Spatio-Temporal Floristic Study Of The Saharan Rangelands Of South-East Algeria Case Of The Souf And Ouedrigh Regions

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Summary
The present work is a study of the floristic composition in the region of Souf and OuedRigh. It is carried out in four stations, according to the different geomorphological forms (Wadi beds, Reg, Erg, Dirty soils, Chott). The sampling of the flora revealed the existence of 26 spontaneous species belonging to 15 botanical families, of which 10 families are represented by only one species. AMARANTACEAE with 05 species, 19.23% of the total number of species, are the most represented family, followed by POACEAE with 4 species (15.38%), BRASSICACEAE with 03 species (11.53%) and ZYGOPHYLLACEAE and FABACEAE with 2 species (7.69%) each. According to the biological category, perennials have 19 species, and ephemeral 7 species, with; in the Erg 15 species (10 perennials, 5 ephemeral), the wadi beds 14 species (12 perennials, 2 ephemeral), the Reg 8 species (5 perennials, 3 ephemeral), the dirty soils 5 perennial species, and the chott4 perennial species.
The distribution of these species is different in space and time, remains heterogeneous and uneven from one biotope to another and from one season to another. The distribution of species is linked to the influence of several factors, namely: geomorphology, the variability of floristic associations, drought, salinity, humidity and the nature of the soil. They are grouped according to their ecological affinities.

Keywords: spatio-temporal, Saharanroutes, spontaneous flora, distribution, geomorphology.

Introduction

The Sahara, which occupies 10% of the surface of the African continent, is the largest hot desert in the world [1]. It is characterized by a high temperature, and a wind regime that results in hot and dry currents [2]. The Sahara occupies more than three quarters of the total surface of Algeria. The floristic cover of its northern part is characterized by a very irregular distribution of species [3], [4]. This unequal distribution is a function of the different geomorphological formations forming the 6 types of Saharan rangelands: wadi bed, depression, hamada, reg, sandy soils and salty soils [5]. The vegetation of the arid zones, and in particular that of the Sahara, is very sparse, with a generally bare and desolate aspect, the trees are as rare as they are scattered and the grasses only appear there during a very short period of the year, when conditions become favorable[6].
The Saharan flora appears to be very poor if we compare the small number of species that inhabit this desert to the enormity of the surface it covers [7]. On the other hand, we can say that the number of genera is relatively high, because it is common for a genus to be represented by a single species [8].According to Ozenda[7], the mode of adaptation to drought of Saharan plants makes it possible to differentiate between two categories of perennial and ephemeral plants.
Nevertheless very few recent studies have been made on the floristic diversity and their relationship with the physico-chemical characteristics of the geomorphological formations in the regions of souf and ouedrigh.
It is in this sense and to study the heterogeneous distribution of species and the effect of seasonal variations on the floristic behavior of the Saharan plant cover, that we conducted a spatio-temporal study on the different camel routes of the northern Algerian Sahara in the Souf and OuedRigh Region.

Material and methods

For the study of the distribution of spontaneous flora in the region of Souf and OuedRigh, seasonal sampling was carried out during the period from March 2021 to December 2021. The criteria for choosing the stations are based on the most important ecological factors. Discriminators of vegetation, in particular geomorphology and soil.

Study sites:
Our study site, located between the 5th and 8th degree of longitude E and between the 32nd and 34th degree of latitude N, is divided into two zones representative of the different camel routes (wadis beds, reg, sandy soils ,Chott and saline soils).
-Zone 1: located in Souf, presented by two stations Hamraia-Sif el menadi grouping 11 sub stations and ChottDiba grouping 03 sub stations in the beds of wadis, sandy soils and dirty soils.
- Zone 02: located at wadiRigh, presented by two stations, M'rara grouping 06 sub-stations and Lake ayata grouped 03 sub-stations, in the beds of wadis, the Regs and the Chott.

Sampling
Phytoecological surveys were carried out in parallel with the change in plant associations on the 23 substations. The survey is carried out using the subjective sampling method using the minimum area method (GOUNOT, 1969).
Some authors such as (GOUNOT, 1969) and (DJEBAILI, 1984) agree that the minimum area ranging from 60 to 100 m^2 is sufficiently representative in the Mediterranean formations, for the Saharan zones as is the case of the region of Souf and ouedRigh studies have shown that it is necessary to have much larger surfaces, starting with 100 m^2 (CHEHMA et al. 2005). The location of the study stations is shown in Figure 1.

