0,0142	0,0213	0,0142	0,0142	0,0355	0,0142

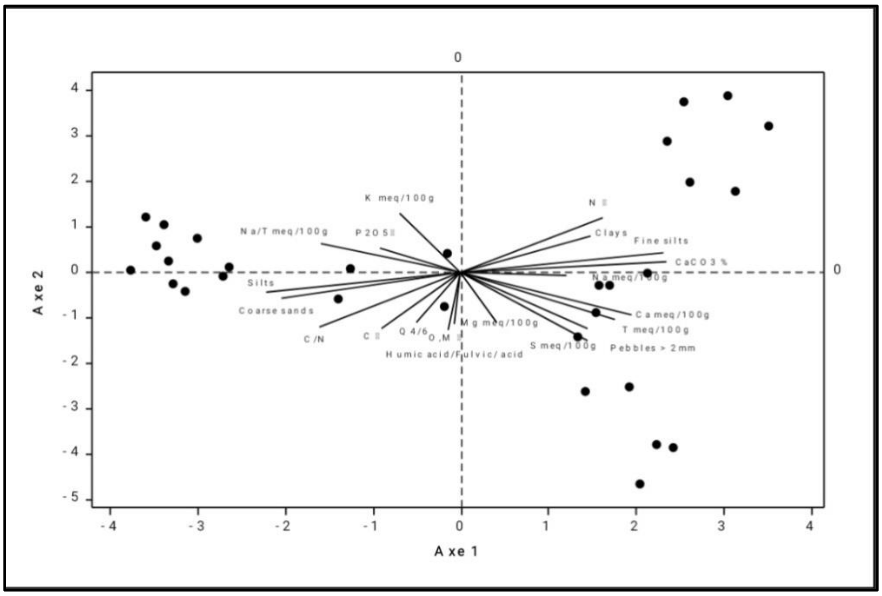

Figure 3:Principal component analysis (PCA) carried out on the edaphic variables of three soil profiles at 1100 m altitude in the El Aricha region.

The two figures show that the soil selects certain species according to their edaphic variables, of which an increase in NaCl content induces a richness of the environment in chamaephytes, especially Artemisia inculta.
Table I: The proportion of coarse sand increases with depth in the three profiles, from 4 to 34%.
Fine sand decreases in the lower horizons with a ratio between 52-25%.
The percentage of silt increases with depth and varies from 17 to 30%.
The percentage of clay varies from horizon to horizon and ranges from 14% to 22%.
Table II: Coarse sand decreases in profiles (II and III), except in profile I where its percentage varies between 5 and 44%.
The percentage of fine sand remains the same in the first profile and increases slightly in the other two, from 23 to 25% and from 28 to 30% respectively.
The silt values show an increase in profile 1 (52 to 46%) and a decrease in the other two (36 to 43% and 17 to 28%). Finally, clays increase with soil depth, with values varying between
11 to 24%.All the soils examined in the study area contain coarse elements, often in high quantities (14 to 27%). The clay content increases significantly in soils with Artemisia inculta, reaching 20 to 24%. The silt content varies

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considerably from one site to another (17 to 52%). This means that the soil texture of the chamaephytes in the study area is of the silty-sandy type: It is a permeable and light soil.

Chemical analysis:

Organic matter:

Table I:

Organic matter increases in profiles 1 and 2 (16.55 ‰ to 26.55 ‰). It remains constant in the horizons of profile 2. The value of the Q 4/6 ratio increases in the first two profiles (3.69 ‰ and 4.32 to 70 ‰). In the third profile we see the opposite phenomenon (from 5.10 to 4.90 ‰).

Nitrogen stabilises in profile 1, decreases slightly in the second profile (0.62-0.50 ‰) and increases in the last profile (0.44 to 0.76 ‰). The C/N percentage increases in the first two profiles (from 16 to 24.80 ‰ and from 26.13 to 32.16 ‰) and decreases in the third profile (18.64 to 15.13).

Table II: The organic matter content shows a decrease in the first two profiles (from 21.89 to 17.77 ‰ and from 27.93 to 19.67 ‰), on the other hand it shows the opposite in the last profile (16.09 to 28.61 ‰). The Q 4/6 values are less important, they are between 4.04 and 4.27 ‰, we can also observe slight variations from one horizon to another in the different profiles. The C/N ratio indicates instability (6.92 to 24.41).

Mineral reserves:

Table I: The percentage of calcium carbonate decreases with depth (12.73 to 10%). For phosphorus, there is an increase in the first profile (from 0.5 to 0.81 ‰) and a slight decrease in the other two (1.19 to 0.84 ‰ and from 0.78 to 0.5 ‰).

Table II: Limestone content decreases slightly in the three profiles (20 to 9.09%). Phosphorus is stable in the first profile and decreases in the other two profiles (from 1.06 to 0.5 ‰).