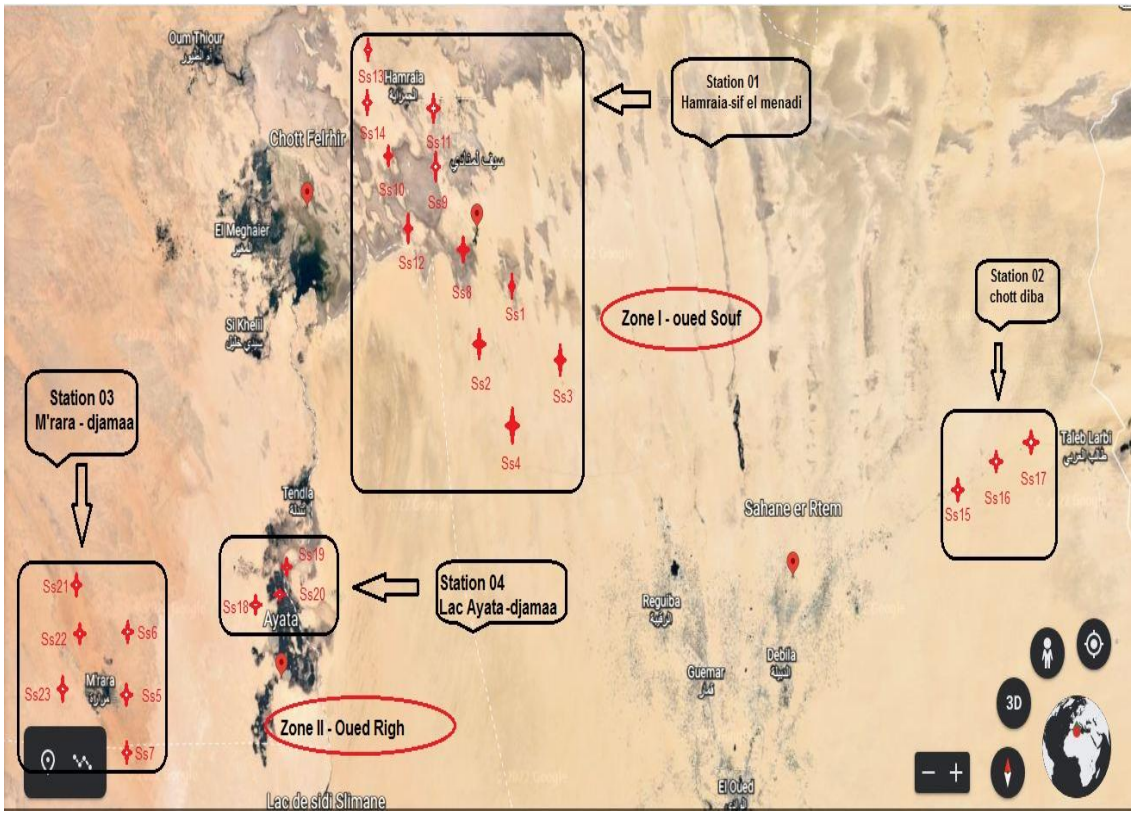

Figure 1.Geographical location of study areas.

Statistical analysis:
A statistical study was carried out by applying the Student Test (t-test) using the STATISTICA 8 software, the statistical analysis (Student Test) highlighting a significant difference between the floristic richness (number of species) in the different routes, the differences were considered statistically significant for ($p<0.05$), highly significant for ($p<0.01$) and very highly significant for ($p<0.001$).

Results and discussion:
1- Floristic study:
Inventory of the spontaneous flora of the study region:
The floristic inventories of the different study regions gave us a total of 26 plant species of which 27% are ephemeral and 73% are perennials. These species belong to 15 botanical families. 10 families are represented by only one species (Figure 2).

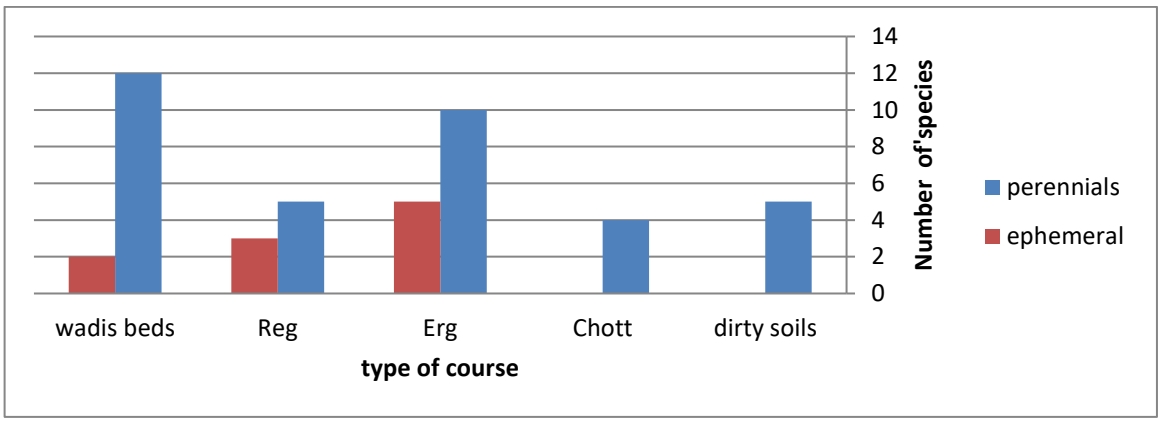

Figure 2.Distribution of species by biological category.

AMARANTACEAE with 05 species or 19.23% of the total number of species, are the most represented family, followed by POACEAE with 4 species (15.38%), BRASSICACEAE with 03 species (11.53%) and ZYGOPHYLLACEAE and FABACEAE with 2 species (7.69%) each. (Figure 3).

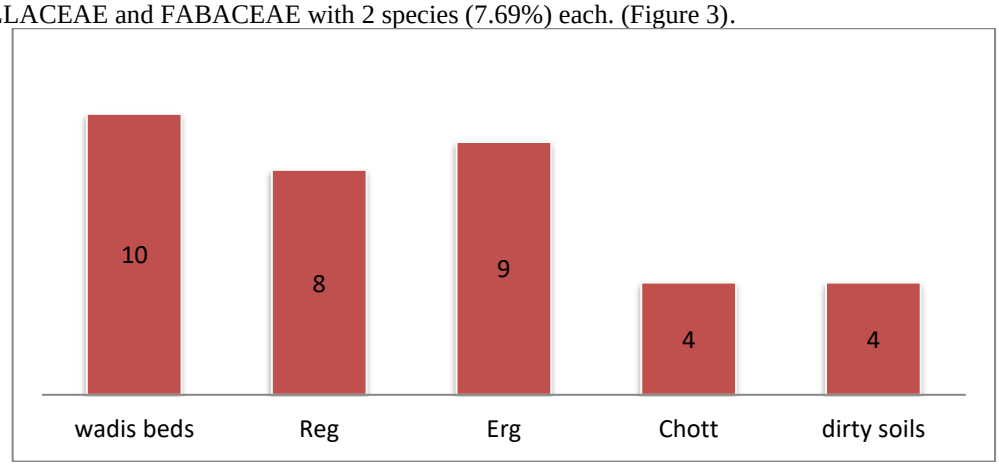

Figure 3. Number of families following the different routes.

2- Etude quantitative:

Temporal distribution: it should be noted that if the 19 listed perennial species are present throughout the year, the 07 mayflies are only partially present. Indeed, the surveys carried out show us that the largest number of species is observed in spring with 26 species (19 perennials and 7 ephemeral) During the other seasons the distribution is of the order of 24 species in winter (19 perennials and 5 achebs) , 22 species in autumn (19 perennials and 3 achebs) and 19 species in summer (19 perennials) (Figure 4). This inequality in the seasonal distribution of these species is directly linked to their mode of adaptation to drought [7] and their direct dependence on precipitation.