Absorbent complex

Table I:

- The increase in calcium content with depth in profiles 1 and 3 (18.80 to 21.6 and 18.80 to 23 meq/100g).
- The magnesium content is low in the second profile (5.08 to 4.75 meq/100g).
- The levels of potassium and sodium vary. The values vary: 0.61 to 1.2 meq/100g for potassium and 1 to 6.4 meq/100g for sodium.
- The cation exchange capacity decreases in profile II (from 9.2 to 7 meq/100g).

Table II:

- Calcium decreases from the first to the second horizon line in all profiles (30.40 to 18 meq/100 g).
- Magnesium increases with soil depth only in the third profile (from 3.33 to 5.10 meq/100g), whereas its proportions vary in the other profiles from 3.33 to 5.10 meq/100g.
- Potassium increases with depth (0.23 to 1.35 meq/100g) in the first two horizons, its rate seems to stabilise in the last profile (1 to 0.94 meq/100g).
- Sodium decreases in profile I (from 2.70 to 2.55 meq/100g) and increases with depth in the other profiles, with values oscillating between 4.20 and 5 meq/100g.

pH

Table I:

pH: it is alkaline, except for some variations that are not relevant from one horizon to another and from one profile to another.

Electrical conductivity:

NaCl values vary considerably with depth (from 115.4 to 529 ms/cm).

Sulphates:

They are low and decrease with depth in the first two profiles (from 0.304 to 0.132%). They increase in profile 3 (0.181 0.27%).

Chlorides: The percentage is low, it increases in profile 1 and decreases at the level of profile 2 (0.0142 to 0.0781%). This percentage remains constant in the last profile.

Table II:

pH:

It is alkaline and the variations are not significant from one horizon to another and from one profile to another (from 8.34 to 8.89).

Electrical conductivity:

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Vol 25, No. 1 (2024)
http://www.veterinaria.org
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The variations are not significant in the first two profiles. However, they are more important in the last profile (208 to 122.9 µs/cm).

Sulphates:

The ratio is low, we observe an increase with depth in profiles 1 and 2 (0.0160 to 0.247%).

Chlorides:

The ratio is low and varies slightly from one profile to another (from 0.0142 to 0.0355%).

INTERPRETATION AND DISCUSSION

Physical analyses

Granulometry

The results of the granulometric analysis show percentages between 56% and 70% of sands, a silt fraction that varies between 20% and 40%, and the finest clay fraction is less present in the soil, between 4% and 20%. Therefore, regardless of the station, there is no significant difference in the granulometry, which is sandy-silty.

Brady and Nyle [8] have demonstrated that saline soils have poor physical properties (high dispersion of organic colloids and minerals, poor permeability and low aeration), while Maury and Rivoire [9] state that: "The soil texture influences the rooting of plants, it is generally accepted that root growth is favoured by a coarse texture, as well as the amount of organic matter in the horizons depends on the age and grouping, but also on the abundance of coarse elements [10].

This affects the stability of the soil structure, where the influence of organic matter on structural stability has long been observed [11]. This is reflected in a positive correlation between the amount of water stable aggregates and the organic matter content.

EDAPHIC (ECOLOGICAL) PROFILE OF THE EL ARICHA I STATION

At this station the texture is silty-clayey to clayey, with particulate structures. Salinity, total limestone and pH hardly change compared to the first station. In fact, the species of the two stations generally coexist in the same way, with a herbaceous plant physiognomy. However, in addition to a significant reduction in the moisture spectrum. It only stabilises between profiles I and II.

This is also true for the structure.

EDAPHIC (ECOLOGICAL) PROFILE OF THE EL ARICHA II STATION

This station offers a rather limited ecological domain. Here the ecological profile reflects a certain requirement of the existing steppe grouping. Low percentages are recorded for the following parameters

- Electrical conductivity;
- Total limestone;
- Organic matter.

The pH is slightly alkaline, between 7 and 8.

The soil is silty-clayey to clayey, with a particle and lamellar structure.

CONCLUSIONS

Edaphic factors play a predominant role in the structure of communities from a taxonomic and functional point of view.

The edaphological results of the chamaephytes allow the following conclusions to be drawn

- Composed of a homogeneous texture throughout the depth of the profile.
- Low organic matter content, probably due to the lack of restoration of the organic elements of the vegetation in the soil.
- The quantities of sulphate, chloride, calcium, magnesium and sodium are low throughout the depth of the profile.

The surface of the profile is covered with a fragile raw film (a few millimetres wide) and has a low salinity index. At depth, the soils are brown, darker with a particulate structure. In all cases, the surface or nutrient horizon is made up of silt in which the clays have a compact lamellar structure.

Clay is often found between organic matter and texture. If the population is dense (60% of the cover), the compact layer reaches the lamellar horizon with the nutrient roots. If the population is diffuse, the surface horizon (1 to 3 cm) contains fine or very fine particles.

The flow causes deposition and granulometric distribution from upstream to downstream. The fine particles deposited in the cultivated areas form characteristic stratified deposits. These fine sediments seem to be favourable for the development of chamaephytes.

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