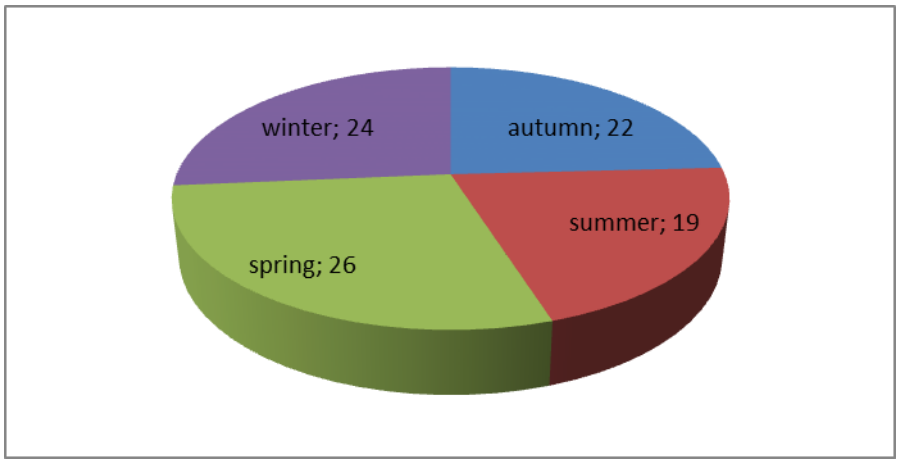

Figure 4.Temporal distribution of species.

Spatial distribution: the distribution of the species encountered varies according to the types of routes studied (Figure 5), so we have:

-The courses of sandy soils-Erg: are the richest and most diversified with the largest number of species (15 species), including 10 perennials and 5 ephemeral. This richness is due to the accumulation of water in winter [2], in this case, it is the psammophile species that settle by dominance because they have a developed root system capable of drawing water from deep.
-Wadi beds: relatively rich in species, where we have inventoried a total of 14 species divided into 12 perennials and 2 ephemeral. The richness and floristic diversity of wadi beds are essentially due to favorable soil conditions conducive to the development and maintenance of spontaneous vegetation [10]. Chehma et al 2005 report that wadi beds with rocky bottom are much richer than those with sandy bottoms.
-The Regs courses: where we were able to identify 8 species with 5 perennials and 3 ephemeral. This floristic richness seems very poor compared to the results found by Baameure, 2015, who noted 19 species in the Hassi ben abdellahreg[11], and the results found by Chehmaet al, 2005, by 12 species in the Reg route[3]. Ozenda, 1983 indicates that the vegetation of the Reg is loose and poor but on the contrary diversified and important[2].
-The salty soil courses: where we have inventoried only 5 perennial species. This richness is close to the results obtained by Baameure, 2015 who noted 07 perennial species in the sebkha of Bamendil[11], while Koull, 2013 showed the existence of 6 perennial species in the chotts of SidiSlimane, Chehma al, 2005 show that the plant communities of dirty soils are generally poor and characterized by the predominance of perennial species specially adapted to soil salinity.
-The Chott courses: which are the poorest, with only 4 perennial species. This inventory reflects a very poor diversity which is already known for arid regions (Ozenda, 1983).
Chenchoni (2012) indicated the existence of 13 species in Lake Ayata[13], while Koull (2013) showed the existence of 10 species in the same lake[12]. little diversified but well adapted to the unfavorable ecological conditions which reign on the soil (salinity) and the climate (drought)[13].

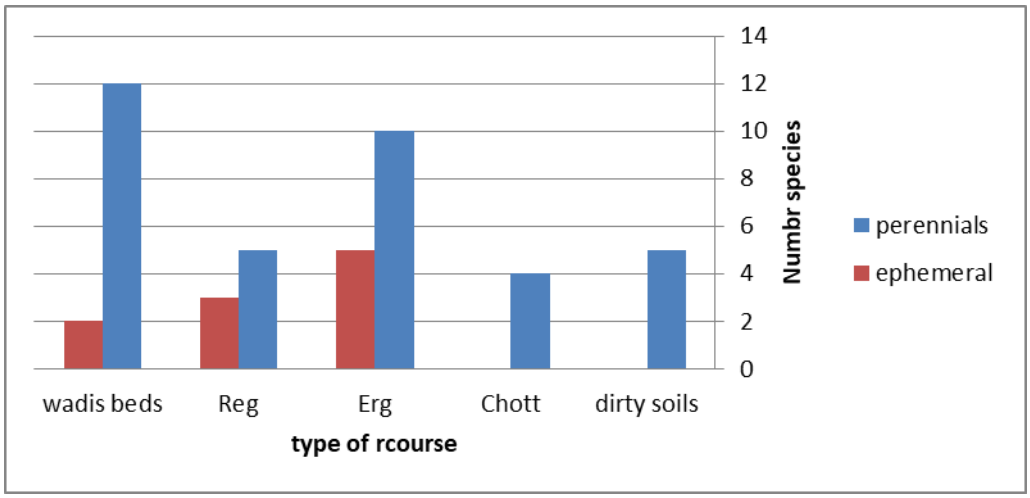

Figure 5. Number of species inventoried according to the different routes.

3. Relation floristic richness and type of course
-3.1: Classification test of homogeneous groups (LSD file):
The Homogeneous Groups Classification Test (LSD file) illustrates the presence of two heterogeneous groups (Table 1).
The first group groups the species in the rangeland into three homogeneous subgroups (Dirty soils, Reg, Chott) which characterizes the species with halophytic affinity.
while the second group makes it possible to group the species in the rangelands into three homogeneous subgroups (Wadi beds, Erg, Chott) which characterizes the species with hydrophyte affinity.

Table 1: Classification of homogeneous groups (LSD file).

Cell No	LSD test : variable nomberd'éspeces (Spreadsheet 1) Homogenous Groups . alpha = 05000 Error : Between MS = 3.5843 .df =18.000			
	Type du parcours	Nombre d'éspecesMean	1	2
5	Dirty soils	1.500000	***	
2	Reg	2.200000	***	
4	Chott	3.333333	***	***
3	Erg	5.200000		***
1	Wadi beds	5.250000		***

We noticed that the species presented in the Chott biotopes are found in the two heterogeneous groups, which confirms a positive correlation between them. We can say that the first group expresses an increasing gradient of salinity and humidity, on the other hand the second group expresses a decreasing gradient of salinity and increasing humidity. This correlation is based on two ecological factors, one is the geomorphological types and the other is the variability of the floristic associations.

- 3.3: Factorial analysis of correspondences:

The factorial analysis of species correspondences makes it possible to identify three phytoecological groups for the 4 study stations, divided into 8 sub-groups, the distribution of which is linked to the variation in geomorphological formation and soil humidity.(Figure 6)

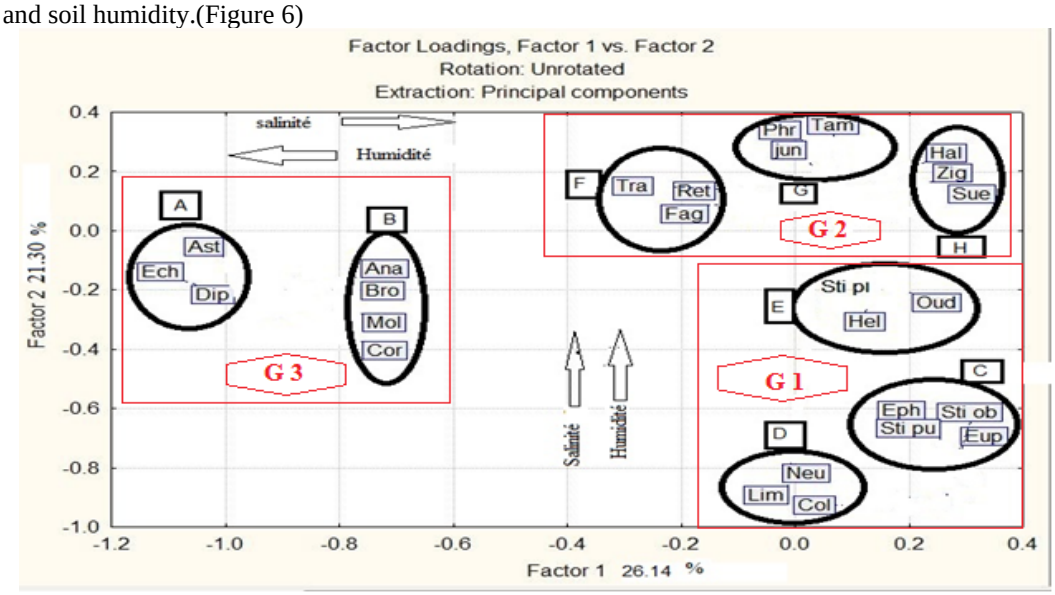

Figure 6: Representation on the factorial plane of the plant species of the different study stations

The first group includes the two subgroups *__C__* and *__E__* comprising the **psammophylous** species (Stipagrostisplumosa, Stipagorostispungens, Stipagorostisobtusa, Helianthemumlippii, Oudneyaafricana, Ephedra alata, Euphorbia guyoniana) of the species which characterize the geomorphological types **Erg**, The under group *__D__* comprised the species (Neuradaprocumbens, Limoniastrumguyonianum, Calligonumcomosum) which characterize the **Reg**.

a second group presents the *__H__* subgroup comprising the **halophyte** species (Halocnemumstrobilaceum, Zygophyllum album, Suedafructicosa). These species characterize **salty soils**, and a *__G__* subgroup includes species that grow in **salty and very humid soils** (immersed in water) (Tamarixgallica, Juncusmaritimus, Phragmitescommunis) which is characterized by **Chott**geomorphological types , and the *__F__* subgroup includes the **psammophylous** species (Traganumnudatum , Retamaraetam , Fagoniaglutinosa) which represent the types of **Erg**.

The third group which includes the *__A__* subgroup comprising the ephemeral species such as (Astragalusgyzensis, Echiumhumile and Diplotaxishara) which characterize the **Wadi Beds**, and the *__B__* subgroup comprising the **psammophylous** species (Anabasis articulata ,Brocchia-cotula , Malcomiaaegyptiaca , Cornulacamonacantha) which characterize **the sandy soil range Erg.**

We noticed that the axis factor 1: 26.14% expresses an increasing gradient of salinity and decreasing humidity, while on the second axis factor 2: 21.30% we noticed an increasing gradient of salinity and humidity.

The analysis of the results obtained makes it possible to show the existence of a positive correlation between the species (Stipagrostis plumosa, Stipagrostis pungens, Stipagrostis obtusa, Oudneya africana, Ephedra alata, Euphorbia guyoniana, Traganum nudatum, Retama raetam, Fagonia glutinosa Anabasis articulata, Brocchia-cotula , Malcomia aegyptiaca, Cornulaca monacantha) and **rangeland sandy soils**, and between species (Halocnemum strobilaceum , Zygophyllum album , Sueda fructicosa) and **dirty soils**, and between species (Tamarix gallica , Juncus maritimus, Phragmites communis, Astragalus gyzensis , Echium humile , Diplotaxis hara, Helianthemum lippii, Neurada procumbens ,Limoniastrum guyonianum, Calligonum comosum) and the **Chott and Wadis Beds**.

Conclusion:

The floristic surveys of the study area showed the existence of 26 species belonging to 15 botanical families, 27% ephemeral and 73% perennials, the richest courses are the sandy courses, then the wadi beds, reg , then dirty floors and chotts .

The distribution of these species in the study area is different from one site to another according to the types of rangelands and their salinity and humidity, **psammophylous** species and **sandy soil ranges**, and between **halophyte** species and **dirty soils**, and **hygrohalophyte** species and **chott, wadi beds**. The distribution and association of vegetation in the region of Souf and OuedRigh remains heterogeneous and uneven from one biotope to another and from

one season to another, and are essentially dependent on the availability of water , temperature, light, and the physico-chemical characteristics of the soil as well as the geomorphology, etc. This spatio-temporal variation essentially comes from the ability of the plant species to adapt to the edapho-climatic conditions specific to each habitat.

Numerical processing by factorial analysis of correspondences AFC allowed a global vision of the relations which exist between the biotopes and the spontaneous species, each species develops in its own environment, the variations of the floristic richnesses between the various species show fluctuations which result essentially from the nature of each biotope.

Through our study and result we can say that there is a real relationship between the distribution of vegetation and their "soil" support.

Nevertheless it should be noted that the inhospitable conditions of the Sahara have greatly limited the present study, for this purpose and to have a more complete idea of the spatio-temporal floristic study in the region of Souf and OuedRigh, it is essential to increase the number of surveys per region and per biotope, this amounts to increasing the number of stations to be sampled, the sampling period must be spread out to better understand the spatio-temporal distribution of spontaneous plants and to study plant associations.

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